RECLAMATION

Managing Water in the West

Southern Delivery System Final Environmental Impact Statement

Great Plains Region

U.S. Department of the Interior
Bureau of Reclamation
Eastern Colorado Area Office
Loveland, Colorado

December 2008

Mission Statements

The mission of the Department of the Interior is to protect and provide access to our Nation's natural and cultural heritage and honor our trust responsibilities to Indian Tribes and our commitments to island communities.

The mission of the Bureau of Reclamation is to manage, develop, and protect water and related resources in an environmentally and economically sound manner in the interest of the American public.

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Filing Number: FES 08-63

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Southern Delivery System
Final Environmental Impact Statement

Prepared by the U.S. Department of the Interior, Bureau of Reclamation

Cooperating Agencies:

- U.S. Army Corps of Engineers
- U.S. Bureau of Land Management
- U.S. Environmental Protection Agency
- U.S. Fish and Wildlife Service

Abstract:

This Final Environmental Impact Statement (FEIS) describes the effects of contracts with the U.S. Department of the Interior, Bureau of Reclamation that were requested by the City of Colorado Springs, City of Fountain, Security Water District, and Pueblo West Metropolitan District (collectively referred to as the Participants). The contracts would allow the development of a water supply project known as the Southern Delivery System (SDS) Project.

The purpose of the SDS Project is to provide a safe, reliable, and sustainable water supply for the Participants through the foreseeable future. The primary major federal action analyzed in the FEIS is the execution of up to 40-year contracts with the Bureau of Reclamation, for the use of Fryingpan-Arkansas Project (Fry-Ark Project) facilities. To operate the SDS Project, the Participants require contracts that provide for use of excess storage capacity in Pueblo Reservoir (part of the Fry-Ark Project), conveyance of water through facilities associated with Pueblo Reservoir, and exchange of water between Pueblo Reservoir and Fry-Ark Project reservoirs in the upper Arkansas River Basin.

The FEIS describes and analyzes the potential effects of seven SDS Project alternatives, including a no action alternative, on environmental and human resources in the upper Colorado River and Arkansas River basins in Colorado. A Draft Environmental Impact Statement (DEIS) was issued on February 29, 2008 and a Supplemental Information Report was issued on October 3, 2008. This FEIS reflects public comments on both the DEIS and Supplemental Information Report and has been prepared in compliance with the National Environmental Policy Act.

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Abbreviations and Acronyms

°C	Celsius
°F	Fahrenheit
ac	acres
ac-ft	acre-foot
ac-ft/yr	acre-feet per year
ACHP	Advisory Council on Historic Preservation
ADT	Average Daily Traffic
AFA	Air Force Academy
AHRA	Arkansas Headwaters Recreation Area
AIRFA	American Indian Religious Freedom Act
APE	Area of Potential Effect
Ark-Otero Diversion/Intake	Otero Intake on the Arkansas River
ARUCPS	Arkansas River Upstream of Confluence Pump Station
ARWNA	Arkansas River Water Needs Assessment
ASCE	American Society of Civil Engineers
ASTM	American Society of Testing Materials
AVC	Arkansas Valley Conduit
BASH	Bird Aircraft Strike Hazard
BBC	BBC Research and Consulting
BG	Block Group
BLM	U.S. Bureau of Land Management
BMP	best management practice
CCPA	Colorado Council of Professional Archaeologists
CDLE/OPS	Colorado Division of Labor and Employment Division of Oil and Public Safety
CDNIS	Colorado Natural Diversity Information System
CDNR	Colorado Department of Natural Resources
CDOLA	Colorado Department of Local Affairs
CDOT	Colorado Department of Transportation
CDOW	Colorado Division of Wildlife
CDP	census designated place
CDPHE	Colorado Department of Public Health and Environment
CDPOR	Colorado Division of Parks and Outdoor Recreation
CDPS	Colorado Discharge Permit System
CDSS	Colorado Decision Support System
CDWR	Colorado Division of Water Resources
CEC	Chadwick Ecological Consultants, Inc.
CEQ	Council on Environmental Quality

CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CF&I	Colorado Fuel and Iron Corporation
CFR	Code of Federal Regulation
cfs	cubic feet per second
CGS	Colorado Geological Survey
CL	centerline
CLG	Certified Local Governments
CLOMR	Conditional Letter of Map Revision
CMP	Construction Management Plan
CNHP	Colorado Natural Heritage Program
CO_2	carbon dioxide
Colorado Springs	City of Colorado Springs or Colorado Springs Utilities
Corps	U.S. Army Corps of Engineers
COS/Peterson	Colorado Springs Airport/Peterson Air Force Base
CP	Comprehensive Plan
CROA	Colorado River Outfitters Association
CSLB	Colorado State Land Board
CSP	Colorado State Parks
CSU	Colorado Springs Utilities
cutbow	cutthroat-rainbow
CWA	Clear Water Act
CWCB	Colorado Water Conservation Board
dB	decibels
dBA	decibels A scale
DBPS	Drainage Basin Planning Study
DEIS	Draft Environmental Impact Statement
DOI	U.S. Department of the Interior
E&H	Engineering and Hydrosystems
E. coli	*Escherichia coli*
EG	existing ground surface
EIS	Environmental Impact Statement
ELEV	elevation
EPA	U.S. Environmental Protection Agency
EPCDOT	El Paso County Department of Transportation
ERO	ERO Resources Corporation
ESA	Endangered Species Act
ET	evapotranspiration
FEIS	Final Environmental Impact Statement
FEMA	Federal Emergency Management Agency

FG	finished ground surface
FHWA	Federal Highway Administration
FMP	Flow Management Program
Fort Carson	U.S. Department of the Army Fort Carson Military Reservation
FONSI	Finding of No Significant Impact
Fountain	City of Fountain
Fry-Ark Project	Fryingpan-Arkansas Project
ft/d	feet per day
ft^2/1000 ft	square feet of Weighted Usable Area per 1,000 feet of stream
FVA	Fountain Valley Authority
GEI	GEI Consultants, Inc.
GHG	greenhouse gases
GIS	Geographic Information System
gpcd	gallons per capita-day
gpd	gallons per day
gpm	gallons per minute
GPS	Global Positioning System
Guidelines	EPA's 404(b)(1) Guidelines for discharge of dredge and fill material into wetlands and waters of the U.S. (40 CFR 230)
HARP	Historic Arkansas Riverwalk of Pueblo
HEAP	Home Efficiency Assistance Program
HEC-RAS	Hydrologic Engineering Center River Analysis System
HGM	Hydrogeomorphic
Homestake	Otero Homestake System
HRS	HRS Water Consultants
I-25	Interstate 25
IFIM	Instream Flow Incremental Methodology
IGA	Intergovernmental Agreement
IHA	indicators of hydrologic alteration
IPCC	Intergovernmental Panel of Climate Change
ITA	Indian Trust Assets
JD Phillips WRF	J.D. Phillips Water Reclamation Facility
km	kilometer
Kw	soil erodibility factor
lbs/ac	pounds (of fish) per acre
LDC	Land Development Consultants
LOMR	Letter of Map Revision
LVSWWTF	Las Vegas Street Wastewater Treatment Facility
MBTA	Migratory Bird Treaty Act
MCL	Maximum Contaminant Level
mg/L	milligrams per liter

mgd	million gallons per day
MIN	minimum
mL	milliliter
Montana Method	Montana Wetland Assessment Method
MW·h/d	megawatt hours per day
NAAQS	National Ambient Air Quality Standards
NAGPRA	Native American Graves Protection and Repatriation Act
NASS	National Agriculture Statistics Service
NAST	National Assessment Synthesis Team
NEPA	National Environmental Policy Act
NHPA	National Historic Preservation Act
NLCD	National Land Cover Data
NOI	Notice of Intent
NPC	Noise Pollution Clearinghouse
NRCS	Natural Resources Conservation Service
NRHP	National Register of Historic Places
OAHP	Office of Archaeology and Historic Preservation
P	probability of a flood value being equaled or exceeded in a given year
PA	Programmatic Agreement
PAC	Primary Activity Areas
PACOG	Pueblo Area Council of Governments
PBWW	Pueblo Board of Water Works
PCE	Primary Constituent Elements
PFMP	Pueblo Flow Management Program
PHABSIM	Physical Habitat Simulation Model
$PM_{2.5}$	Particulate Matter less than 2.5 microns in diameter
PM_{10}	Particulate Matter less than 10 microns in diameter
PMF	Probable Maximum Flood
Policy Plan	County-Wide Policy Plan
PPACG	Pike Peak Area Council of Governments
PPRBD	Pikes Peak Regional Building Department
Preble's	Preble's meadow jumping mouse
PSOP	Preferred Storage Options Plan
Pueblo West	Pueblo West Metropolitan District
PUMS	Public Use Microdata
PWMD	Pueblo West Metropolitan District
RCRA	Resource Conservation and Recovery Act
Reclamation	U.S. Bureau of Reclamation
ROD	Record of Decision
ROY	Restoration of Yield

S1	critically imperiled
S2	imperiled
SCADA	Supervisory Control and Data Acquisition
SDS	Southern Delivery System
SDWA	Safe Drinking Water Act
Security	Security Water District
SECWCD	Southeastern Colorado Water Conservancy District
SEO	Colorado State Engineer's Office
Service	U.S. Fish and Wildlife Service
SFE	Single Family Equivalents
SHPO	State Historic Preservation Officer
SMAD	Simulated Mean Annual Deliveries
SMAPD	Simulated Mean Annual Project Deliveries
sq mi	square mile
SWA	State Wildlife Areas
SWSI	Statewide Water Supply Initiative
T	recurrence interval
T3	Third Terrace
TCP	Traditional Cultural Property
TDS	total dissolved solids
TE&C	Threatened, Endangered and Candidate
TOPS	Trails, Open Space and Parks
TSI	Trophic State Index
TYP	typical
UAVFMP	Upper Arkansas Voluntary Flow Management Program
URS	URS Corporation
USC	United States Code
USDA	U.S. Division of Agriculture
USFS	U.S. Forest Service
USGS	U.S. Geological Survey
VCRA	Voluntary Cleanup and Redevelopment Act
VRM	Visual Resource Management System
WCRM	Western Cultural Resource Management, Inc.
WEG	Wind Erodibility Group
WMO	World Meteorological Organization
WQCD	Water Quality Control Division
WQA	Water Quality Assessment
WQS	Water Quality Standards
WSEL	Water Surface Elevation
WUA	Weighted Usable Area

WWSP	Winter Water Storage Program
WWTF	wastewater treatment facility
μg/L	micrograms per liter
μS/cm	microsiemens per centimeter

1.0 Purpose and Need

1.1 Introduction

The Southern Delivery System (SDS) Project is a proposed regional water delivery project designed to serve most or all future water needs through 2046 of the City of Colorado Springs, City of Fountain, Security Water District, and Pueblo West Metropolitan District (the "Participants"). As proposed, the SDS Project would deliver Fryingpan-Arkansas (Fry-Ark) Project water and non-Fry-Ark Project water from Pueblo Reservoir to the Participants for storage, treatment, and distribution to customers.

This Final Environmental Impact Statement (FEIS) for the SDS Project documents an analysis of the potential environmental consequences of contracts requested by the Participants. Environmental consequences are described within the FEIS study area, which encompasses portions of the Arkansas River and Upper Colorado River basins in Colorado.

Pueblo West is a conditional participant in SDS infrastructure. In an action unrelated to the SDS Project, the U.S. Department of the Interior, Bureau of Reclamation (Reclamation) approved in 2003 a special use permit for Pueblo West to construct a new water intake and pump station on the Arkansas River downstream of Pueblo Dam (Reclamation 2003). Pueblo West would participate in the proposed SDS infrastructure only if Reclamation selects an alternative that includes diverting water from facilities associated with Pueblo Reservoir. Pueblo West would construct its new water intake and pump station on the Arkansas River downstream of Pueblo Dam if Reclamation selects another alternative. Pueblo West has also requested storage in Pueblo Reservoir in all Action Alternatives.

1.1.1 Proposed Federal Action

Three interrelated federal actions by Reclamation are analyzed in this FEIS: entering into excess capacity contracts with the Participants for use of Fry-Ark facilities; issuance of a special use permit to connect to Fry-Ark facilities; and an "administrative swap" of Fountain Valley Authority (FVA) water associated with SDS Project deliveries.

1.1.1.1 Excess Capacity Contracts

The first federal action analyzed in this FEIS involves Reclamation entering into up-to-40-year contracts with the Project Participants for use of the Eastern Slope System of the Fry-Ark Project in Colorado. The Participants would need contracts with Reclamation that provide for use of Fry-Ark facilities by the SDS Project. The contracts could be for use of existing storage capacity in Pueblo Reservoir when this space is not filled with Fry-Ark Project water, conveyance of water through facilities associated with Pueblo Reservoir, and exchange of water between Pueblo Reservoir and Reclamation reservoirs in the upper Arkansas River Basin of Colorado. Pueblo Reservoir and all facilities associated with the Fry-Ark Project are owned by the United States and operated by Reclamation. The use of these facilities by entities other than Reclamation for water storage or conveyance requires a contract with Reclamation. Execution of up-to-40-year contracts for the use of Reclamation facilities is the major federal action analyzed in this FEIS. These contracts have been requested by the Participants and would allow the Participants to develop the SDS Project.

The authority for Reclamation to enter into long-term contracts for excess capacity is pursuant to the Reclamation Act of 1902, as amended and supplemented, Section 14 of the Reclamation Projects Act of 1939, and more specifically the Fry-Ark Project Act of August 16, 1962, as amended and supplemented. Reclamation has not yet entered into contract negotiations with the Participants. These negotiations will take place under a process separate from the National Environmental Policy Act (NEPA) process under which this FEIS was prepared.

The Fry-Ark Project was constructed and is operated and maintained as set forth in House Document Number 187, 83rd Congress; House Document Number 353, 86th Congress; House Document 130, 87th Congress; and as further modified and described in the description of the proposal contained in the Final Environmental Statement dated April 16, 1975. The Fry-Ark Project is a multipurpose project in Colorado that diverts water from the Colorado River Basin on the Western Slope and transports it through the Continental Divide to the Arkansas River Basin on the Eastern Slope. Through its authorizing legislation, the Fry-Ark Project provides supplemental water supplies for irrigation, municipal, domestic, and industrial uses. Additional authorized purposes of the Fry-Ark Project include generation and transmission of hydroelectrical power, and the conservation and development of fish and wildlife, recreation, and flood control.

Federal laws specific to Reclamation encompass numerous statutes relating to specific projects as well as those of general application. Two important laws related to the SDS Project are the Reclamation Projects Act of 1939 and the Fryingpan-Arkansas Project Act of 1962, which authorized the Fry-Ark Project. Section 14 of the Reclamation Projects Act of 1939 authorizes Reclamation to enter into contracts:

> *The Secretary [of the Interior] is further authorized, for the purpose of orderly and economical construction or operation and maintenance of any project, to enter into such contracts for exchange or replacement of water, water rights, or electric energy, or for the adjustment of water rights, as in his judgment are necessary and in the interests of the United States and the project.*

Reclamation will determine whether the proposed contracts meet the requirements of Section 14.

1.1.1.2 Special Use Permit or Agreement

The second federal action analyzed in this FEIS is issuance of a special use permit or other agreement from Reclamation to connect the SDS Project pipeline to Reclamation facilities. Pueblo West would continue to maintain its existing conveyance contract with Reclamation to use the joint use manifold from Pueblo Reservoir.

1.1.1.3 FVA Administrative Swap

A third federal action analyzed in this FEIS is the approval of an administrative trade ("swap") of an equal amount of capacity in the FVA pipeline for capacity in the SDS Project untreated water pipeline and water treatment plant. This trade would allow Fountain to use a portion of Colorado Springs' FVA capacity in trade for Colorado Springs' use of an equal amount of Fountain's capacity in the proposed SDS Project. Details of the FVA system and the proposed administrative swap are described in subsequent sections of the FEIS.

What the Proposed SDS Project Is and Is Not

The proposed project is:

- A regional water supply project
- A proposal by the Project Participants – Colorado Springs, Fountain, Security, and Pueblo West – in response to projected growth
- Funded entirely by the Project Participants through water rates and water development charges (or tap fees)
- A use of the Project Participants' existing water rights
- A use of excess capacity in existing Fry-Ark facilities on an as-available basis only

The proposed project is not:

- A federal proposal or undertaking, although it would require federal contracts and approvals
- Funded through federal, state, or local taxes
- A means of acquiring new water rights
- Competing with other water supply projects such as the proposed Arkansas Valley Conduit for storage or conveyance capacity

1.1.2 Federal Agency's Purpose and Need

The Project Participants have made a request to Reclamation to issue long-term excess capacity, conveyance, and exchange contracts for use of the Fry-Ark Project facilities. Reclamation needs to decide if the requested contracts will be approved.

1.1.3 Basic Project Purpose

The basic project purpose is to provide a safe, reliable, and sustainable water supply for the Participants through the foreseeable future.

1.1.4 Project Participants' Needs

The Project Participants have three needs that would be fulfilled by the proposed SDS Project. The basis of these needs is described in greater detail in Section 1.5 below. The Participants have the following needs:

- The Participants have a need to use developed and undeveloped water supplies to meet most or all projected future demands through 2046
- The Participants have a need to develop additional water storage, delivery, and treatment capacity to provide system redundancy
- The Participants have a need to perfect and deliver their existing Arkansas River Basin water rights

Each Participant is individually requesting a long-term excess capacity storage and/or exchange contract from Reclamation. Colorado Springs has requested 28,000 acre-feet (ac-ft) of storage annually and 10,000 ac-ft of contract exchange annually. Security has requested 1,500 ac-ft of storage annually. Fountain has requested up to 2,500 ac-ft of storage annually, and Pueblo West has requested 10,000 ac-ft of storage annually.

1.2 Lead and Cooperating Agencies

Reclamation is the lead agency for the federal action. It is responsible for environmental evaluation and preparation of this FEIS, and preparation of a Record of Decision (ROD).

Four cooperating agencies provided data, assisted in reviews, helped analyze effects, and contributed to this FEIS. Agencies were invited to be cooperating agencies if they had jurisdiction by law or special expertise with respect to the environmental effects of the proposed federal action. The cooperating agencies for this FEIS are:

- U.S. Army Corps of Engineers (Corps)
- U.S. Environmental Protection Agency (EPA)
- U.S. Bureau of Land Management (BLM)
- U.S. Fish and Wildlife Service (Service)

The Corps, EPA, and Service participated in one or more scoping meetings. All of the above agencies participated in meetings on alternatives development (Chapter 4) and provided comments on the Draft Environmental Impact Statement (DEIS).

1.3 Scope of this FEIS

This FEIS discloses the effects of the Participants' Proposed Action, a No Action Alternative, and a range of other reasonable alternatives. The FEIS considers direct, indirect, and cumulative effects that may result from the Participants' Proposed Action and each alternative. All actions connected to the Participants' Proposed Action and alternatives are evaluated. The FEIS also evaluates potential mitigation measures to avoid, minimize, or rectify identified environmental effects. Because up-to-40-year contracts are being considered and a Reclamation decision was originally anticipated in 2006, this FEIS considers potential effects through 2046. A decision by Reclamation was not possible by 2006. Consequently, the effects of contracts potentially extending through 2050 are summarized at the end of Chapter 3. This FEIS addresses public comments on the DEIS (Reclamation 2008a) and a Supplemental Information Report (Reclamation 2008b).

1.3.1 Organization of this FEIS

This chapter of the FEIS describes the purpose of and need for the SDS Project and the proposed federal action. The purpose and need of the proposed federal action is described in Section 1.1.2, and is in accordance with the Council on Environmental Quality (CEQ) regulations for implementing NEPA. Under the CEQ's regulations, an EIS "shall briefly specify the underlying purpose and need to which the agency is responding in proposing the alternatives including the proposed action" (40 CFR 1502.13). The purpose and need describes the goal or objective of the proposed federal action and why the proposed federal action is needed. The Participants' purpose and need is different from the federal purpose and need, and is described in more detail in Section 1.5.

Chapter 2 of this FEIS summarizes six Action Alternatives and a separate and distinct No Action Alternative for each Project Participant. Chapter 3 discusses the affected environment and discloses the potential environmental effects of the alternatives. Chapter 4 discusses consultation and coordination, Chapter 5 is a list of environmental commitments for Reclamation's Preferred Alternative, and Chapter 7 provides a list of FEIS preparers. Other Chapters and various appendices provide supplemental information pertaining largely to FEIS preparation.

1.3.2 NEPA Compliance

The analysis in this FEIS complies with NEPA, CEQ's regulations that implement NEPA (40 CFR 1500) and Reclamation's draft NEPA handbook (Reclamation 2000). Based on a review of the proposed project, Reclamation determined that the SDS Project is a major action that may significantly affect the environment.

A Clean Water Act Section 404 permit from the Corps may be necessary to construct the SDS Project. Section 404 permitting of any SDS Project alternative would be an independent process from Reclamation's NEPA compliance. The Participants have been and would continue to work with the Albuquerque District, Regulatory Division, of the Corps, to address Clean Water Act requirements, including compliance with EPA's 404(b)(1) Guidelines for discharge of dredge and fill material into wetlands and waters of the U.S. (40 CFR 230). Reclamation did, however, consider the Guidelines during alternatives development and analysis for this FEIS. The Participants submitted a draft 404(b)(1) showing (a technical analysis) to the Corps in October 2008. That document is available through Colorado Springs Utilities.

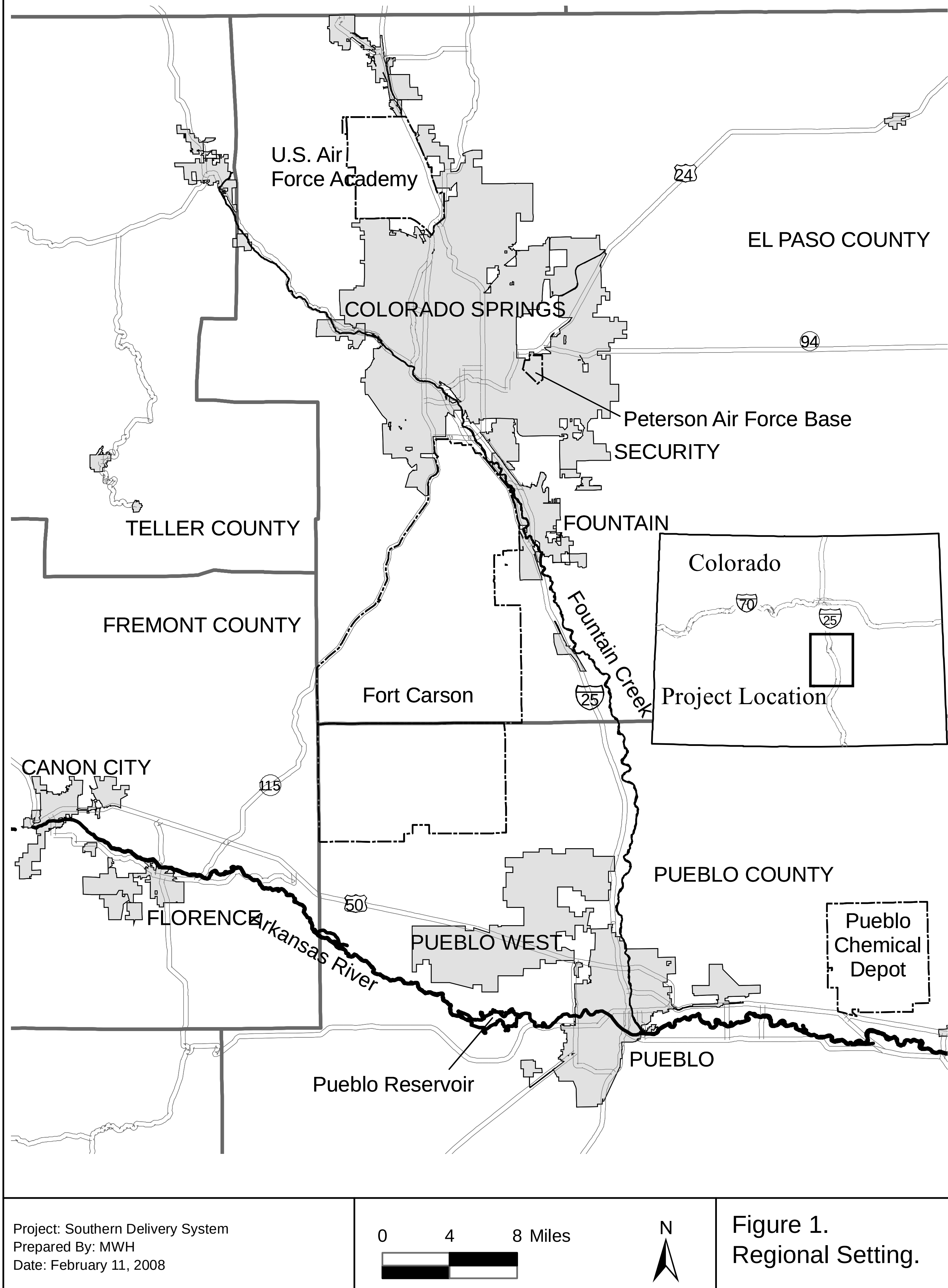
1.4 Project Setting

1.4.1 The Existing Fryingpan-Arkansas Project

The Fry-Ark Project was built between 1964 and the mid-1980s by Reclamation, and is a multipurpose transmountain water diversion and delivery project in southern and central Colorado. A "transmountain" system conveys water from one river basin to another, in this case across the Continental Divide. The United States owns and Reclamation operates all facilities associated with the Fry-Ark Project. The Fry-Ark Project makes possible an average annual diversion of 52,000 ac-ft of water from the Fryingpan River and other tributaries of the Roaring Fork River, on the Western Slope of the Rocky Mountains, to the Arkansas River Basin on the Eastern Slope (MWH 2005). Water diverted from the Western Slope, together with available water supplies in the Arkansas River Basin, provides an average annual water supply of 73,300 ac-ft for both municipal and industrial use and the supplemental irrigation of 280,600 acres in the Arkansas Valley (MWH 2005). Pueblo Dam and Reservoir, a large storage reservoir, is on the Arkansas River in Pueblo County about 6 miles upstream and west of the City of Pueblo (Figure 1). The Southeastern Colorado Water Conservancy District (SECWCD) is responsible for allocating Fry-Ark Project water and holds the associated water rights. In this FEIS, water used by the Fry-Ark Project is called Fry-Ark Project water.

Under contract with Reclamation, the FVA operates a pipeline that conveys Fry-Ark Project water from an outlet of Pueblo Dam to a water treatment plant about 17 miles southwest of Colorado Springs. The pipeline is west of Interstate 25 (I-25) and crosses the east side of U.S. Department of the Army's Fort Carson Military Reservation (Fort Carson). Colorado Springs, Fountain, Security, the Stratmoor Hills Water District, and the Widefield Water and Sanitation District are FVA participants.

The SECWCD entered into a contract with the federal government on January 21, 1965, in which the SECWCD agreed to pay a portion of the construction costs and the annual operation and maintenance costs of the Fry-Ark Project. Pursuant to the contract, the SECWCD agreed to pay $74,348,993 in reimbursable construction costs allocated to irrigation purposes and costs and $57,888,485 in reimbursable construction costs allocated to the municipal and industrial purposes. To pay those costs the SECWCD issues mill levies on taxpayers in the nine counties that are in the SECWCD. The citizens of El Paso County,



Project: Southern Delivery System
Prepared By: MWH
Date: February 11, 2008

Figure 1.
Regional Setting.

Filepath: [G:\GIS\Ch1\Regional_setting.mxd] where three of the SDS Project Participants are located, have paid approximately 73 percent of the tax revenues received by the SECWCD.

1.4.2 Participants' Proposed Action

The SDS Project is a proposed regional water delivery project designed to serve most or all Participants' future water needs through 2046. The Participants' Proposed Action would meet their purpose and need by providing additional yield and system redundancy, and by using the Participants' existing Arkansas River Basin water rights. As proposed, the SDS Project would deliver Fry-Ark Project water and non-Fry-Ark Project water from Pueblo Reservoir to the Participants' service areas. The Participants' Proposed Action would include construction and operation of the following components:

- Use of 42,000 ac-ft of existing excess storage capacity in Pueblo Reservoir if and when space is available
- Use of existing Reclamation pipeline and outlet structures below Pueblo Dam to connect to an untreated water pipeline
- Installation of 2,200 feet of 78-inch diameter pipeline capable of conveying 96 million gallons per day (mgd) and 1,100 feet of 72-inch diameter pipeline capable of conveying 78 mgd of untreated water
- Installation of a 160-foot long, 36-inch diameter pipeline capable of conveying 18 mgd of untreated water to the existing Pueblo West Pump Station
- Installation of a 53-mile long, 66- to 72-inch diameter pipeline and three pump stations capable of conveying 78 mgd of untreated water

Definitions

1 ac-ft equals 325,851 gallons.

Yield is water available from untreated water collection systems, expressed primarily in acre-feet per year (**ac-ft/yr**). Yield can vary depending on the demands in the service area and on the level of service assumed. Three project-related yield terms are discussed below.

Firm yield is the highest water demand that can be continuously fulfilled based on historical hydrologic conditions. The firm yield is the water demand fulfilled just prior to the level that produces system shortages.

Simulated Mean Annual Deliveries (SMAD) is the average annual amount of demand met by the untreated water collection, storage, and distribution system evaluated at a specific demand level. For the purposes of this FEIS, SMAD is always evaluated at a demand level equal to the 2046 demand from the Participants' Planning Demand Forecast.

Simulated Mean Annual Project Deliveries (SMAPD) is the average annual increase in the SMAD of the untreated water collection, storage, and distribution system due to the SDS Project. It is also always evaluated in this FEIS at a demand level equal to the 2046 demand from the Participants' Planning Demand Forecast.

Capacity is the amount of water that can be physically conveyed, treated, or stored.

Capacity for conveyance and treatment systems is expressed primarily in million gallons per day (**mgd**).

Capacity for storage is expressed primarily in acre-feet (**ac-ft**).

A **water right** is a right to use a portion of the public's water resources. A right to surface water is generally expressed in cubic feet per second (**cfs**).

- Construction of a 30,500-ac-ft local terminal storage reservoir to store untreated water
- Relocation of an electric transmission line and a liquid petroleum pipeline at the local terminal storage reservoir site
- Construction of a water treatment plant, with capacity to treat up to 109 mgd of

water, to provide potable water for municipal and industrial use

- Installation of transmission pipelines to convey treated water from the water treatment plant to local water distribution systems
- Construction of a 28,500-ac-ft return flow storage reservoir and an associated conveyance system to store Colorado Springs' reusable return flows
- Installation of a 5-mile long, 84-inch diameter buried pipeline capable of conveying 194 mgd of return flows west from Williams Creek Reservoir to Fountain Creek

In Colorado, water imported from one basin, such as the Fryingpan River and other tributaries of the Roaring Fork River, to another basin, such as the Arkansas River Basin, can be reused and successively used to extinction. In this FEIS, water that can be used multiple times is called "reusable return flows." Most of the water that would be diverted by the Participants' Proposed Action under typical operating conditions would consist of reusable return flows.

The primary means of delivering water to the SDS Project would be through an exchange. Exchanges have operated in Colorado and been managed by the State Engineer's Office since the 1890s as a means to fully use water supplies within the state (CDWR 2004). The basic concept of an exchange is that a water user may divert water at one location (that they would otherwise not be entitled to) as long as a like amount of water is returned to the stream at another location. This operation can be performed as long as no senior (i.e., older) water rights are injured. Exchanges are typically employed when an entity owns the right to use water that is physically downstream from the location where it wants to use the water. Additional information about exchanges and Colorado water law is presented in Appendix A.

1.5 Purpose and Need

1.5.1 Needs Associated with Projected Water Demands

1.5.1.1 Additional Yield

The SDS Project would provide the Participants with additional water, using existing water rights, to meet most or all of their projected future demand through 2046. The SDS Project would provide the Participants increased yield and simulated mean annual project deliveries (SMAPD). Total firm yield of the SDS Project would be 42,400 ac-ft, and total SMAPD would be 52,900 ac-ft (Table 1).

Firm yield and SMAPD for Colorado Springs is based on modeling using 1950 through 2003 historical hydrologic conditions and projected demands in 2046. Firm yield for other Participants is estimated based on each Participant's knowledge of its water rights. SMAPD is generally higher than firm yield because the amount of water available is higher during wet years.

Table 1. Project Yield for Each Participant.

Participant	Firm Yield (ac-ft/yr)	SMAPD (ac-ft/yr)
Colorado Springs	38,000	47,800
Fountain	2,500	2,500
Security	1,400	1,500
Pueblo West	500	1,100
Total	42,400	52,900

Source: MWH 2005 (Colorado Springs); Black & Veatch 2004 (Fountain); Harding 2004 (Security); Higgins 2005 (Pueblo West).

1.5.1.2 Future Water Demand of an Increasing Population

Each Participant is proposing to use the SDS Project to provide a safe, reliable water supply to meet the future water demand resulting from increased population and increased industrial use. Because Colorado Springs, Fountain, and Security are water providers in El Paso County, an estimate of the future population of the county provides a general indication of the likely future water demand for these Participants. Colorado Springs is the largest water provider in El Paso County.

The Colorado State Demography Office in the Colorado Department of Local Affairs (CDOLA) projects future population growth for all counties in Colorado, including El Paso County. Pikes Peak Area Council of Governments (PPACG), the Metropolitan Planning Organization for the area, consults with the Colorado State Demography Office during development of El Paso County projections and adopts the State Demography Office's forecasts. At the time of the most recent projections that included all Participants (2004-2005), the State Demography Office's projections anticipated that El Paso County would grow from its 2002 population of about 541,000 residents to about 800,000 residents by 2030 (Table 2). The projected average annual population growth rate for El Paso County through 2030 was 1.4 percent. The population forecast for El Paso County reflected a trend of adding about 100,000 residents each decade. The State Demography Office's projection indicated that, by 2030, El Paso County would be the most populous county in Colorado (CDOLA 2003).

If Colorado Springs continues to grow slightly slower than the county as a whole, Colorado Springs will have about 518,000 residents in 2030, according to Colorado Springs Utilities' projections (2005). This will be an increase of about 145,000 residents from the 2002 city population of 373,000 (Colorado Springs Utilities 2005). Municipal population forecasts (subdivisions of the CDOLA county-level forecast) produced by PPACG in 2004 anticipated a more dispersed growth pattern and a 2030 population in Colorado Springs of about 460,000 residents (PPACG 2004a). The PPACG small area forecast of 2004 does not reflect substantial changes in the overall El Paso County population forecasts by the State Demography Office since that time. PPACG is currently revising these forecasts as of 2008. The more up to date municipal population forecasts developed by Colorado Springs Utilities in 2005 were used for this FEIS.

Fountain, which has grown at a more rapid rate than El Paso County as a whole over the past decade, is expected to continue this growth pattern in the future. The 2004 population projections for Fountain anticipated a population of over 49,000 in 2030 and an average annual growth rate of 4.0 percent (Black & Veatch 2004; Crowleys Consulting 2004). The PPACG forecast for Fountain anticipates 35,000 residents in 2020 and just over 40,000 residents by 2030 (PPACG 2004a).

The population served by Security is expected to grow from a current population of 18,000 to about 26,900 by 2020. Security's projected 2020 population includes the proposed Waterview development, which would be served by Security (Security Water District and GMS, Inc. 2001).

Subsequent to the 2004-2005 projections, the Colorado State Demography Office has revised forecasts for El Paso County, and the City of Fountain updated the population projections for its water service area. The State Demography Office forecasts of El Paso County population now extend to 2035. These forecasts anticipate a county-wide population of about 935,500 in 2035 and are about 7 to 9 percent higher for the years between 2010 and 2030 than the previous forecasts shown in Table 2. Fountain's updated projections (Black & Veatch 2007) anticipate a water service area population of 59,400 in 2035 and are 7 to 15 percent higher from 2010 through 2030 than that city's previous forecast shown in Table 2. These revised, higher population growth projections were used for the modeling and analyses that were conducted for the FEIS.

Pueblo West is in Pueblo County and is anticipated to reach community buildout in 2018. Pueblo West expects a population of 47,000 people at build out and has sufficient water supplies to meet projected annual demand of about 10,600 ac-ft. The SDS Project would provide Pueblo West with water to meet projected peak-day demands through buildout.

Each Participant forecasted future water demand based primarily on future population

Table 2. Projected Future Population and Growth Rate of El Paso County and Participants.

Area	Population†				Average Annual Growth Rate 2000-2030
	2000	2010	2020	2030	
Colorado Springs	360,890	410,502	463,645	517,788	1.2%
Fountain	15,197	26,470	38,380	49,970	4.0%
Security‡	18,000	24,300	26,900	27,000	1.4%
Balance of County	122,842	144,030	170,341	204,260	1.7%
El Paso County	516,929	605,302	699,266	799,018	1.4%
Pueblo West§	16,853	33,443	47,205	47,205	3.5%

†Reflects the projections available from the State Demography Office and the Participants as of 2004-2005. Since that time, Fountain has issued a new projection, while the other Participants have not. This table continues to reflect the older projections because the consistent timeframe during which they were developed allows for more meaningful comparison of growth rates among areas. Fountains' most recent projections have been used in hydrologic and financial analyses elsewhere in this FEIS.

‡Reflects Security estimate of current population served and projected growth in water demand through 2022 and anticipated buildout in 2025. Includes proposed Waterview development.

§Reflects Pueblo West estimate of current population served and projected growth in water demand through anticipated buildout in 2018 from PWMD (2004).

Source: CDOLA 2003; Black & Veatch 2002; Black & Veatch 2004; Crowleys Consulting 2004; Security Water District and GMS, Inc. 2001; Colorado Springs Utilities 2005; PWMD 2004.

growth. Because of its size and system complexity, Colorado Springs uses more intricate forecasting methods than the other three Participants. To assist in planning for future demands, Colorado Springs developed two demand scenarios: the “revenue forecast” scenario and the “planning forecast” scenario (Figure 2). The revenue forecast is a median forecast with equal probability of being higher or lower than actual conditions. The planning forecast is used to ensure reliable water service and timing of major projects. The planning forecast is based on the revenue forecast. It represents a water demand forecast for which actual water demands will be at or below the forecast at least 95 percent of the time. The forecasts shown in Figure 2 were prepared in 2005; Colorado Springs updates the forecasts annually. Although the most recent forecast varies slightly from those shown in Figure 2, Reclamation determined the 2005 forecasts provide an adequate basis to assess the need for the project and to disclose environmental effects. A description of Colorado Springs’ forecasts is found in Appendix A.

The anticipated demand in 2046 for each Participant is presented in Table 3. Colorado Springs’ and Fountain’s anticipated future water demands in 2046 are based on an increased population within their respective service areas and other variables in their forecasts. The anticipated 2046 demands for Security and Pueblo West are based on the population anticipated within their respective

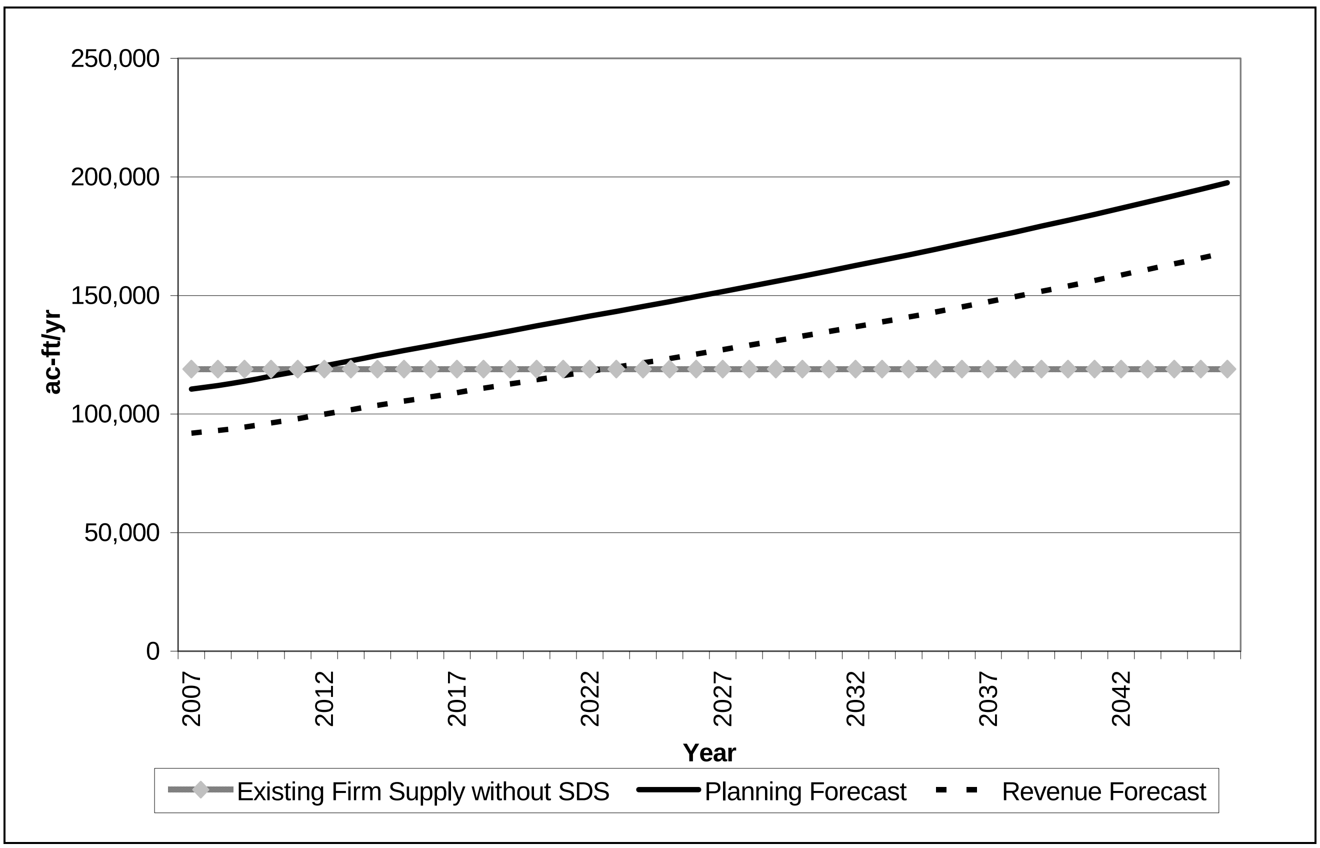


Figure 2. Colorado Springs’ Projected Future Water Demands.

Source: Colorado Springs Utilities 2005a.

Table 3. Participants' Existing Supplies, Future Water Demand, and Anticipated Yield from the Participants' Proposed Action.

Participant	2046 Planning Demand (ac-ft)	Firm Yield (ac-ft)				SMAD (ac-ft)			
		Existing Supplies	SDS Project Yield	Supplies with SDS Project	2046 Unmet Demand with SDS	Existing Supplies	SDS Project SMAPD	Supplies with SDS Project	2046 Unmet Demand with SDS
Colorado Springs	197,500	119,000	38,000	157,000	40,500	132,200	47,800	180,000	17,500
Fountain	13,200	5,500	2,500	8,000	5,200	6,700	2,500	9,200	4,000
Security	6,500	4,000	1,400	5,400	1,100	4,000	1,500	5,500	1,000
Pueblo West	10,600	5,900	500	6,400	4,200	10,800	1,100	11,900	0

All values have been rounded to nearest 100 ac-ft.

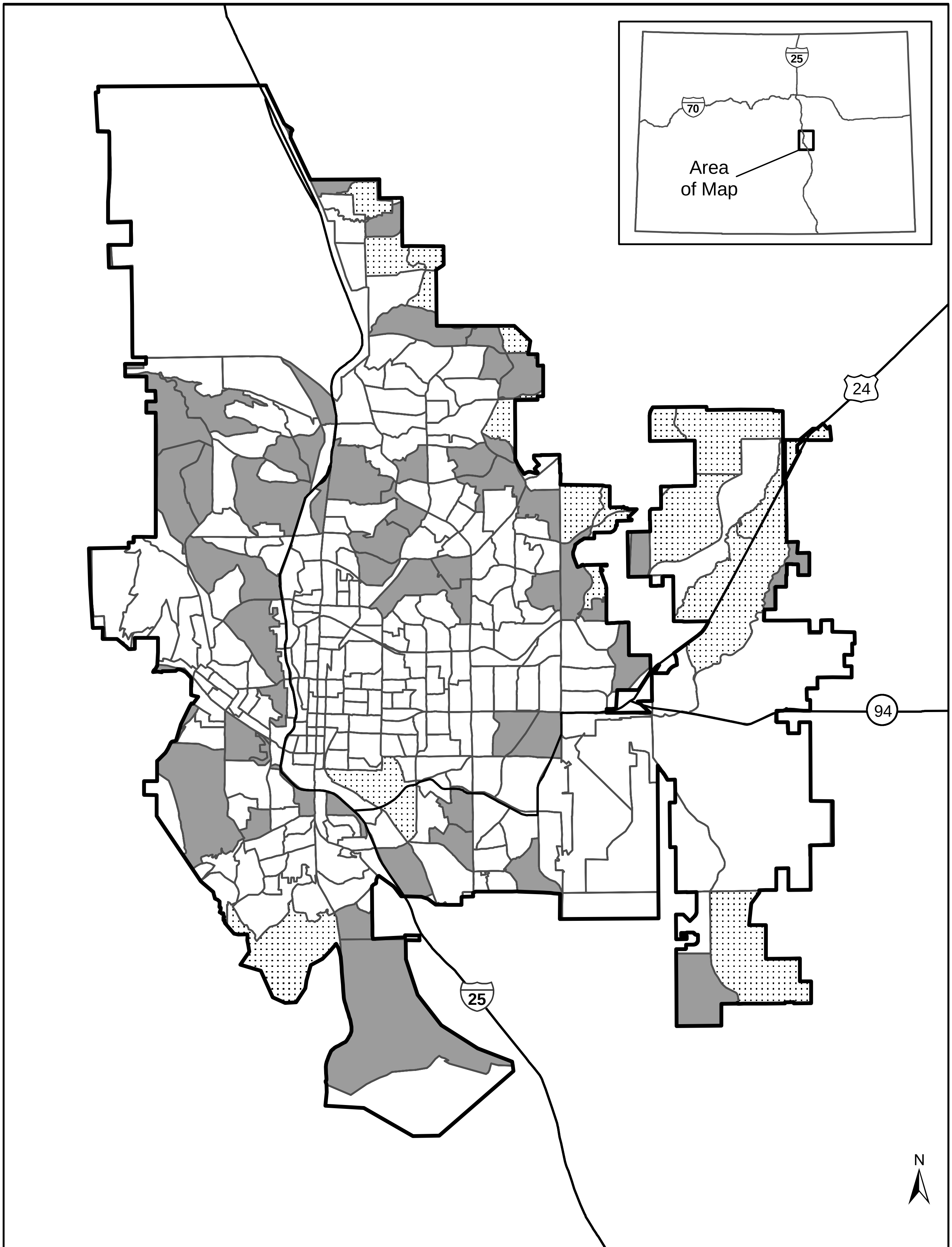
service areas when buildout is complete and no future growth is anticipated. Table 3 also presents each Participant's existing firm yield and SMAD and the firm yield and SMAPD expected from the SDS Project. For each of the Participants, the SDS Project would not meet all future demands. The Participants' unmet demand in 2046 would be met by Participant-specific combinations of undetermined water projects, reuse, and water conservation.

A more comprehensive description of each Participant's existing water supplies and delivery systems, methods used to forecast demand, and existing and future conservation measures is found in Section 2.4.1.

1.5.1.3 Distribution of Future Population Growth

The PPACG allocates the State Demography Office's population forecast to small geographical areas, called traffic analysis zones. PPACG, El Paso County, and the Colorado Department of Transportation use these projections to assess future transportation requirements. A traffic analysis zone is an area defined by state and/or local transportation officials for traffic modeling and is based on census tracts. Although the boundaries of the traffic analysis zones do not correspond directly to Colorado Springs' water service area, they provide a reasonable estimate of where Colorado Springs' future population growth is expected to occur. Colorado Springs uses PPACG's traffic zone population allocation to plan its water distribution system. Total distribution system average and maximum day demands are calibrated to the overall system forecast so that they are consistent from both the bottom up (population) and top down (demand). PPACG predicts most of the future population growth in Colorado Springs' service area will occur on the east side of the service area (Figure 3). Most of the projected growth around the perimeter of Colorado Springs would be new residential and associated commercial development.

Because of the anticipated location of future population growth, Colorado Springs has a need for additional water supplies, treatment, and delivery facilities on the east side of its service area. Locating new facilities in this



Project: Southern Delivery System
Prepared By: ERO Resources Corp.
Source: PPACG 2004
Date: August 25, 2005

Traffic Analysis Zone

Population Change

0 - 200 (5% of growth)

200 - 2000 (35% of growth)

> 2000 (60% of growth)

0 1.5 3 Miles

Scale 1 Inch = 3 miles

Figure 3. Projected Location of Colorado Springs' Future Population Growth.

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area will minimize local social and environmental impacts by minimizing the need to build treated water distribution lines through more populated and developed sections of Colorado Springs.

Cost is another reason to locate new facilities on the eastern side of the service area. Colorado Springs is sizing the water treatment plant to be capable of delivering up to 109 mgd of treated water (peak water demand in 2046) to the Participants in El Paso County. From the terminal storage reservoir, pipelines and pumps delivering water to and from the treatment plant need to be sized to deliver up to 180 mgd (anticipated demand at buildout, which would occur after 2046). The terminal storage reservoir collects water at the constant average daily demand level, stores it, and delivers water at the peak demand level, which fluctuates. Pipelines and pumps delivering water from the terminal storage reservoir and water treatment plant need to be sized to deliver the future peak water demand. If terminal storage is located near the water treatment facility, the amount of pipeline sized to 180 mgd is minimized. Pumping 180 mgd of treated water uses considerably more energy and is more expensive than pumping 49 mgd (daily average) of untreated water. For these reasons, Colorado Springs needs new facilities on the east side of its service area.

1.5.2 Needs Associated with Redundancy

One of the most significant concerns facing water providers across the Nation is aging infrastructure (ASCE 2005). The Participants' major water delivery systems range in age from about 20 to 50 years old.

Except for Pueblo West, the Participants are not located on a major river system; as a result, the Participants rely on major pipeline delivery systems for most of their drinking water supply. This is unique among Colorado's Front Range communities and places additional vulnerability on the Participants that is not experienced by other Front Range water providers. This vulnerability due to potential loss of water supply is derived from aging infrastructure, the need for major maintenance activities, unplanned outages from system failures, and future pipeline replacement. Redundancy is needed to reduce these risks and provide greater overall service reliability. Each Participant's need for redundancy is somewhat different from the others' needs and is described below. The SDS Project would provide additional delivery capacity and system redundancy.

1.5.2.1 Colorado Springs

Colorado Springs is the state's second largest city and imports a majority of its water supplies. The following describes existing facilities used to deliver water from these sources to customers.

Delivery Systems

Colorado Springs' delivery of treated water to its customers is limited by its existing untreated water delivery systems. Colorado Springs' existing delivery systems provide 119,000 ac-ft/yr of firm yield and 132,200 ac-ft/yr of SMAD (Table 3). Each delivery system and its limitations are described in Appendix A.

Three pipeline systems, the Blue River Pipeline, the Homestake (Otero) Pipeline, and the FVA Pipeline, provide about 65 percent of the total firm yield for Colorado Springs (Figure 4). The Blue River Pipeline, a 30-inch pipeline from Montgomery Reservoir to the north slope of Pikes Peak, was built in the 1950s. The Homestake Pipeline from Twin Lakes to Rampart Reservoir was built in the 1960s. The FVA Pipeline from Pueblo

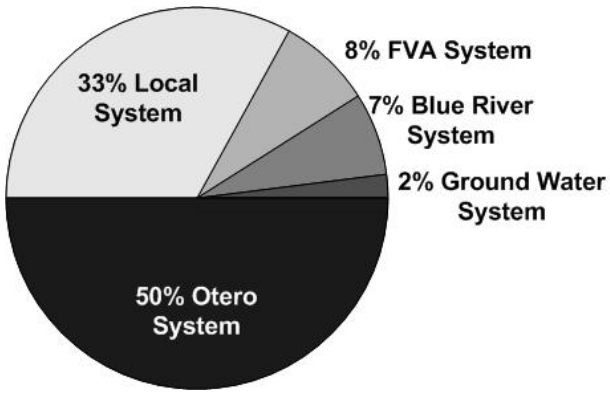

Figure 4. Colorado Springs' Existing Delivery Systems, Percent of Total Firm Yield.

Source: Calculated from Table A-1 of Appendix A.

Reservoir to the Fountain Valley Water Treatment Plant was built in the 1970s and 1980s.

Historically, these systems have been shut down for extended periods for both planned and unplanned reasons. In 1990, the Homestake Pipeline was unexpectedly shut down for 6 months due to a major switchgear failure resulting in a fire at the Otero Pump Station. The pipeline was shut down for 2 months in 1999 and 2003 for planned and unplanned events. The system was shut down for 1 month in 1999 to perform inspection of about 5 miles of pipeline and repair of air vacuum valve nozzles. The system was shut down for a month in 2002 to support construction projects. The system was shut down for a month in 2003 during the fall for repairs necessitated by a lightning strike on the pipeline. Between 1986 and 1999, the system has been shut down for one week each on seven different occasions for repair of leaking joints.

The FVA also has experienced unexpected shutdowns. In 1986, 2 miles of pipe required replacement due to a thunderstorm-caused landslide; the pipeline did not operate for nine months. Another similar washout in 1999 shut down the pipeline for 13 months while 5 miles of pipeline were replaced. Colorado Springs made major repairs to the Homestake Pipeline's Goddard Tunnel in 2006; this is an example of a routine repair. As these systems continue to age, planned and unplanned shutdowns will become more frequent.

One way to assess the need for redundancy is to evaluate the effect on overall system delivery capacity under a scenario where one of the existing systems is not operating due to regular maintenance or unanticipated repair. For Colorado Springs, the worst case would be for the Homestake System to be down. Without the Homestake System operating, Colorado Springs would lose 50 percent of its firm yield. As demand grows, the reliance on one conveyance system for delivery capacity of 50 percent of Colorado Springs' water supply would pose an unacceptable risk. Colorado Springs needs another major delivery system to provide delivery system redundancy.

Local Terminal Storage

Another way Colorado Springs evaluates system vulnerability is to compare average daily demand to local terminal storage capacity. During a delivery system outage, water demands for the affected system are met through withdrawals from local terminal storage. Colorado Springs has about 60,200 ac-ft of local terminal storage. By assuming no transmission of untreated water into local terminal storage, the role of local terminal storage in meeting projected water demands can be isolated. This analysis shows how many days the average daily water demand can be met using only what is available in local terminal storage. For example, without the SDS Project and with aggregate local terminal storage 100 percent full, local terminal storage could meet current demand for about 289 days and 2046 demand for about 131 days. With the SDS Project, local terminal storage would increase after construction of the proposed local terminal storage reservoir in 2018 (proposed completion date). With the proposed additional terminal storage, local terminal storage would increase by about 50 percent. This would provide approximately 191 days of average daily demand in 2046 in local terminal storage.

In the 2002 drought, local terminal storage decreased to 29 percent of capacity. If a similar drought were to happen in 2046, without proposed local terminal storage, about 17,500 ac-ft would be in local terminal storage, which would meet average daily demand for about 38 days. Colorado Springs needs the SDS Project to provide additional local terminal storage to provide redundancy to its existing local terminal storage reservoirs.

Treatment

Colorado Springs' total sustained treatment capacity is currently 205 mgd. About 146 mgd of this capacity is provided through the Pine Valley (84 mgd) and McCullough (62 mgd) treatment facilities, which rely primarily on the Homestake System as their source of untreated water supply. If the Pine Valley Water Treatment Plant were not operational due to planned or unplanned outages, 41 percent of Colorado Springs' treatment capacity would be unavailable. If the McCullough Water Treatment Plant were not operational due to planned or unplanned outages, 30 percent of Colorado Springs' treatment capacity would be unavailable.

As demand grows, the reliance on two water treatment plants for production of 71 percent of Colorado Springs' water supply would pose an unacceptable risk to Colorado Springs. The proposed water treatment plant would have an initial treatment capacity of 50 mgd, expandable up to 109 mgd to provide treatment capacity redundancy to the existing system as well as capacity to SDS Participants.

Treated Water Transmission and Distribution

The SDS Project would provide redundancy and reliability to Colorado Springs' treated water transmission and distribution system. Currently, about 70 percent of the City's water is treated at the Pine Valley and McCullough treatment facilities. Treated water from these facilities is conveyed through three pipelines, the most important of which is the East Loop Transmission Main. This main supplies water to nearly one-third of Colorado Springs. If this main were not operational due to a planned or unplanned outage, only 35 percent of average summer day demands could be met for the northern and eastern portions of Colorado Springs. Such an event could compromise flow of water for fire fighting in these areas. With the SDS Project, 80 to 90 percent of average summer day demands would be met in these areas, providing fire flow protection to these areas.

1.5.2.2 Fountain

Fountain relies on two water systems for its water supply. The Fountain Creek Alluvial Wellfield provides about 25 percent of Fountain's water supply; the FVA Pipeline provides the remaining 75 percent. The significant repairs required over the past 20 years on the FVA Pipeline were discussed previously. As demand grows, reliance on these existing delivery systems for Fountain's water supply poses an unacceptable risk to Fountain. Fountain needs additional delivery system redundancy. Fountain anticipates meeting this need through development of local ground water supplies independent of the SDS Project.

1.5.2.3 Security Water District

Like Fountain, Security relies primarily on two water systems for its water supply. The Widefield Aquifer provides 50 percent of Security's water supply and the FVA Pipeline provides 37 percent. A contract with Colorado Springs that expires in 2012 provides the remainder of Security's supply. Security has entered into a lease of an additional Widefield Aquifer allocation beginning in 2012 to replace water leased from Colorado Springs.

In 1987, the Widefield Aquifer was contaminated with tetrachloroethene, a carcinogenic compound used as a degreaser. The contamination originated at a facility owned by the Schlage Lock Company. Schlage Lock is currently cleaning up the contamination under oversight by the Colorado Department of Public Health and Environment (CDPHE). Affected Security wells were either shut down, or water treatment systems were installed to remove the contamination. The contamination highlighted one of the risks associated with Security's reliance on a shallow aquifer for half of its water supply. The reliance on two delivery systems for most of Security's water supply poses an unacceptable risk to Security. Security needs another major delivery system to provide delivery system redundancy. All Action Alternatives would provide redundancy to Security through an interconnection with Colorado Springs' treated water distribution system (Section 2.2.2.1).

1.5.2.4 Pueblo West

Pueblo West relies solely on one water system – surface water from Pueblo Dam and the Arkansas River – for its water supply. Pueblo West historically relied on ground water wells to provide its water supply, but these wells are now used primarily for exchange purposes and can be used for supplemental irrigation and emergency potable water. In the event of a system outage, Pueblo West would depend on its stored water, which would provide 2 to 5 days' supply of water. In a severe emergency, about 4 mgd of water typically used for non-potable irrigation of Pueblo West's golf course would be treated for potable consumption. Pueblo West needs another water supply system to provide redundancy for its existing system.

The SDS Project would provide redundancy to address and reduce the risks described above. The Participants recognize that as water demands increase over time, the redundant capacity of the SDS Project would decrease. However, future projects, which are not yet determined and are beyond the scope of this FEIS, are expected to address future redundancy needs.

1.5.3 Needs Associated with Water Rights Use

A primary project need is to meet most or all of the future water demand of the Participants by utilizing their existing Arkansas River Basin water rights (see Table 4). Colorado Springs' water rights activities over the last 30 years were intended to develop senior rights of sufficient volume to meet the needs of Colorado Springs. This has resulted in a portfolio of surface water rights in the Arkansas River Basin, which generally prevents an over reliance on local non-renewable Denver Basin ground water resources available to Colorado Springs. Much of these existing water rights are in part conditional, meaning they may be further developed to appropriate more water for the Participants' uses. However, further development of these conditional rights depends in part on the Participants' ability to deliver water from the Arkansas River. The Participants' inability to fully develop their

Table 4. Participants' Water Rights Proposed for Use in the SDS Project.

Name	Participant(s)	Type
Primary Sources of Supply		
Colorado Springs Arkansas River Exchange	Colorado Springs	Exchange of transmountain return flows, consumptive use water, or consumptive use return flows
Colorado Canal Companies (Colorado Canal, Lake Henry, Lake Meredith)	Colorado Springs, Fountain, and Pueblo West	Change and exchange of consumptive use water and consumptive use return flows
Fryingpan-Arkansas Project Decrees	Colorado Springs, Fountain, and Security	Transmountain imports from the Fryingpan River to the upper Arkansas River Basin and native Eastern Slope waters
City of Fountain - Plan for Augmentation including Exchange and Change of Water Rights	Fountain	Fountain Creek native waters and reusable Fry-Ark return flows
Independence Pass Transmountain Diversion System (Twin Lakes and Canal Company) Decrees	Pueblo West	Transmountain imports from the Roaring Fork River to the upper Arkansas River Basin
Pueblo West - Plan for Reuse and Exchange	Pueblo West	Exchange of transmountain or consumptive use water
Secondary Sources of Supply[†]		
Independence Pass Transmountain Diversion System (Twin Lakes and Canal Company) Decrees	Colorado Springs	Transmountain imports from the Roaring Fork River to the upper Arkansas River Basin
Homestake Project Decrees	Colorado Springs	Transmountain imports from the Eagle River to the upper Arkansas River Basin
CF&I Water Rights	Colorado Springs	Native Arkansas River water rights

[†] Secondary sources of supply would be delivered through the SDS Project if existing systems were not operating. These supplies are currently delivered through the existing Homestake Delivery System.

existing Arkansas River Basin water rights may result in the inability to perfect these water rights and would require additional reliance on limited local water resources (i.e., Denver Basin ground water) to meet future demands. Therefore, any alternative that would not use the Participants' existing Arkansas River Basin water rights would not meet the purpose and need of this project.

Colorado Springs has two primary water sources for use in the SDS Project: Colorado Canal Companies' water and reusable return flow water by exchange. Five existing water right decrees provide Colorado Springs the legal right to use these supplies. Fountain's and Security's primary water sources for the SDS Project are their use of reusable return flows associated with their respective interests in the Fry-Ark Project and FVA. Additionally, Fountain purchased the Miller Ditch water right, which is expected to yield 300 ac-ft for use in the SDS Project and, like Colorado Springs, has shareholder interest in the Colorado Canal Companies. Pueblo West would use its existing water rights and reusable return flows in the SDS Project.

Colorado Springs' Arkansas River Exchange Program allows for the transfer of Colorado Canal consumptive use water (i.e., the amount of irrigation water that was historically used by plants for growth). The Colorado Canal decrees allow return flows from the use of this transferred consumptive use water to be reused by exchange to upstream locations. Fountain also may use and reuse its share in the Colorado Canal Companies water in this manner.

In addition to the primary water supplies used in the SDS Project, Colorado Springs occasionally may make releases from stored water supplies in the upper Arkansas River Basin. Stored water supplies include water derived from Colorado Springs' transmountain diversion projects, native Arkansas River Basin water, and reusable return flows that typically would be conveyed through the existing Homestake System. The decrees for transmountain supplies allow (and sometimes require) return flows from these imports to be reused to extinction. These return flows constitute the basis of Colorado Springs' Arkansas River Exchange Program. The Arkansas River Exchange Program decrees allow a total exchange of 181 cfs of reusable return flows from Fountain Creek and 1,000 cfs from exchange storage. These flows can be exchanged from the confluence of Fountain Creek and the Arkansas River to upstream reservoirs and diversions, including Pueblo Reservoir, Turquoise Lake, Twin Lakes, Fountain Valley Pipeline, South Slope System, Clear Creek Reservoir, Rosemont System, and the Otero Pump Station river diversion (Ark-Otero Diversion).

1.6 Timing of the Project

Firm untreated water yield is used as a measure to determine when an untreated water delivery project should become operational, because it represents the "worst case" or highest need. Colorado Springs uses the planning forecast to determine the timing of implementation of major water delivery projects because of the long lead time, usually several years, to implement such projects. Based on the planning forecast, average annual demand exceeds the firm untreated water system capacity in 2012 (Figure 2).

Maximum day treated water demand is used as a measure to determine when a treated water delivery project should become operational. Colorado Springs estimates maximum treated water demands using the revenue forecast and a water distribution system peaking factor of 2.5 times the average day demand (Black & Veatch 2005a). Based on this approach, maximum day treated water demand exceeds the current and planned treated water treatment capacity beyond 2015.

To ensure adequate water supplies, Colorado Springs needs additional untreated and treated water systems capacity in 2012. Project need dates for Fountain, Security, and Pueblo West are between 2009 and 2012 (Appendix A).

1.7 Next Steps

Reclamation will select one or a combination of the Action Alternatives studied in detail in this FEIS, or the No Action Alternative as its final Preferred Alternative. If an Action Alternative or combination of Action Alternatives is selected, Reclamation would allow contracts with the Participants. Reclamation will document the decision regarding whether to issue contracts to the Participants in a ROD issued no sooner than 30 days after this FEIS has been filed with the EPA.

2.0 Alternatives

Department of the Interior (DOI) regulations (43 CFR 46.420) require an EIS to consider a range of alternatives. The range of alternatives includes those reasonable alternatives that meet the purpose and need of the proposed action, and address one or more significant issues. NEPA regulations (40 CFR 1502.14a) require that all reasonable alternatives be considered to ensure that a proposed action is well conceived and thoroughly evaluated. Reasonable alternatives include those that are technically and economically practical or feasible and meet the purpose and need of the proposed action (43 CFR 46.420(b)). Because an alternative may be developed to address more than one significant issue, no specific number of alternatives is required or prescribed.

This chapter identifies and describes a range of alternatives for the SDS Project including a No Action Alternative, the Participants' Proposed Action, and five other Action Alternatives. These alternatives have been developed in accordance with NEPA regulations to provide the decision-maker and the public with a clear basis for choice (40 CFR 1502.14).

Chapter 2 presents the following information:

- Significant issues identified during scoping
- The process of developing a range of reasonable alternatives in response to the issues
- Alternatives eliminated from detailed analysis
- A description of the seven alternatives evaluated in the FEIS

The direct, indirect, and cumulative impacts of the seven selected alternatives described in this chapter are evaluated in detail in Chapter 3. A tabular summary of each alternative's projected effects is provided in Section 2.6.

2.1 Alternatives Development

This section describes the process used to develop and screen alternatives to meet the purpose and need for the proposed SDS Project. As described in Chapter 1, the basic purpose of the action proposed in this FEIS is to provide a safe, reliable, and sustainable water supply for the Participants through the foreseeable future. The Participants have three identified needs to be fulfilled by the SDS Project:

- To use developed and undeveloped water supplies to meet most or all projected future demands through 2046
- To develop additional water storage, delivery, and treatment capacity to provide system redundancy
- To perfect and deliver the Participants' existing Arkansas River Basin water rights

The alternatives development process is described in greater detail in the Alternatives Analysis report (Reclamation 2006a) and Alternatives Analysis Addendum (Reclamation 2007a). Public comments received by Reclamation during the alternatives development process are summarized in the Alternatives Public Review Summary Report (Reclamation 2006b). Modifications to the alternatives analyzed in the DEIS are described in the Supplemental Information Report (Reclamation 2008b). Responses to suggested alternatives and modifications to alternatives analyzed in detail received during public review of the DEIS and Supplemental

Information Report are provided in Appendix B and C, respectively].

2.1.1 Significant Issues Identified During Scoping

In accordance with NEPA and DOI regulations, Reclamation used significant issues identified during scoping to guide the development of alternatives. The formal SDS EIS scoping period for the general public began on September 8, 2003, with the publication of a Notice of Intent in the Federal Register. The scoping process is described in Chapter 4 and detailed in the Public Scoping Report (MWH 2004). Press releases were sent to 75 local and national media organizations, public agencies, and other potentially interested parties. Advertisements announcing public scoping meetings and soliciting participation in the scoping process were published in seven local newspapers. Reclamation held five public scoping meetings to solicit issues and concerns about the project from the public. During the scoping period, Reclamation held a multi-agency scoping meeting, and an individual briefing session with the EPA. Reclamation sent a letter to representatives of 16 Native American Tribes to solicit their input for the scoping process. Reclamation also sent a consultation request to the Southwest Region, the Great Plains Region, the Rocky Mountain Region, and the Southern Plains Region of the Bureau of Indian Affairs.

During scoping, 53 written submissions were received: 23 letters and 30 comment cards. From these 53 submissions, 414 substantive comments were gathered. An additional 41 comments were recorded on easel note pads during the public and agency scoping meetings. Based on the issues and recommendations identified in the scoping comments, as well as guidance from NEPA, ten significant issues were identified and used to develop alternatives:

1. Surface Water Flow. The proposed project may increase or decrease surface water flow in Monument Creek, Fountain Creek, Jimmy Camp Creek, Williams Creek, or the Arkansas River.
2. Surface Water Quality. Water quality in Monument Creek, Fountain Creek, Jimmy Camp Creek, Williams Creek, or the Arkansas River may change due to water diversions or wastewater return flows.
3. Channel Stability and Morphology. Changes in the timing and amount of water diversions or wastewater return flows may affect channel stability and morphology (i.e., erosion, deposition, and sediment transport) in project area streams and rivers.
4. Sedimentation. Changes in surface water flow, channel stability, and morphology in project area streams and rivers may affect the amount of sediment load in these channels.
5. Water Rights. Operation of the proposed SDS Project will require the Participants to have adequate water rights. There is a concern about the project’s effects on other water right holders.
6. Fish and Other Aquatic Life. Project facility construction or changes in surface water flows may affect fish and other aquatic life. The proposed project may result in changes in fish populations or habitat.
7. Wetlands and Other Waters of the U.S. Project facility construction or altered surface water flows may result in impacts to wetlands and other waters of the United States.

8. Wildlife. Project facility construction and changes in surface water flows may affect wildlife and their habitat. Threatened, endangered, or state rare wildlife species also may be affected.
9. Socioeconomic Conditions. The proposed project may affect socioeconomic conditions in Pueblo, El Paso, and Fremont counties, communities in these counties, downstream water users, and other communities within the Arkansas River Basin.
10. Recreation Resources. Project facility construction or changes in surface water flows may affect the type, location, and amount of recreational opportunities in the project area.

Public comments were received on preliminary alternatives during a series of meetings on the alternatives held in October and November 2005 (Section 2.1.3). Comments about the project's potential environmental effects also were received during the alternatives meetings. Those comments confirmed that the significant issues identified during public scoping remain valid (Reclamation 2006a). Comments on the DEIS also reaffirmed the significant issues from scoping.

2.1.2 Development of Alternatives

A full range of alternatives was developed, as required by NEPA and DOI regulations. DOI regulations (43 CFR Part 46) and Reclamation (2000) guidance emphasize evaluation of alternatives to the Proposed Action that would avoid or minimize adverse environmental impacts.

NEPA regulations require analysis of a No Action alternative in each EIS to serve as the basis of comparison to all other alternatives. Reclamation's Draft NEPA Handbook states that "no action" represents the most reasonable future responses or conditions that could occur during the life of the project without the Action Alternatives being implemented. "The No Action Alternative should not automatically be considered to be the same as the existing condition of the affected environment, since reasonably foreseeable future actions may be taken whether or not any of the project Action Alternatives are chosen. No action is therefore often described as the future without the project" (Reclamation 2000).

CEQ (46 FR 18027, Forty Most Asked Questions Concerning CEQ's NEPA Regulations) states that "no action," in cases involving federal decisions on proposals for a project, would mean that the proposed activity would not take place. In this FEIS, the proposed activity is the execution of federal contracts between the Participants and Reclamation. The resulting environmental effects from taking no action would be compared with the effects of permitting the proposed activity or an alternative activity to go forward. A choice of "no action" by the agency would result in predictable actions by others. This consequence of the no action alternative should be included in the analysis.

In this FEIS, no action consists of an alternative requiring no major action by Reclamation. The No Action Alternative need not meet the purpose and need of the Participants' Proposed Action and might not seem reasonable or feasible (DOI 2005).

Each Action Alternative was developed to meet purpose and need. Components were sized the same for all alternatives and were not optimized for individual alternatives. Thus, the optimum size of some components may be smaller for certain alternatives. Some component optimization may occur during final design of the Preferred Alternative. Yields for each alternative were obtained based on the standard component sizes. The alternatives were not developed to meet a specific yield goal. However, the demands and deliveries at the water treatment plants were simulated to be comparable among all alternatives in the daily hydrologic model used for this FEIS. An example of the comparable simulated deliveries to the proposed water treatment plant can be found in Appendix D, Table D-10.

In addition to satisfying NEPA and DOI requirements for the selection of alternatives, projects subject to permitting by the Corps under the Clean Water Act also must comply with the EPA's 404(b)(1) Guidelines (Guidelines) for discharge of dredge and fill material into wetlands and waters of the U.S. (40 CFR 230). It is anticipated that one or more SDS Project facilities would need a Section 404 permit from the Corps (Section 3.11). The Guidelines specify "no discharge of dredged or fill material shall be permitted if there is a practicable alternative to the proposed discharge which would have less adverse impact on the aquatic ecosystem, so long as the alternative does not have other significant adverse environmental consequences." An alternative is considered practicable if "it is capable of being done after taking into consideration cost, existing technology, and logistics in the light of overall project purposes." Under the Guidelines, "where the activity associated with a discharge which is proposed for a [wetland or other] special aquatic site … does not require access or proximity to or siting within the special aquatic site in question to fulfill its basic purpose (i.e., is not "water dependent"), practicable alternatives that do not involve special aquatic sites are presumed to be available, unless clearly demonstrated otherwise." The Guidelines also provide that "where a discharge is proposed for a special aquatic site, all practicable alternatives to the proposed discharge which do not involve a discharge into a special aquatic site are presumed to have less adverse impact on the aquatic ecosystem, unless clearly demonstrated otherwise" (40 CFR 230.10).

The alternative analysis required for the Guidelines can be conducted either as a separate analysis during the Section 404 permitting process, or incorporated into the NEPA process. Reclamation's NEPA procedures (DOI 2004; Taylor 2003) encourage integration of NEPA analyses with other permitting and approval processes. Although this FEIS is not intended to fulfill the Corps' Section 404 permitting requirements (Section 1.3.2), the Guidelines were considered in Reclamation's alternatives development and analysis.

2.1.2.1 Project Components and Options

To develop a range of reasonable alternatives, the proposed SDS Project was separated into components. *Components* are discrete activities or facilities (e.g., an untreated water intake location) that, when combined with other components, form an alternative. *Options* were identified for each component. An option is an alternate way of completing an activity, or an alternate geographic location for a facility (component), such as alternate methods for diverting water or alternate geographic locations for a water intake. Options generate the differences among alternatives. An *alternative* is a complete project that has all the components necessary to fulfill the project purpose and need. The alternatives can be composed of the following components:

- Regulating Storage
- Untreated Water Intake
- Untreated Water Conveyance
- Terminal Storage and Water Treatment Plant

- Treated Water Conveyance
- Return Flow Storage and Conveyance

Options for each component were identified by the public or agencies during public scoping (MWH 2004) or review of the DEIS, by Reclamation and the EIS interdisciplinary team (Chapter 7), or by the Project Participants. Because of Pueblo West's conditional participation, alternatives were not developed for delivery of water to Pueblo West. The Participants' Proposed Action (Section 2.2.2), as well as other alternatives that divert water from Pueblo Reservoir, would allow these deliveries. A general example of components used in the alternatives is shown in Figure 5 and the components are defined as follows.

The maximum capacity of the untreated water intake and conveyance system was analyzed in Colorado Springs Utilities' Raw Water Yield Study (MWH 2005). This study investigated several pipeline sizes ranging from 48-inch to 84-inch diameter, which correspond to delivery capacities ranging from 29 mgd to 136 mgd for Colorado Springs, with an additional 2.25 mgd for Fountain and 1.3 mgd for Security. The analysis showed that firm yield increases with increases in pipeline capacity, that larger pipeline capacities (98 mgd and greater) would seldom fill during firm yield demand levels, and that smaller pipeline capacities (46 mgd and smaller) would remain nearly entirely full at both firm yield and 2046 demand levels. Based on this information, the Participants have requested that the SDS untreated water intake and conveyance system have a maximum capacity of 78 mgd.

Regulating Storage

Regulating storage would provide the Participants the ability to store Arkansas River water exchanged with reusable return flows for delivery to an untreated water conveyance system. The regulating storage also would provide the ability to store water if not immediately delivered to the water conveyance system (also known as "carry-over storage"). As proposed, the SDS Project would use 42,000 ac-ft of excess storage capacity in Pueblo Reservoir. In contract requests to Reclamation, Colorado Springs requested 28,000 ac-ft of storage, Fountain 2,500 ac-ft, Security 1,500 ac-ft, and Pueblo West 10,000 ac-ft. Excess capacity contracts would allow the Participants to store non Fry-Ark Project water in Fry-Ark storage space as long as there is space available after storing Fry-Ark Project water. Operation under these types of contracts is discussed further in Appendix D. Although Pueblo West is a conditional Participant in the SDS Project infrastructure, it has requested excess storage capacity in Pueblo Reservoir for all alternatives except the No Action Alternative.

Untreated Water Intake

The untreated water intake component would be the location at which untreated water would be diverted for conveyance to either terminal storage or to a water treatment plant. With the exception of the No Action Alternative, the untreated water intake must be capable of diverting up to 78 mgd (excluding 18 mgd of capacity for Pueblo West in options involving connection Pueblo Dam), which is about 120 cfs, of untreated water from the Arkansas River or regulating storage. The Arkansas River intake for the No Action Alternative (Colorado Springs' portion only) is sized for 74.5 mgd. Because the Arkansas River varies in water quality throughout its length, source water quality would be affected by the location of the untreated water intake. Water quality at some intake locations would require treatment facilities for sediment and salt removal beyond the conventional water treatment included in the Participants' Proposed Action.

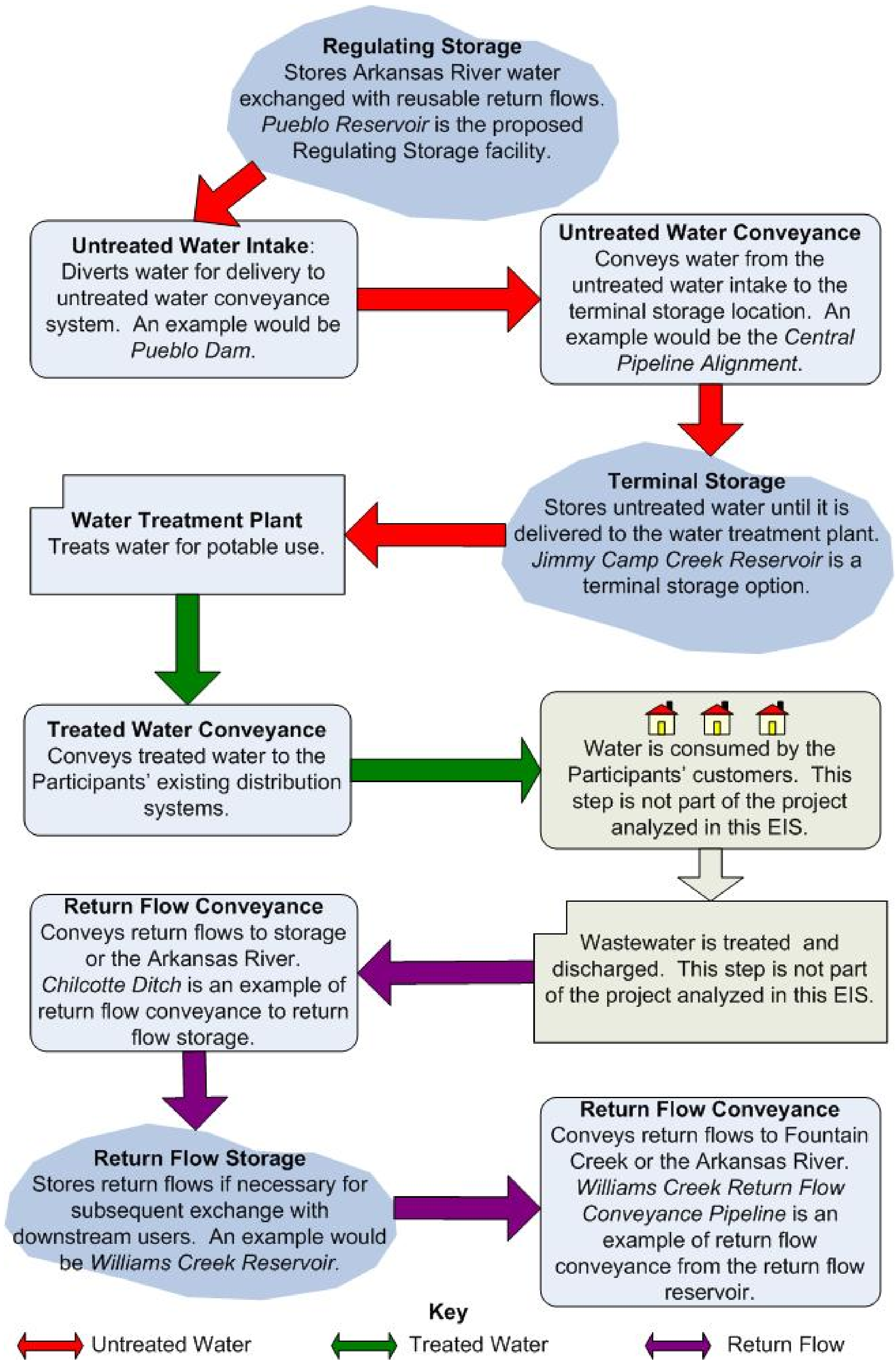

Figure 5. Project Components.

Untreated Water Conveyance

The untreated water conveyance component would convey water from the untreated water intake location to a terminal storage location or water treatment plant. Untreated water conveyance would include a pipeline, pumping stations, and electrical and communication facilities to serve each pumping station. To meet purpose and need, the untreated water conveyance must be capable of delivering 78 mgd of untreated water. For any alternative using an untreated water intake at Pueblo Dam, the capacity of the initial 2,200 feet of untreated water conveyance pipeline would be increased by 18 mgd for deliveries to Pueblo West.

Terminal Storage and Water Treatment Plant

Terminal storage is defined as water storage capacity that acts as a buffer between average annual and peak daily demands. Terminal storage allows the facilities between the untreated water intake and the terminal storage to be sized for average annual demands by storing the extra water conveyed during the low demand periods for release during high demand periods. Facilities between the terminal storage and the service area must be sized for peak daily demands. The Water treatment plant treats water to meet potable standards. To meet purpose and need, the terminal storage facility must be capable of storing 28,000 ac-ft of untreated water, and provide redundancy to the Participants' existing storage facilities. The water treatment plant must be capable of delivering 50 mgd of treated water (maximum day demand) to the expected areas of growth in the Participants' service areas by 2012 and 109 mgd by 2024. If approved by Reclamation as part of the SDS Project, Pueblo West would use Pueblo Reservoir for terminal storage and would not require an additional terminal storage facility or treatment plant.

During alternatives development, terminal storage and the water treatment plant were considered as one component for several reasons. Ideally, a water treatment plant would be located at an elevation that would allow water to flow by gravity from terminal storage to the water treatment plant. Locating a water treatment plant near the demand would reduce the size and cost of treated water conveyance facilities, which would be sized for delivery of maximum day demands. Relative to the size of the terminal storage reservoir site (more than 700 acres), the water treatment plant would be small (less than 100 acres), would have minor environmental effects, and could be located anywhere in the general vicinity of the storage facility. A water treatment plant that is not located adjacent to a proposed terminal storage site was added after the DEIS was issued and was disclosed in a Supplemental Information Report (Reclamation 2008b).

Treated Water Conveyance

Treated water conveyance is the method to convey treated water from the new water treatment plant to the Participants' existing water distribution systems. Treated water is typically conveyed in underground pipelines with pumping stations as necessary to maintain acceptable water pressure. Pipelines would be sized to meet the maximum day demand for treated water. In general, these pipelines would provide treated water to areas of anticipated future demand in the eastern portion of Colorado Springs, and to portions of Fountain and Security. Pueblo West would not develop any new treated water conveyance. The pipelines serving Colorado Springs also would provide redundancy to the existing distribution system serving the southern and eastern portions of Colorado Springs. The Project Participants developed the connection locations between the treated water conveyance and their existing distribution systems based on existing and projected water demand and a desire to optimize redundancy.

Return Flow Storage and Conveyance

Return flow storage and conveyance are the location and method of capturing, storing, and conveying Colorado Springs' reusable return flows for subsequent exchange with downstream water users. All Participants need to exercise exchange water rights to meet their projected water demand using their water rights (Chapter 1). However, only Colorado Springs needs specialized facilities to manage its reusable return flows. Fountain and Security would convey reusable return flows to the Arkansas River via wastewater treatment plant discharges to Fountain Creek, independent of the SDS Project. Pueblo West would convey reusable return flows to Pueblo Reservoir (discussed in Section 3.1.3.1) via wastewater treatment plant discharges to a tributary, independent of the SDS Project.

To meet the project's purpose and need, Colorado Springs must be able to convey reusable return flows to the Arkansas River at times when those flows could be exchanged upstream in accordance with existing water rights. Two primary configurations of Colorado Springs' return flow options were evaluated. The first would use up to 130 cfs of conveyance from Fountain Creek to storage, 25,000 ac-ft of storage, and up to 300 cfs (194 mgd) of conveyance from storage to Fountain Creek and the Arkansas River. Reusable return flows conveyed to the Arkansas River via Fountain Creek would be exchanged upstream to and stored in Pueblo Reservoir in accordance with decreed rights and proposed storage contracts. This configuration, using primarily an irrigation ditch from Fountain Creek to storage, and a pipeline from storage to convey flows to Fountain Creek, is the Participants' Proposed Action. A modification of this configuration, using a ditch from Fountain Creek to storage, and a pipeline from storage to the confluence of Fountain Creek and the Arkansas River was added as an option based on public comment.

The second configuration would use 130 cfs of conveyance from Fountain Creek directly to the Arkansas River upstream of Pueblo Reservoir, eliminating the need for return flow storage in the Fountain Creek Basin. Reusable return flows conveyed to the Arkansas River upstream of Pueblo Reservoir would be conveyed downstream to and stored in Pueblo Reservoir.

2.1.3 Screening Process

Reclamation used a screening process designed to produce a range of reasonable alternatives that meet the project's purpose and need and are responsive to significant issues raised in the scoping process (Section 2.1.1). Requirements of the 404(b)(1) Guidelines also were considered throughout the process. The alternatives screening process is discussed in detail in the Alternatives Analysis report (Reclamation 2006a).

A series of steps was used for screening options and developing alternatives (Figure 6). The Participants' Proposed Action was broken down into components, and options for each component were identified. These options were screened using criteria for substantial logistical, technical, or environmental deficiencies. Readily available information and data sources were used to evaluate each option. Options with one or more substantial logistical, technical, or environmental deficiency were eliminated from further analysis. Next,

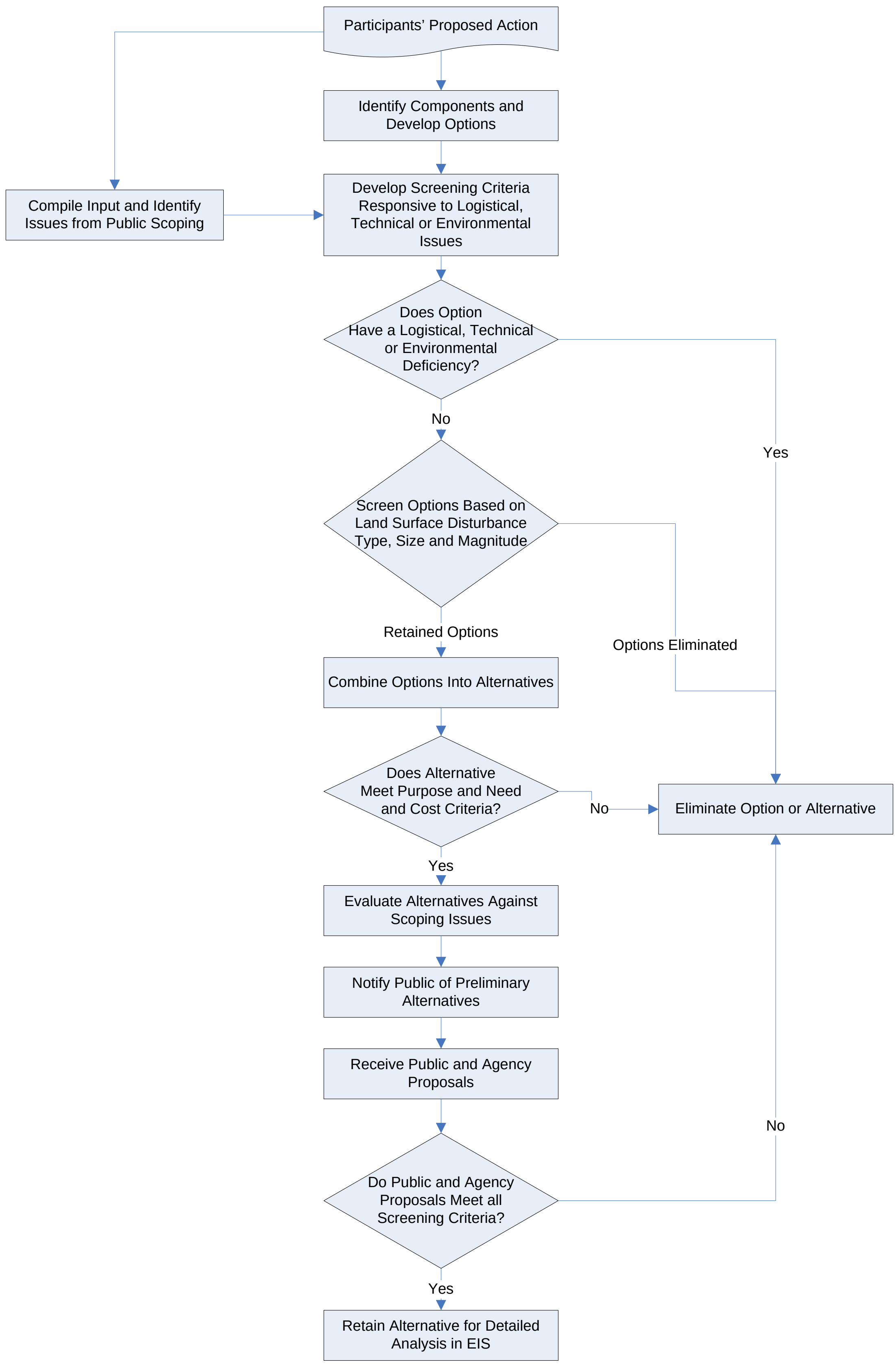

Figure 6. Alternatives Development and Screening Process.

remaining options were screened using a set of indicators reflecting general environmental characteristics (e.g., total amount of area disturbed, area of wetlands disturbed, marine shale inundated, and total dam embankment volume). Options with more favorable environmental characteristics were retained and other options were eliminated from further analysis. Environmental characteristics of options comprising the Participants' Proposed Action were described; however, those options were not screened based on those characteristics (i.e., all options were retained). Next, options for each component were combined into potentially viable alternatives. Each component or alternative was developed to a level that allowed for comparison of significant environmental issues and costs.

The potentially viable alternatives were screened using criteria based on the project purpose and need (Chapter 1) and cost. Cost screening criteria were developed by evaluating recent Front Range water projects to determine what nearby communities were willing to pay (an indicator of market value) for delivery of untreated water ready for conventional treatment. These cost criteria were $25,000 per ac-ft/year based on firm yield and $21,000 per ac-ft/year based on SMAPD. A screening-level cost for untreated water delivery, terminal storage, and any required treatment above and beyond conventional treatment was estimated for each alternative (Reclamation 2006a). Conventional treatment consists of a series of processes that remove common water impurities such as organic solids and suspended solids. The screening-level costs used a 50-year horizon for operation and maintenance costs to allow comparison with available information for other Front Range water projects.

Any alternative whose costs were greater than either cost criterion was eliminated. Alternatives that fulfilled the purpose and need and met the cost criteria were retained. From the retained alternatives, five alternatives representing seven themes (e.g., No Action, Participants' Proposed Action, and public scoping issues) were selected for public review and comment. Two additional alternatives that exceeded cost criteria were selected based on public interest. All other alternatives were eliminated from further analysis; these alternatives are discussed in Section 2.3. A series of public and agency workshops was held to discuss the preliminary alternatives (Reclamation 2006b). Based upon comments received from the public and agencies, new components or options were screened using the process described in the preceding paragraphs and either retained or eliminated from detailed analysis. New components, options, or alternatives suggested during public review of the DEIS and Supplemental Information Report were evaluated using the same process.

2.1.4 Alternatives Analyzed in this FEIS

Seven alternatives were selected by Reclamation for detailed evaluation in this FEIS and are depicted in Figure 7. The alternatives are the No Action Alternative, the Participants' Proposed Action, and five other Action Alternatives. Options and related information associated with each alternative are presented in Table 5.

Cost information in this table reflects more detailed design than the screening-level costs used to evaluate preliminary alternatives and a 34-year horizon (2012 to 2046) for operation and maintenance. Additionally, the costs in the table are for construction, operation, and maintenance of complete alternatives (including conventional treatment and treated

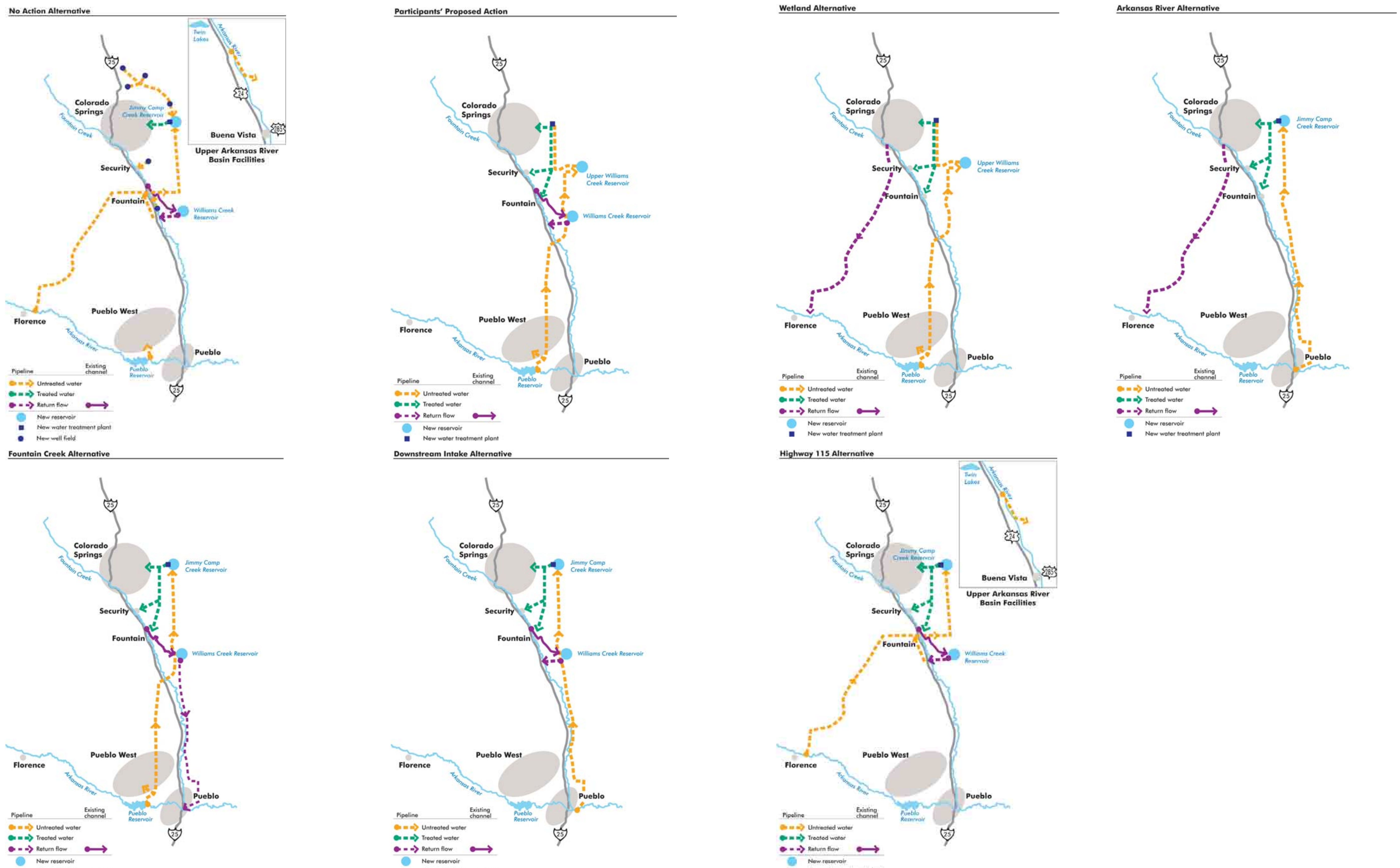

Figure 7. Schematics of the Alternatives.

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Table 5. Major Components and Options of Each Alternative.

Component	No Action Alternative				Participants' Proposed Action	Wetland Alternative	Arkansas River Alternative	Fountain Creek Alternative	Downstream Intake Alternative	Highway 115 Alternative
	Colorado Springs	Fountain	Security	Pueblo West						
Long-term Contracts with Reclamation	None	None	None	None	Storage, Conveyance, and Exchange	Storage, Conveyance, and Exchange	Storage and Exchange	Storage, Conveyance, and Exchange	Storage and Exchange	Storage and Exchange
Regulating Storage	None	None	None	None	Pueblo Reservoir	Pueblo Reservoir	Pueblo Reservoir	Pueblo Reservoir	Pueblo Reservoir	Pueblo Reservoir
Untreated Water Intake	Arkansas River near Colorado 115, FVA supply, Denver Basin Wells, and Ark-Otero Intake Improvements	Fountain Creek Alluvial Wells	Fountain Creek Aquifer Wells (see FEIS Section 2.2.1.3 for other possible options)	Arkansas River below Pueblo Dam	Pueblo Dam: Joint Use Manifold and North River Outlet Works	Pueblo Dam: Joint Use Manifold and North River Outlet Works	Arkansas River above Fountain Creek	Pueblo Dam: Joint Use Manifold and North River Outlet Works	Arkansas River below Fountain Creek	Arkansas River near Colorado 115, FVA supply, and Ark-Otero Intake Improvements
Untreated Water Conveyance										
Alignment	Colorado 115 and Central and Denver Basin Wellfield	No Action	No Action	No Action	Western and Central	Western and Central	Eastern and Central	Western and Central	Eastern and Central	Colorado 115 and Central
Pipelines	84 miles	1.5 miles	0	<0.1 miles	53 miles	53 miles	46 miles	44 miles	46 miles	53 miles
Pump Stations	5	0	0	0	3	3	4	3	4	5
Terminal Storage	Jimmy Camp Creek Reservoir (30,500 ac-ft, 674 ac)	None	None	None	Upper Williams Creek Reservoir (30,500 ac-ft, 950 ac)	Upper Williams Creek Reservoir (30,500 ac-ft, 950 ac)	Jimmy Camp Creek Reservoir (30,500 ac-ft, 674 ac)	Jimmy Camp Creek Reservoir (30,500 ac-ft, 674 ac)	Jimmy Camp Creek Reservoir (30,500 ac-ft, 674 ac)	Jimmy Camp Creek Reservoir (30,500 ac-ft, 674 ac)
Water Treatment Plants	Conventional (Jimmy Camp Creek Site)	RO[†] w/Brine Disposal (50 percent) Conventional (50 percent)	Wellhead Disinfection	Conventional	Conventional (Upper Williams Creek Site)	Conventional (Upper Williams Creek Site)	Conventional (Jimmy Camp Creek Site)	Conventional (Jimmy Camp Creek Site)	RO[†] w/Brine Recovery (50 percent) Conventional (50 percent) (Jimmy Camp Creek Site)	Conventional (Jimmy Camp Creek Site)
Treated Water Conveyance										
Pipelines	18 miles	None	None	None	9 miles	9 miles	18 miles	18 miles	18 miles	18 miles
Booster Pump Stations	1	0	0	0	0	0	1	1	1	1
Return Flow Storage	Williams Creek Reservoir (28,500 ac-ft, 1,057 ac)	None	None	None	Williams Creek Reservoir (28,500 ac-ft, 1,057 ac)	Pueblo Reservoir (existing)	Pueblo Reservoir (existing)	Williams Creek Reservoir (28,500 ac-ft, 1,057 ac)	Williams Creek Reservoir (28,500 ac-ft, 1,057 ac)	Williams Creek Reservoir (28,500 ac-ft, 1,057 ac)
Return Flow Conveyance										
Conveyance from Fountain Creek	Chilcotte Ditch (10 miles)	None	None	None	Chilcotte Ditch (10 miles)	Fountain Mutual Irrigation Ditch (0.4 miles)	Fountain Mutual Irrigation Ditch (0.4 miles)	Chilcotte Ditch (10 miles)	Chilcotte Ditch (10 miles)	Chilcotte Ditch (10 miles)
Conveyance to Arkansas River	Williams Creek Return Flow Conveyance Pipeline (5 Miles) and Fountain Creek	None	None	None	Williams Creek Return Flow Conveyance Pipeline (5 Miles) and Fountain Creek	Highway 115 Return Flow Pipeline (38 miles)	Highway 115 Return Flow Pipeline (38 miles)	Eastern Return Flow Pipeline (29 miles)	Williams Creek Return Flow Conveyance Pipeline (5 Miles) and Fountain Creek	Williams Creek Return Flow Conveyance Pipeline (5 Miles) and Fountain Creek
Pump Stations	0	0	0	0	0	2	2	0	0	0
Estimated Firm Yield	42,400 ac-ft				42,400 ac-ft	74,900 ac-ft	74,400 ac-ft	46,400 ac-ft	68,400 ac-ft	37,900 ac-ft
Estimated SMAPD	54,400 ac-ft				52,900 ac-ft	69,300 ac-ft	68,100 ac-ft	59,500 ac-ft	65,700 ac-ft	47,200 ac-ft
Estimated Capital Cost[‡]	$1,307,300,000				$1,090,900,000	$1,242,800,000	$1,239,400,000	$1,247,900,000	$1,274,200,000	$1,213,300,000
Estimated Operation and Maintenance Cost 2012-2046[‡]	$701,900,000				$651,400,000	$866,800,000	$918,900,000	$672,200,000	$1,168,800,000	$671,300,000
Estimated Unit Cost for Firm Yield and SMAPD[§]	$47,400/ac-ft firm $36,900/ac-ft SMAPD				$41,100/ac-ft firm $32,900/ac-ft SMAPD	$28,200/ac-ft firm $30,400/ac-ft SMAPD	$29,000/ac-ft firm $31,700/ac-ft SMAPD	$41,400/ac-ft firm $32,300/ac-ft SMAPD	$35,700/ac-ft firm $37,200/ac-ft SMAPD	$48,300/ac-ft firm $39,900/ac-ft SMAPD

[†]RO – reverse osmosis. [‡]All costs, both capital and operation and maintenance, are in 2007 dollars and do not include any discounting of future cash flows (i.e., are not present worth costs) (CH2M HILL 2008a). [§]Sum of estimated capital and operation and maintenance costs divided by firm yield and SMAPD, rounded to nearest $100/ac-ft.

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water conveyance). Therefore, the costs in Table 5 are not comparable to the initial cost screening criteria.

Conservation measures (discussed in Section 2.4.1) will continue to be implemented, improved, and expanded by the Participants under the seven alternatives evaluated in detail. These alternatives provide a range of reasonable and practicable alternatives responsive to significant scoping issues, satisfy requirements for alternative selection under NEPA and DOI regulations, and consistent with the 404(b)(1) Guidelines.

Throughout this FEIS, Alternatives 2 through 7 are referred to as Action Alternatives and Alternative 1 as the No Action Alternative. All Action Alternatives would include contracts with Reclamation as discussed in Section 1.1) The contracts would be for storage in Pueblo Reservoir (a Fry-Ark water storage facility on the Arkansas River), conveyance of water through facilities associated with Pueblo Reservoir, and exchange of water between Pueblo Reservoir and Fry-Ark Project reservoirs in the upper Arkansas River Basin. The effects of the Action Alternatives within each specific resource area are evaluated against the No Action Alternative throughout the FEIS.

Alternatives 3 through 5 were designed to respond to one or more significant scoping issue. Although these alternatives have been designed to consider one or a few specific resources, each alternative would address other resources to the extent consistent with its emphasis. Alternative 6 was designed to respond to public interest in an alternative that included an untreated water intake on the Arkansas River downstream of Fountain Creek. Alternative 7 was designed to respond to public interest in an alternative that followed the Colorado 115 corridor for pipeline alignments. Because Alternatives 6 and 7 were not designed to respond to significant scoping issues, they were not screened against the significant scoping issues. In Chapter 3, each alternative chosen for detailed analysis in the FEIS is evaluated for its effect on a variety of environmental resources including water, aquatics, wetlands, vegetation, wildlife, and for its cultural resources, socioeconomics, and land use effects.

If an Action Alternative is selected in the ROD, final design and construction would be completed after the ROD is issued. Construction of all of the alternatives would be performed in phases. The first phase is proposed to be completed by 2012 and would consist of pipelines, pump stations, a water treatment plant, and treated water pipelines. The next phase would consist primarily of reservoir development and water treatment plant expansion. The purpose of phasing is to reduce rate impacts to the Participants' customers and allow the safe operation of the water system during construction, while bringing facilities on-line to meet the project's purpose and need. In each of these cases, the phasing would delay the effects, beneficial and adverse, associated with the components in later phases. The timeline for construction of the components for each alternative is shown in Figure 8 and discussed in the subsections below.

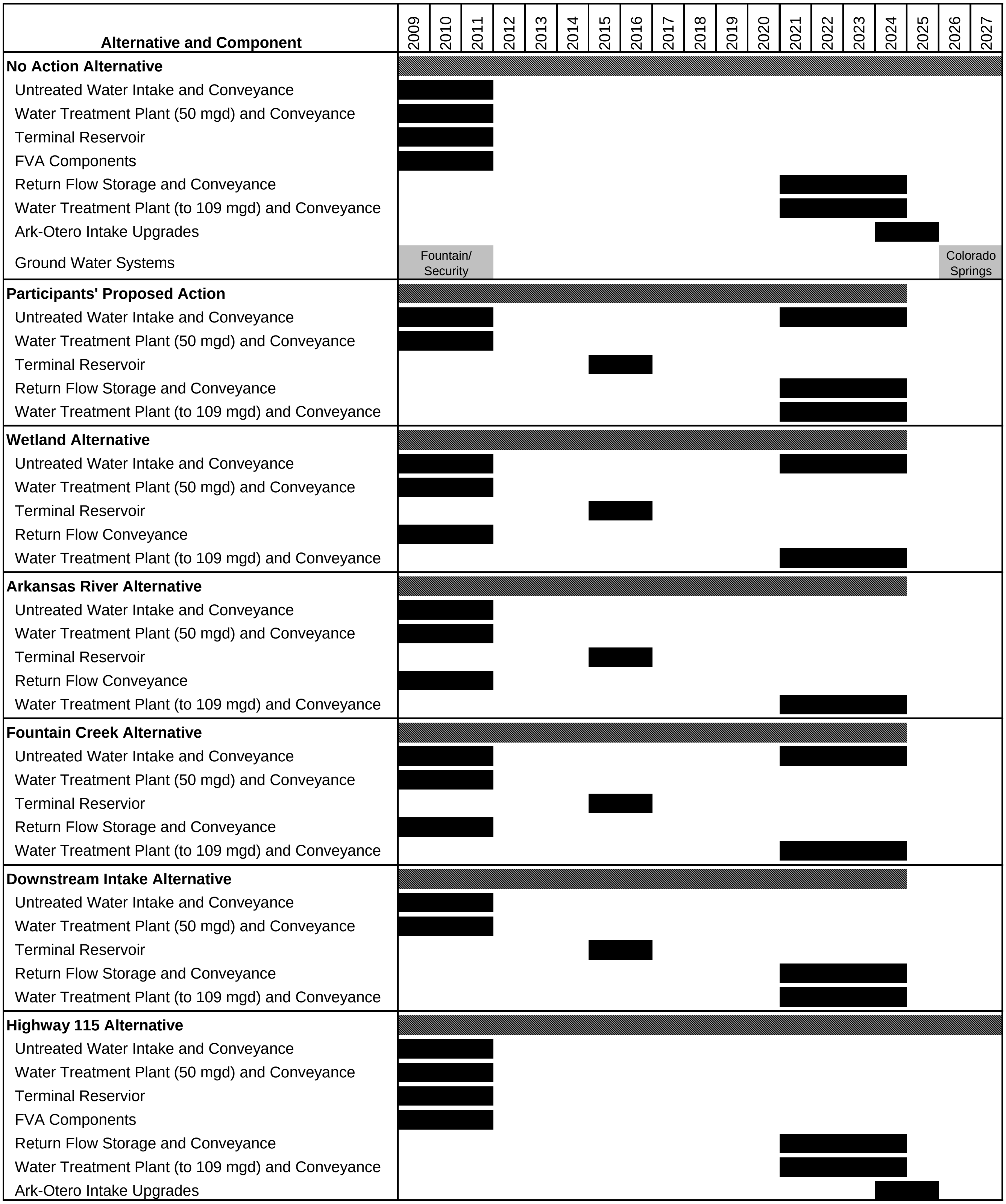


Figure 8. Proposed Schedule for Component Implementation.

Construction timing would generally be as follows:

- Untreated Water Intake and Conveyance: For all alternatives, the untreated water intake and conveyance facilities would be constructed by 2012
- Terminal Storage: For all alternatives except the No Action and Highway 115 Alternatives, the terminal storage component would not be on-line until 2018
- Williams Creek Reservoir and associated return flow facilities: For the No Action, Participants' Proposed Action, Downstream Intake, and Highway 115 alternatives, these facilities would not be completed until 2025. The effects associated with these facilities would not occur until construction in 2022 to 2024
- Water Treatment Plant and treated water conveyance: The water treatment plant would be built at an initial size of 50 mgd by 2012, and expanded to 109 mgd in 2025. Portions of the treated water conveyance system would also be expanded in 2025
- Ark-Otero facilities: The Ark-Otero diversion facilities and pump station included in the No Action and Highway 115 alternatives would be phased to be on-line in 2027
- Ground water: The ground water facilities included in the No Action Alternative would be constructed by 2012 for Fountain and Security and 2029 for Colorado Springs

2.2 Description of Alternatives Analyzed in this FEIS

The following subsections provide detailed descriptions of the development, layout, components, and operations for each of the alternatives analyzed in the FEIS. Elements common to all alternatives and construction and restoration methods are described in Sections 2.4 and 2.5, respectively.

Modifications to the Alternatives

The SDS Project alternatives were modified between the DEIS and this FEIS. Modifications were made to the physical layout of the alternatives to avoid or minimize effects described in the DEIS. Additional modifications were made to the physical layout of the alternatives to accommodate changes in infrastructure unrelated to the SDS Project. These changes were disclosed in a Supplemental Information Report (Reclamation 2008b) and released for public review (Chapter 4). This FEIS describes the alternatives with the modifications and the effects of those alternatives.

2.2.1 No Action Alternative

NEPA requires a No Action Alternative to be studied in an EIS. For the SDS Project, the No Action Alternative represents the most likely future water development project in the absence of a major Reclamation action, such as a long-term excess capacity storage contract. Each Project Participant has determined its most likely course of action if contracts with Reclamation are denied and the separate components for each Participant are discussed below. Unlike the Action Alternatives, there would likely be no regional sharing of project facilities. Each Project Participant would independently develop other water supplies in response to projected demands (CH2M HILL 2007a, 2007b, 2007c, 2007d). Development of these water supplies would not require long-term contracts with Reclamation.

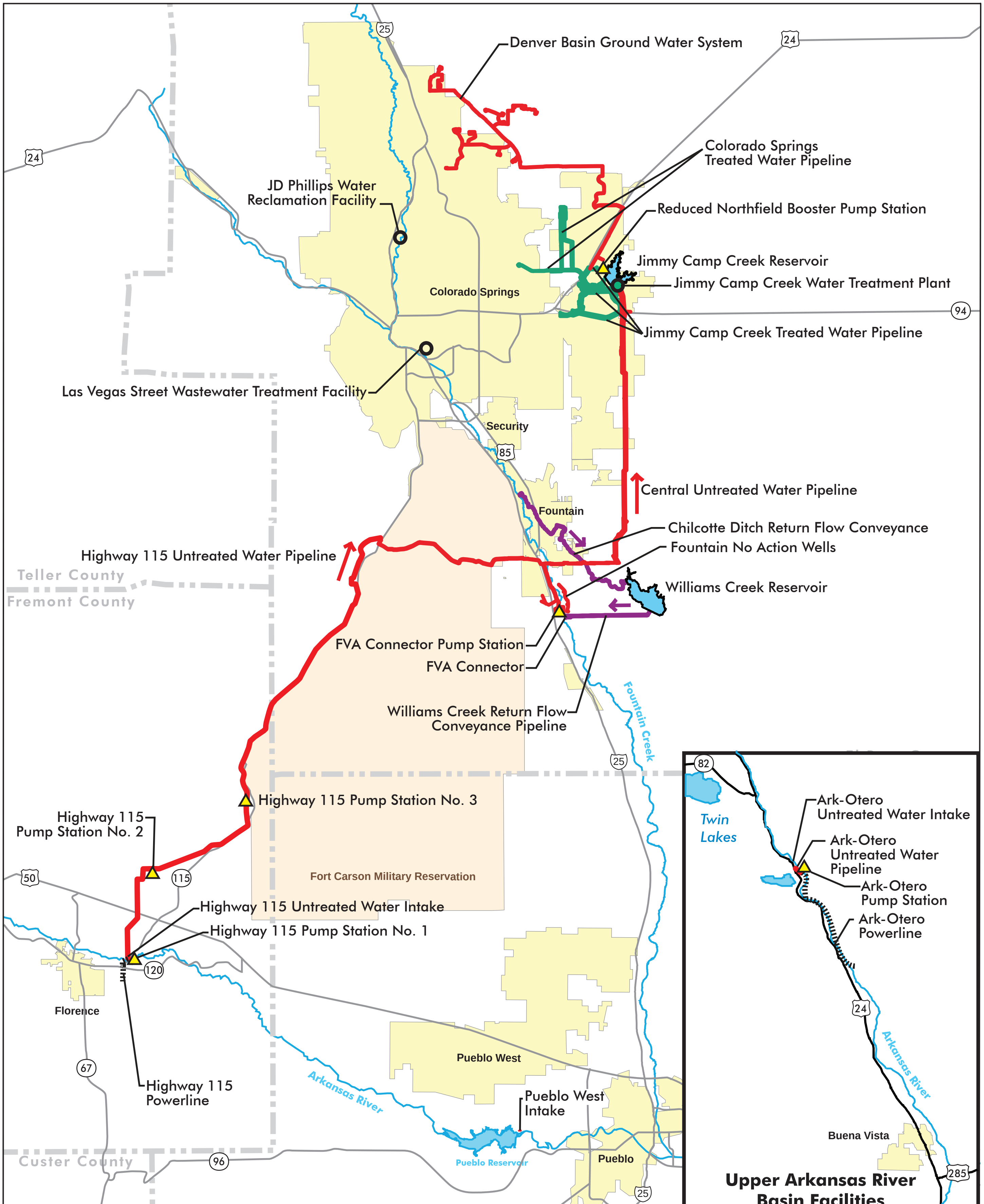
Colorado Springs, Fountain, and Security likely would expand ground water use. Colorado Springs would use Denver Basin ground water, Fountain would probably expand its Fountain Creek alluvial wellfield, and Security likely would acquire additional water rights in the Widefield Aquifer. In addition, Colorado Springs would divert water from the Arkansas River near Florence and convey it through a pipeline generally following Colorado 115, and build two new reservoirs. Pueblo West would likely obtain its water from an intake on the Arkansas River near Pueblo Reservoir, which was previously authorized (Reclamation 2003).

The No Action Alternative serves as the basis of comparison for all Action Alternatives (Section 3.4.6.1). Differences in effects among alternatives are also compared throughout this FEIS. Because the No Action Alternative would not use Security's existing Arkansas Basin water rights, and would not provide the same level of redundancy as the SDS Project, it would not fulfill completely the project needs of Colorado Springs, Fountain, and Security (Chapter 1). However, the No Action Alternative would make use of reusable return flows as required by Colorado Springs' transmountain decrees. Construction and restoration methods for all alternatives are described in Section 2.5 and alternative-specific construction and restoration methods are described below. The following subsections describe the No Action Alternative in more detail. Operational characteristics for all alternatives are described in Appendix D.

> The following numbers are sometimes used to identify the alternatives:
>
> - Alternative 1 (No Action Alternative)
> - Alternative 2 (Participants' Proposed Action)
> - Alternative 3 (Wetland Alternative)
> - Alternative 4 (Arkansas River Alternative)
> - Alternative 5 (Fountain Creek Alternative)
> - Alternative 6 (Downstream Intake Alternative)
> - Alternative 7 (Highway 115 Alternative)
>
> Alternatives 2 through 7 are referred to as "Action Alternatives" throughout this FEIS.

2.2.1.1 Colorado Springs Components

Colorado Springs would likely meet the projected future water demand by diverting water from the Arkansas River near Florence and developing a Denver Basin ground water system (Figure 9). Untreated water would be diverted from the Arkansas River at the site of the existing Lester & Attebery Ditch (Highway 115 Untreated Water Intake), stored in a new reservoir on Jimmy Camp Creek, blended with ground water, treated, and distributed to Colorado Springs' customers. A portion of Colorado Springs' reusable return flows



Untreated Water Conveyance
Treated Water Conveyance
Return Flow Conveyance
Reservoir
Powerline
Pump Station
Water Treatment Plant
Wastewater Treatment Plant
(Not Part of SDS)

0 3 6 Miles

N

Project: Southern Delivery System
Prepared By: ERO Resources Corp.
Date: 9/181/08

Figure 9.
No Action
Alternative.

would be stored in a new reservoir on Williams Creek prior to exchange down Fountain Creek. A connection between the existing Fountain FVA pipeline and the proposed untreated water pipeline would maximize flow in the FVA pipeline, which would increase Colorado Springs' delivery capabilities.

Colorado Springs' existing Otero Intake diversion on the Arkansas River (Ark-Otero Intake) would increase Colorado Springs' flexibility in operating exchange decrees on the Arkansas River and facilitate the diversion of streamflow at the proposed intake at Colorado 115. The ground water system would probably include Denver Basin wells, a network of collection pipelines, and a conveyance pipeline to a new terminal storage reservoir on Jimmy Camp Creek. Both the ground water system and the Arkansas River system would probably share a common terminal storage reservoir, conventional water treatment plant, and treated water conveyance system. Each of these systems, and their shared components, is described below.

Colorado Springs has minimal ownership of water rights within the Dawson Aquifer, which is the upper-most Denver Basin aquifer (these aquifers are described in Section 3.6). Furthermore, an existing Colorado Springs City Council resolution (233-86) prohibits development of ground water from the Dawson Aquifer. This prohibition was created as a "good neighbor" policy toward individual homeowners in Black Forest, most of which rely upon wells in the Dawson Formation. The Black Forest area is a group of small communities' northeast of Colorado Springs.

The same City Council resolution limits all Denver Basin ground water use to emergency supplemental supply and limited irrigation uses. The policy is to protect against Colorado Springs' depletions of the sole water supply for the neighboring communities of Monument, Woodmoor, Glen Eagle, Palmer Lake, and Black Forest. Use of Denver Basin ground water would require changes to the existing Colorado Springs City Council resolution.

Denver Basin ground water is a non-renewable resource. Colorado Springs, through its ground water policy, recognizes the non-renewable nature of Denver Basin ground water, and therefore currently uses the supply only as a supplemental emergency supply and limited irrigation. This alternative would, in part, use non-renewable ground water; once depleted, another water source would have to be developed.

Structural

Arkansas River Conveyance System

Regulating Storage

The No Action Alternative would not use regulating storage.

Untreated Water Intake

A new, 74.5-mgd diversion dam and intake (Highway 115 Untreated Water Intake) would be constructed on the Arkansas River immediately upstream of the Colorado 115 bridge (CH2M HILL 2005a) (Figure 10). The diversion structure would consist primarily of a concrete sill and inflatable rubber dam that would cross the river (CH2M HILL 2003a). Combined, the sill and dam, when inflated, would be about 2.5 feet above the streambed elevation. A concrete sluiceway would be constructed along the south bank of the river and streamflows would flow into screened bays with sedimentation basins. The intake would include stainless steel fish screens with 0.069-inch openings. Depending on regulatory requirements, the sediment would either be pumped back to the river or pumped to drying

Project: Southern Delivery System
Prepared By: CH2MHILL
Date: July 24, 2007
Source: (see text)

Legend

- NEW OVERHEAD POWER
- UNTREATED WATER PIPELINE
- PARCELS OWNED BY OTHERS

Figure 10. Preliminary Layout of Highway 115 Intake and Pump Station No. 1.

beds for dewatering and later disposal. Provisions for boat passage would be included in the intake design. The existing Lester & Attebery Ditch would be incorporated into the new intake, with the ditch receiving flows from the new diversion. The Lester & Attebery Ditch capacity in the untreated water intake would be consistent with the capacity of its existing diversion structure.

The existing Ark-Otero Intake would be upgraded, which would increase Colorado Springs' flexibility in operating decreed exchanges on the Arkansas River and facilitate the diversion of Arkansas River streamflow at the Highway 115 Intake. Water previously used by Colorado Springs to fill the Homestake Pipeline (described in Appendix A) would be released to the Arkansas River for diversion at the Highway 115 Intake. Colorado Springs' exchange water would then be used to fill the Homestake Pipeline.

Untreated Water Conveyance

The primary untreated water conveyance for the Arkansas River conveyance system in the No Action Alternative would consist of three pump stations and about 54 miles of pipeline (Highway 115 Untreated Water Pipeline) (CH2M HILL 2007a). The welded-steel pipeline would be 65 inches in diameter and capable of conveying 74.5 mgd of untreated water. The secondary conveyance would be a connection from the existing FVA pipeline to the Highway 115 Pipeline, which would be added to maximize flow in the FVA pipeline, and increase Colorado Springs' delivery capabilities. The FVA connection would consist of one pump station and about 3.2 miles of 24-inch diameter welded steel pipeline capable of conveying 8 mgd of untreated water. The final untreated water conveyance would be the upgraded Ark-Otero Intake, capable of conveying 68-mgd of untreated water to the existing Otero Pump Station.

The Highway 115 Untreated Water Pipeline would originate at the Highway 115 Untreated Water Intake and head about 6 miles north to a location south of Brush Hollow Reservoir, then continue northeast along Colorado 115 for about 23 miles to Fort Carson (Figure 9). The pipeline would head east across Fort Carson along an existing road and exit Fort Carson on commercial and industrial lands. The pipeline would continue east along Squirrel Creek Road to a location about 4 miles east of the intersection with Old Pueblo Road. North of this location, the pipeline would go north between the proposed Williams Creek Reservoir (there would be no connection to the reservoir) and the proposed Jimmy Camp Creek Reservoir and water treatment plant. This pipeline reach between the reservoir sites is referred to as the "Central Untreated Water Pipeline." The FVA pipeline connection would originate at the northern terminus of the existing FVA pipeline and head about 1 mile southeast, crossing beneath I-25, then continue about 2 miles north between I-25 and Fountain Creek to intersect with the Highway 115 Untreated Water Pipeline. The Ark-Otero Intake facility would be located at the existing Otero Pump Station diversion on the Arkansas River.

Pump stations would be located adjacent to the Arkansas River at Colorado 115 (Highway 115 Pump Station No. 1), south of Brush Hollow Reservoir (Highway 115 Pump Station No. 2), about 7.5 miles north of Penrose (Highway 115 Pump Station No. 3), at the FVA water treatment plant site, and near the Ark-Otero Intake. Each of the Highway 115 pump station sites would be about 6 acres. Highway 115 Pump Stations No. 2. and No. 3 would each have a 135-foot diameter forebay sized for 2.5 million gallons. Based on preliminary pump sizes and ancillary equipment sizes, the main pump station building would be about 220 feet long, 80 feet wide, and 30 feet high and would have a flat roof. Smaller facilities on the pump station sites would include an office/control building, air-handling buildings, an electric substation (depending upon electrical feed provided by the power supplier), a valve vault, and a stormwater detention pond. Municipal water and sanitary sewer service are not available at the Highway 115 Pump Station No. 1, No. 2, and No. 3 sites. Consequently, an untreated water tap would be used for non-potable purposes (e.g., washdown, cooling, and lavatory), bottled water used for drinking water, and tanks used for onsite sanitary storage. The FVA pump station and the Ark-Otero sites would be substantially smaller than those for the Highway 115 pump stations, but would have the same types of facilities.

Highway 115 Untreated Water Pump Station No. 1 would be on the north bank of the Arkansas River adjacent to the intake (Figure 10). The Highway 115 Untreated Water Pump Station No. 2 would be immediately south of the Brush Hollow Reservoir dam. This facility would have 74.5-mgd capacity. The 74.5-mgd Highway 115 Untreated Water Pump Station No. 3 would be on the west side of Colorado 115 about 7.5 miles north of Penrose. Power would be supplied to the Highway 115 Untreated Water Pump Stations via a new powerline that would connect to existing Black Hills Corporation (formerly Aquila Energy, Inc.) electrical transmission lines located about 3 miles south of Pump Station No. 1 and would follow the untreated water pipeline to Pump Station No. 3. About 14 miles of new poles and conductors would be installed adjacent to the untreated water pipeline. The final location of any new electrical transmission facilities for any SDS Project alternative would be determined by the power supplier rather than the Project Participants.

The FVA pump station would have 8 mgd of capacity. Power would be supplied through a connection to existing Colorado Springs Utilities electrical transmission lines located adjacent to the pump station site.

A 68-mgd untreated water pump station would be located downstream of the upgraded Ark-Otero intake facility and proposed sedimentation basin to connect to the Homestake Pipeline. A 66-inch diameter gravity water supply line would connect the intake facility to the sedimentation basin. A new electrical power supply would be needed for the new pump station (CH2M HILL 2007e). A buried powerline would be installed from the existing Otero Pump Station.

Terminal Storage Reservoir

A new terminal storage reservoir would be constructed east of Colorado Springs northeast of the intersection of U.S. 24 and Colorado 94 on Jimmy Camp Creek (Figure 11). The Jimmy Camp Creek Reservoir would be able to store 30,500 ac-ft of water (28,000 ac-ft active storage and 2,500 ac-ft dead storage).

The dam and reservoir area would occupy about 674 acres. A buffer about 1,000 feet around the normal water surface elevation would be acquired for water quality protection and relocation of power lines and a liquid petroleum pipeline (CH2M HILL 2005b). The maximum water surface elevation would be about 6,506 feet above sea level, or 156 feet deep for normal operations. Releases would be made to pass native flows from the Jimmy Camp Creek Basin, including flood flows. Recreational uses such as fishing, hiking, and picnicking are proposed for this facility. Boating with electric trolling motors and modern petroleum-powered craft would also be permitted at this facility, in conjunction with a permit system to ensure low-pollutant-emission motors. Specific facilities to support these uses have not been defined.

The reservoir would be formed by construction of three earthfill embankments (GEI 2005a):

- A main dam across Jimmy Camp Creek about 3,600 feet long with a maximum height of 187 feet above the downstream streambed
- A wing dam extending about 2,100 feet from the left (east) side of the main dam upstream along the Corral Bluffs confining ridge
- A saddle dam about 1,050 feet long located in a saddle in the Corral Bluffs at a location left (east) and upstream of the wing dam, about 2,500 feet upstream of the left end of the main dam.

The dam cores would be constructed of clay produced by processing claystone from borrow areas within the reservoir site. Upstream and downstream shells and stability berms would be constructed of surficial materials and weathered bedrock from the site. Annual seepage is estimated to be up to 155 ac-ft (about 0.2 cfs).

A concrete spillway, sized to pass the Probable Maximum Flood (the Probable Maximum Flood or PMF is the flood that may be expected from the most severe combination of critical meteorological and hydrologic conditions that are reasonably possible in a particular drainage area), would be located on the left abutment between the main dam and wing dam. A channel would be built, connecting the end of the spillway to Jimmy Camp Creek. A multilevel outlet works would be located through the main dam along the east side of Jimmy Camp Creek. The outlet works would be configured to deliver up to 180 mgd (anticipated buildout) to a water treatment plant on a sustained basis, and to meet the Colorado State Engineer's Office (SEO) criteria for reservoir drawdown (based on dam safety) and stormwater release (based on water rights). Access to the dam would be provided from both the water treatment plant, which would be located downstream of the wing dam, and U.S. 24 to the west. The spillway would be ungated and would operate whenever the reservoir inflow caused the reservoir elevation to exceed the spillway crest elevation. Although the reservoir would provide incidental flood control benefits, it would not be operated as a flood control reservoir. To increase public safety, a streamside conservation easement surrounding Jimmy Camp Creek has been planned to limit development in areas that have historically been prone to flooding. This easement would extend about 2.5 miles to Colorado 94.

Water Treatment Plant

A water treatment plant (Figure 12) would be built immediately south of Jimmy Camp Creek Reservoir (CH2M HILL 2005c). The plant capacity would be 50 mgd initially and 109 mgd by 2025 (CH2M HILL 2007a). It would be a conventional plant. A conventional treatment plant consists of a series of processes that remove common water impurities such as organic solids and suspended solids. The plant would include the following structures:

- Operations and maintenance building
- Untreated water hydraulic control structure and storage tanks
- Two chemical buildings
- Clarification building
- Re-carbonation/ozone contacting structure and ozone generation building

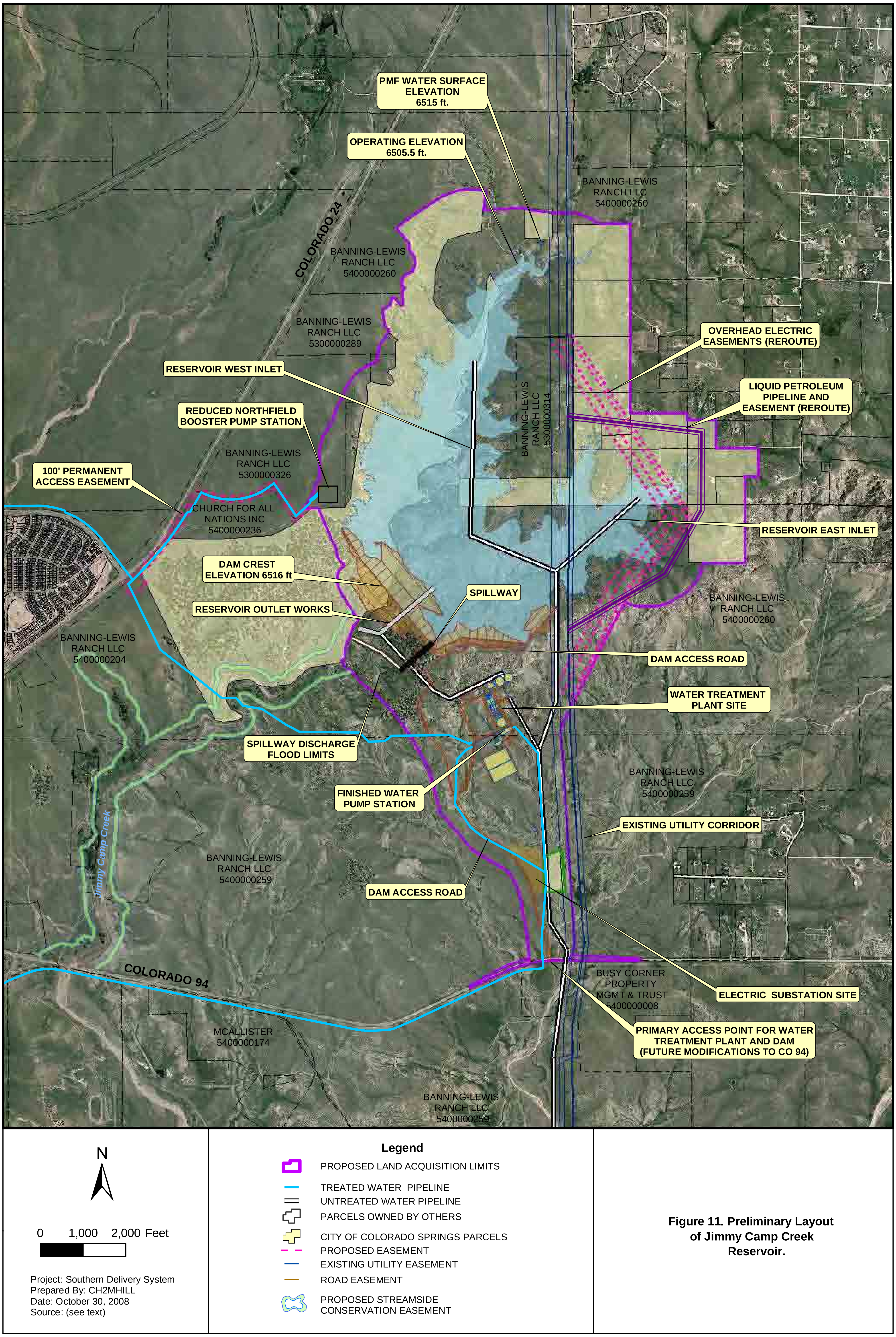


Figure 11. Preliminary Layout of Jimmy Camp Creek Reservoir.

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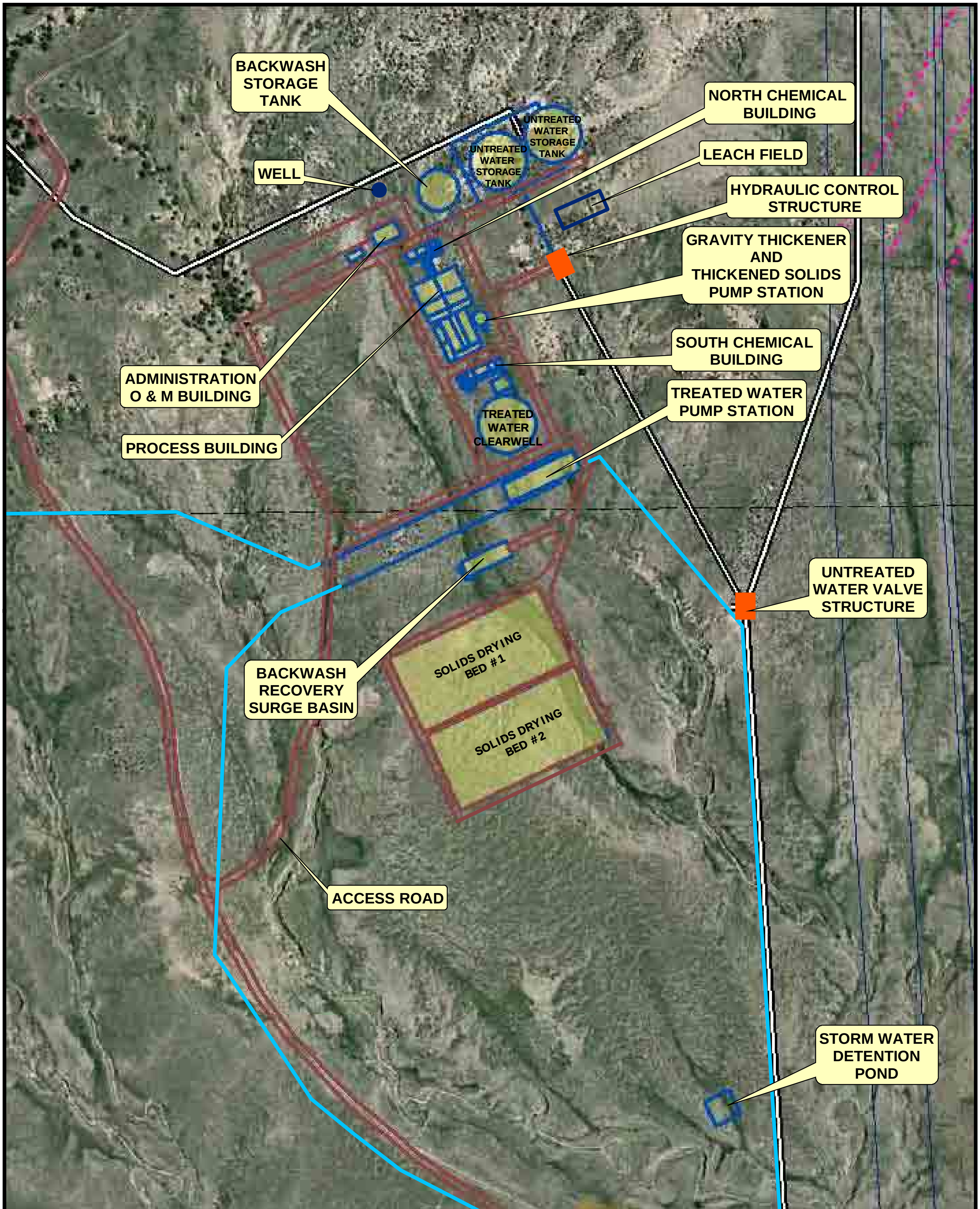

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Project: Southern Delivery System
Prepared By: CH2MHILL
Date: October 30, 2008
Source: (see text)

Legend

UNTREATED WATER PIPELINE
TREATED WATER PIPELINE
EXISTING OVERHEAD ELECTRIC CORRIDOR
ACCESS ROADS
EL PASO COUNTY PARCELS

0 250 500 1,000 Feet

Figure 12. Preliminary Layout for Jimmy Camp Creek Water Treatment Plant.

- Liquid oxygen and carbon dioxide outdoor tank storage pads
- Filtration building
- Treated water storage tanks and pump station
- Backwash wastewater recovery and recycle pump station facilities
- Clarification solids thickening and thickened sludge pump station facilities and solids drying beds
- A connection to an existing electrical transmission line
- Primary electrical and generator building

Water treatment plant structures would be between 20 and 40 feet high. No open bodies of water would be present at the site. Chemical requirements are identified in Table 6. A one-month supply of each chemical would typically be maintained on-site.

Table 6. Water Treatment Plant Chemical Requirements.

Chemical	Total Storage Volume (gallons)
Sulfuric Acid	21,780
Ferric Chloride	21,747
Sodium Bisulfite	369
Anionic Polymer	297
Nonionic Polymer	15
Sodium Hydroxide	32,104
Sodium Hypochlorite	8,772
Carbon Dioxide	120,000 pounds

Source: CH2M HILL 2005d.

Treated Water Conveyance

A network of buried pipelines (36- to 66-inch diameter) and a booster pump station would be constructed to convey treated water from the water treatment plant at Jimmy Camp Creek.

Part of the Colorado Springs Treated Water Pipeline would head northwest around the Jimmy Camp Creek Reservoir Dam and adjacent woodlands to a booster pump station (Reduced Northfield Booster Pump Station) that would be about 0.7 mile east of U.S. 24 and 2 miles north of the intersection of U.S. 24 and Colorado 94 (Figure 9). The Reduced Northfield Booster Pump Station would convey treated water to northerly areas of Colorado Springs' water distribution system. The booster pump station would be east of U.S. 24, about 2.3 miles north of Marksheffel Road. Structures for this 109-mgd (50 mgd initially) facility would be similar to those described for the Highway 115 Untreated Water Pump Station No. 1 described above, although slightly larger (CH2M HILL 2005e). A 5-million gallon aboveground storage tank also would be constructed at the pump station site. Power would be supplied through a connection to existing Colorado Springs electrical transmission lines located adjacent to the Reduced Northfield Booster Pump Station site.

A pipeline would head west from the booster pump station along Constitution Avenue and connect to Colorado Springs' existing water distribution system at Powers Boulevard. West of U.S. 24, a tee would be constructed and a pipeline would head north along the east side of Marksheffel Road, possibly with a portion following an existing Colorado Interstate Gas Company natural gas pipeline, and connect to Colorado Springs' existing water distribution system about 1.5 miles south of Woodmen Road. A second part of the Colorado Springs Treated Water Pipeline would head south from the water treatment plant to Colorado 94, west along Colorado 94, west on Space Village Avenue, and connect to

Colorado Springs' existing water distribution system near Air Lane.

Return Flow Reservoir

A new return flow reservoir would be constructed about 3.5 miles south of Squirrel Creek Road and 4 miles east of Old Pueblo Road on Williams Creek (Figure 13). The Williams Creek Reservoir would be able to store 28,500 ac-ft of water (25,000 ac-ft active storage and 3,500 ac-ft dead storage).

The dam and reservoir area would occupy about 1,057 acres. Colorado Springs owns all of the land at this site, including a 1,000-foot buffer around the water line of the proposed reservoir for water quality protection. The maximum water surface elevation would be about 5,481 feet above sea level, or 71 feet deep, for normal operations. Usage of this capacity would vary among alternatives (Section 3.5). Releases would be made to pass native flows from the Williams Creek Basin, including flood flows, and to make exchanges. No recreational uses are proposed for this facility.

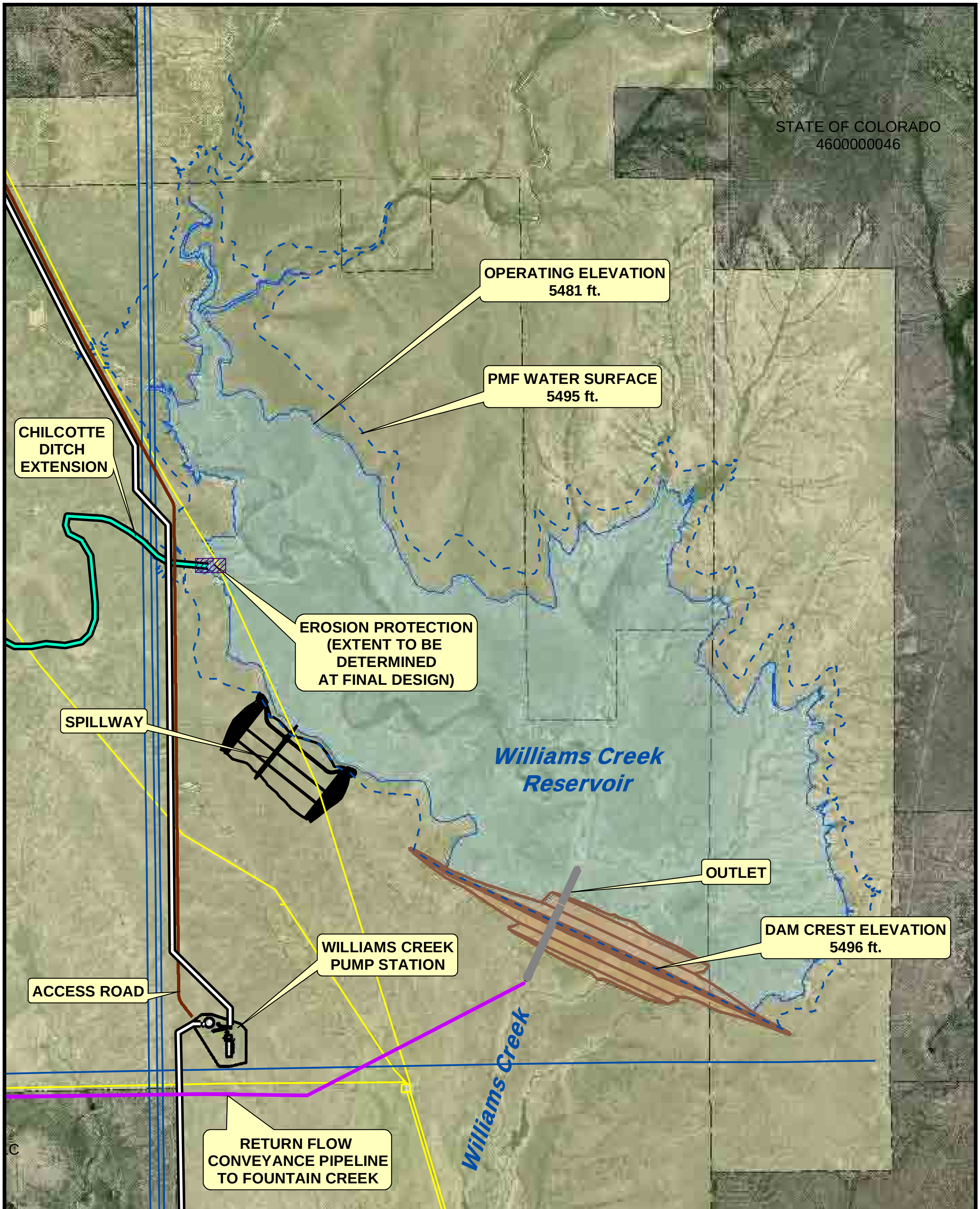
The reservoir would be formed by construction of one earthfill embankment (GEI 2005b). A dam across Williams Creek would be about 3,600 feet long with a maximum height of 102 feet above the downstream streambed. The dam core would be constructed of clayey material produced by processing materials from the reservoir site. Upstream and downstream shells and stability berms would be constructed of surficial materials and weathered bedrock from the site. Construction staging areas would be within the reservoir site or adjacent to the right dam abutment. Annual seepage is estimated to be up to 40 ac-ft (about 0.05 cfs).

A concrete spillway, sized to pass the Probable Maximum Flood, would be located on the right abutment of the dam. A single level outlet works would be located through the dam along the left side of Williams Creek. The outlet works would be configured to deliver up to 300 cfs to Fountain Creek via a pipeline for releases of return flows (discussed below) and to make releases to Williams Creek to meet the Colorado State Engineer's criteria for reservoir drawdown (based on dam safety) and stormwater release (based on water rights). Power would be supplied by Mountain View Rural Electric Association through a connection to existing Tri State Generation and Transmission Association electrical transmission lines located adjacent to the dam site. Access to the dam would be provided from a gravel road originating at Squirrel Creek Road. The spillway would be ungated and would operate whenever the reservoir inflow caused the reservoir elevation to exceed the spillway crest elevation. Although the reservoir would provide incidental flood control benefits, it would not be operated as a flood control reservoir.

Return Flow Conveyance

Colorado Springs' reusable return flows would be diverted from Fountain Creek via the existing Chilcotte Ditch and a proposed extension (CH2M HILL 2005f), stored in the proposed Williams Creek Reservoir, and returned to Fountain Creek via a pipeline. Improvements to Chilcotte Ditch would be required to convey up to 130 cfs of water to the reservoir and up to 32 cfs for continued ditch operations.

Chilcotte Ditch is an existing canal that diverts water from Fountain Creek and delivers it to users located near Security and Fountain. Water is diverted from Fountain Creek using a concrete and grouted rock dam. The dam is split in two by an island near the east side of the creek. Flow at the far east side of the



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Date: October 30, 2008
Source: (see text)

Legend

- UNTREATED WATER PIPELINE
- RETURN FLOW PIPELINE
- GAS PIPELINE
- EXISTING OVERHEAD ELECTRIC
- PARCELS OWNED BY OTHERS
- CITY OF COLORADO SPRINGS PARCELS

0 1,000 2,000 4,000 Feet

Figure 13. Preliminary Layout of Williams Creek Reservoir.

creek, east of the island, enters the Chilcotte Ditch headgates. Flow is fed into the canal by gravity and meanders for about a mile through riparian habitat in the Fountain Creek Regional Park, Cattail Wildlife Area. Once leaving the Wildlife Area, the canal runs southeast for about 10.7 miles until it terminates about 1.3 miles from the Williams Creek Reservoir site. A canal extension would be constructed and a natural drainageway used to convey flow to the reservoir. Other canal improvements would include replacing the headgates, reshaping and lining the channel, and replacing pipes and siphons as detailed in Section 2.5.4.

A 5-mile long, 84-inch diameter buried pipeline would convey up to 194 mgd (300 cfs) of return flows west from Williams Creek Reservoir to Fountain Creek parallel to an existing electric transmission corridor (Figure 9). An energy dissipation structure would be constructed at the return flow site to minimize effects on the stream channel. The discharge would be located immediately downstream of the existing Owen and Hall diversion.

Denver Basin Ground Water System

Ground Water Wells

The Denver Basin ground water system would consist of new wells north or northeast of Colorado Springs and a ground water collection and conveyance system. About 30 wells would be installed in the Denver, Arapahoe, and Laramie-Fox Hills aquifers within the Denver Basin (HRS 2007). Pumping rates would be about 0.1 mgd in 2044 increasing to 4.5 mgd in 2046 as demand increases. The Denver Basin ground water pumping system would be on-line in 2029 to assure firm yield based on the planning forecast demands. However, the most likely first use of the Denver Basin ground water system would be in 2044 based on the revenue forecast demands. The relative distribution of wells among the Denver, Arapahoe, and Laramie-Fox Hills aquifers would ultimately be determined by site-specific geologic and logistic conditions. The approximate locations of the well sites are shown in Figure 9. Well depths would be about 700 to 1,700 feet for the Denver aquifer, 1,100 to 2,100 feet for the Arapaho aquifer, and 1,800 to 2,500 feet for the Laramie-Fox Hills aquifer (HRS 2008).

Individual well sites would range in size from about 0.25 to 0.5 acre. Wellhead facilities would vary from site to site depending on the types of controls and equipment that would be required for each well site. Relatively simple wellhead facilities would consist of only a well, pump, controls, and a limited amount of electrical equipment. For these installations, 1 to 3 feet of well casing, a well cap, and an electrical junction box would be visible at the surface. Alternatively, wellhead equipment may be housed in a below-grade enclosure, where only an access hatch would be visible at the surface. Power would be supplied to the well sites through connections to existing Colorado Springs transmission lines. Some line extensions may be required for more remote well sites.

In addition to the wellhead equipment described above, system components such as meters, piping, and controls also would be located at the central collection sites. These components would be housed in below-grade vaults or above-grade buildings adjacent to the wellheads. For below-grade vault structures, access hatches, and air vents would be the only components visible at the surface. Well site buildings would typically be one story tall and contain instrumentation and controls. These structures would generally occupy an area between 100 to 400 square feet and be constructed from materials such as concrete, brick, or masonry block to match the architectural character of the surrounding area. Equipment such as electric transformers, meters, and some controls typically would be installed on concrete pads adjacent to the well site building.

Ground Water Collection and Conveyance
Ground water would be pumped from individual wells to a central collection site for each group of two to three wells. Collection pipelines would range in diameter from 8 to 16 inches. Ground water would be pumped from these collection sites to a common, 20-inch diameter collection pipeline and conveyed to the Jimmy Camp Creek Reservoir.

Non-structural
The principal non-structural components of Colorado Springs' No Action Alternative would be:

- Long-term Excess Capacity Contract – A long-term excess capacity contract with Reclamation for Pueblo Reservoir would not be required
- Long-term Conveyance Contract – A contract with Reclamation for conveyance through Pueblo Reservoir facilities would not be required because there would not be a connection to Pueblo Dam
- Long-term Exchange Contract – A contract with Reclamation for exchange into upper Arkansas River Basin storage would not be required
- Pueblo Flow Management Program – Colorado Springs and Fountain would not participate in the Pueblo Flow Management Program (PFMP, Section 3.2.6.1)
- Upper Arkansas Voluntary Flow Management Program (UAVFMP, Section 3.2.6.1) – Compliance with the UAVFMP target flows would not be required
- Restoration-of-Yield (ROY) Storage – Colorado Springs and Fountain would maintain ROY storage in the lower Arkansas River Basin through a contract with the Holbrook Reservoir and Canal Company. Up to 6,200 ac-ft of space in existing Holbrook Reservoir would be made available to ROY storage on a space-available basis. This space would be used for storage of reusable return flows that could not be diverted or stored elsewhere. Holbrook Reservoir is the only ROY storage site presently known
- Fountain Valley Authority Connection Approval – An agreement between Fountain and Colorado Spring, and approval by Reclamation, to allow an administrative trade of SDS untreated water pipeline capacity for capacity in the FVA would not be required.
- Chilcotte Ditch Conveyance Contract – An agreement between Colorado Springs and the Chilcotte Ditch Company would be needed to convey return flows through the existing Chilcotte Ditch

2.2.1.2 Fountain Components
Fountain likely would meet its future water demand through additional ground water development. As discussed in Section 3.1.3.1, Fountain plans to develop a ground water collection, treatment, and transmission system (Fountain Creek Alluvial Wellfield system) to meet 8,800 ac-ft/yr of its projected demand (Black & Veatch 2007; CH2M HILL 2007b). This system would use Fountain Creek alluvial ground water and would be independent of the proposed SDS Project. In the No Action Alternative, this system would be expanded.

The expansion would include additional wells and expanded ground water collection and treatment waste disposal facilities. These additional facilities are described in the sections below. The capacity of planned untreated water storage, water treatment, treated water conveyance systems would be increased slightly (CH2M HILL 2007b); however, the environmental effects (e.g., surface disturbance) would not be substantially different with or without the increase. Consequently, these facilities are not described further in this FEIS.

Structural

Ground Water Wells

Five new wells would be added to the Fountain Creek Alluvial Wellfield system on the southern edge of Fountain extending south along Old Pueblo Road (Figure 9). Only approximate locations are shown in the figure because specific locations for the wells have not been determined. Power would be supplied to the wells through connections to existing electric lines along Old Pueblo Road.

Because the wellfield would pump alluvial ground water that is tributary to Fountain Creek, all pumping would require augmentation. Fountain would be required to augment surface water flows depleted by additional ground water pumping in its No Action Alternative. Colorado water court approval would be required for the augmentation plan. Fountain's existing water rights would not be adequate to meet the augmentation requirements. Fountain would acquire and transfer about 1,070 ac-ft of Fountain Creek agricultural water rights to meet augmentation requirements (Black & Veatch 2007). Fountain has not identified specific agricultural water rights to be acquired.

Untreated Water Conveyance

Ground water from the No Action wells would be conveyed to the Fountain Creek Alluvial Wellfield system using one pump per well and a pipeline about 1.5-mile long and ranging in size from 12 to 20 inches in diameter. This pipeline would connect to the aforementioned ground water collection, treatment, and distribution system that Fountain will construct independently of the proposed SDS Project and No Action Alternative.

Treatment Waste Disposal

Fountain anticipates treating about 50 percent of its ground water supply with reverse osmosis. Reverse osmosis (RO) is a process that removes salts, metals, and viruses by "pushing" water through a membrane, leaving the impurities and some water behind. Water that does not pass through the membrane has a high concentration of impurities and therefore must be rejected as waste. About 85 percent of the water that would enter the reverse osmosis treatment process would emerge as treated water, while the remaining 15 percent would be reject waste. Because of the volume and high concentration of impurities in the reject waste stream, it is likely that it could not be discharged into surface streams or ground water aquifers due to Colorado discharge regulations. As discussed in Section 3.1.3.1, Fountain will likely construct about 400 acres of ponds for solar evaporation of the reverse osmosis waste (brine) for the independent ground water development project. In the No Action Alternative, Fountain would likely increase the solar evaporation facilities by about 96 acres (CH2M HILL 2007b). The specific location for these facilities has not been determined. The effects of this additional 96 acres would be minor in the overall context of the No Action Alternative and are not analyzed in this FEIS.

Non-structural

The principal non-structural components of Fountain's No Action Alternative would be the same as those described for Colorado Springs, except a Chilcotte Ditch Conveyance Contract would not be required (Section 2.2.1.1). Fountain would not participate in the PFMP, because the untreated water intake would not be from Pueblo Dam.

2.2.1.3 Security Components

Security would meet projected future water demand through one of three potential options: acquiring new exchange water rights on the Arkansas River for delivery through Colorado Springs' No Action Alternative, acquiring new rights to ground water in the Fountain Creek alluvial aquifer, or acquiring an additional allocation of ground water (in part through constructing aquifer recharge facilities) from the Widefield Aquifer (CH2M HILL 2007c). The option of acquiring additional ground water from the Fountain Creek alluvial aquifer (Figure 9) is analyzed in this FEIS. This option represents an intermediate level of potential environmental effects from the range of effects that may be associated with the three potential options.

Structural

Agricultural or municipal ground water rights would be purchased and transferred to municipal use by Security. Security has not identified specific water rights to be acquired. This additional ground water would likely be withdrawn at some of Security's existing wells, disinfected, and distributed to customers using existing infrastructure. Security would use Fountain Creek agricultural water rights that it recently acquired to meet augmentation requirements.

Non-structural

The principal non-structural components of Security's No Action Alternative would be the same as those described for Colorado Springs, except a Chilcotte Ditch Conveyance Contract would not be required (Section 2.2.1.1).

2.2.1.4 Pueblo West Components

Pueblo West would likely meet projected future water demand by implementing the 18-mgd intake portion of a project previously approved by Reclamation (2003).

Structural

An inflatable rubber diversion dam spanning the Arkansas River would be constructed downstream of Pueblo Dam (CH2M HILL 2007d). The design would be similar to that of the Highway 115 Untreated Water Intake in Colorado Springs' No Action Alternative (Section 2.2.1.1). Flows would be diverted to the north bank of the river via a new sluiceway with screening facilities and then to sedimentation basins. A 200-foot, 36-inch diameter pipeline would be constructed to convey water from the sedimentation basins to Pueblo West's existing pump station. The pump station would convey water to Pueblo West's water treatment plant via a 36-inch diameter pipeline that was constructed in 2005.

Non-structural

The principal non-structural components of Pueblo West's No Action Alternative would be the same as those described for Colorado Springs except a Chilcotte Ditch Conveyance Contract would not be required (Section 2.2.1.1).

2.2.1.5 Schedule

Colorado Springs' Arkansas River conveyance system, Jimmy Camp Creek Reservoir, water treatment plant (50-mgd capacity), treated water conveyance (booster pump station 50-mgd capacity), and FVA facilities would be constructed between 2009 and 2012 (CH2M HILL 2008a). Between 2021 and 2024, Williams Creek Reservoir would be constructed and the capacity of the conventional water treatment plant and treated water booster pump station would be increased to 109 mgd. The treated water connection to the Highline Zone (Appendix A, Section A.2.1.1) would also be added during this time. The Ark-Otero intake upgrades and Colorado Springs' Denver Basin ground water system would be constructed by 2027. The ground water systems for Security and Fountain, as well as Pueblo West's river intake, would be constructed between 2009 and 2012. Construction schedules presented in this FEIS are based on current information and may change slightly based on future conditions.

2.2.1.6 Cost, Energy Use, and Yield

Total capital cost for the No Action Alternative is estimated to be about $1.307 billion (CH2M HILL 2008a). Total operations and maintenance cost between 2012 and 2046 is estimated to be about $702 million. The distribution of costs among Participants for this and all other alternatives is discussed in Section 3.15). The average and peak year construction workforce is summarized in Table 7.

To meet 2046 water demands, average energy use would be about 661 megawatt hours per day (MW·h/d) (CH2M HILL 2008b). Firm yield and SMAPD for each Project Participant are summarized in Table 8. As noted previously, Denver Basin ground water is a non-renewable supply. When this supply is exhausted, SMAPD for Colorado Springs would be reduced by about 11 percent.

Table 7. No Action Construction Workforce.

Construction Workforce (employees/day)	Phase I (2009-2012)	Phase II (2015-2017)	Phase III (2021-2028)
Average	949	0	232
Peak Year	1,247	0	404

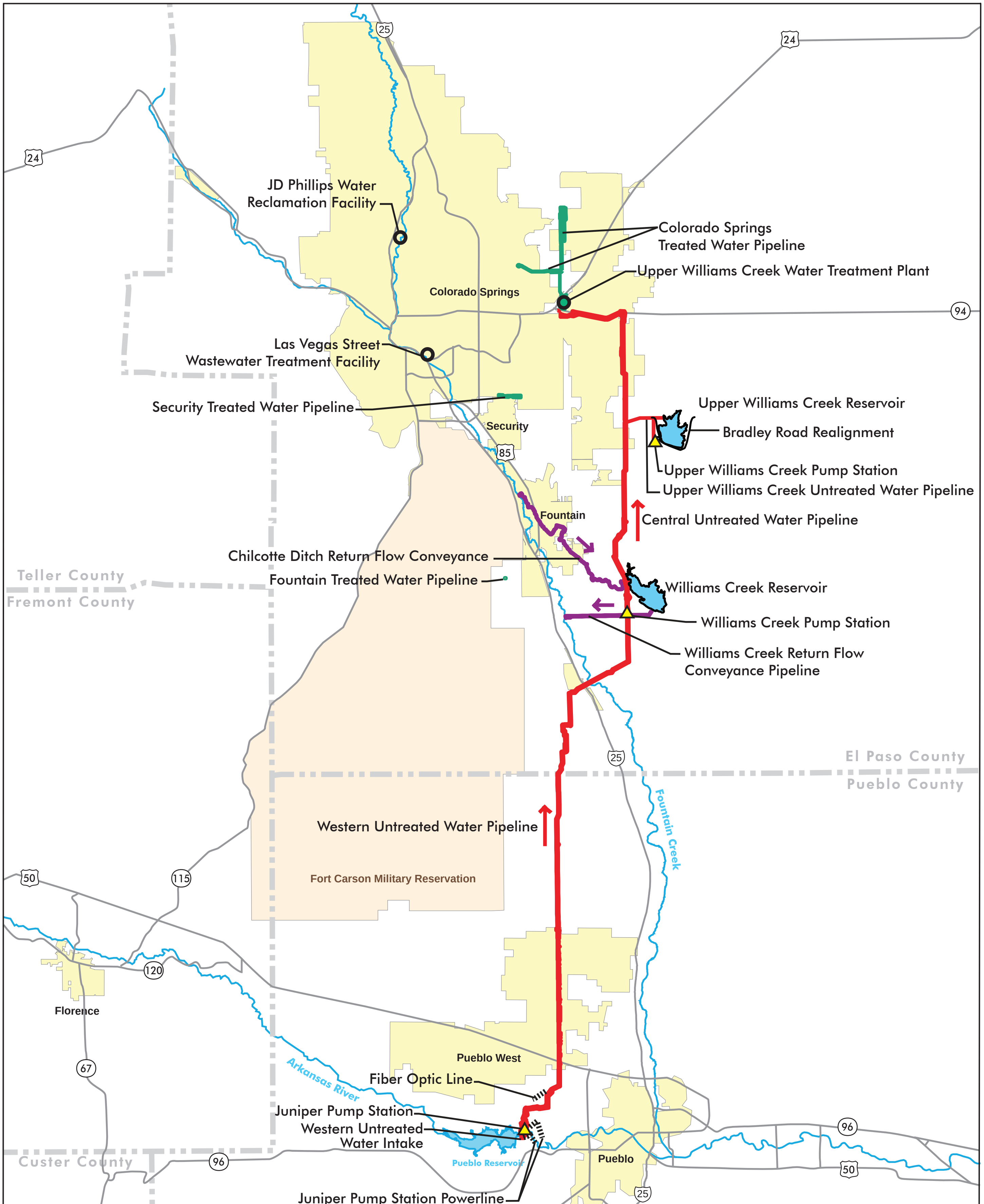
Table 8. Yield for No Action Alternative at 2046 Demands.

Participant	Firm Yield (ac-ft)	SMAPD (ac-ft)
Colorado Springs	38,000	47,300
Fountain	2,500	2,500
Security	1,500	1,500
Pueblo West	500	1,100

Source: Reclamation 2007a (Colorado Springs); Black & Veatch 2004 (Fountain); Harding 2004 (Security); Higgins 2005 (Pueblo West).

2.2.2 Participants' Proposed Action

The Participant' Proposed Action is the Participants' proposal to construct and operate the SDS Project. Untreated water would be stored in, exchanged through, and diverted from Pueblo Reservoir, stored in a new reservoir on upper Williams Creek, treated, and distributed to the Participants' customers (Figure 14). A portion of Colorado Springs' reusable return flows would be stored in a new reservoir on Williams Creek prior to exchange down Fountain Creek. The following subsections describe this alternative in more detail. Construction and restoration methods for all alternatives are described in Section 2.5 and any alternative-specific methods are described below. Operational characteristics for all alternatives are described in Appendix D.



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Untreated Water Conveyance
Treated Water Conveyance
Return Flow Conveyance
Reservoir
Powerline
Pump Station
Water Treatment Plant
Wastewater Treatment Plant (Not Part of SDS)

0 3 6 Miles

N

Figure 14. Participants' Proposed Action.

2.2.2.1 Components

Structural

Regulating Storage

Like all Action Alternatives, the Participants' Proposed Action would use up to 42,000 ac-ft of excess storage capacity in Pueblo Reservoir. Colorado Springs would use 28,000 ac-ft, Fountain 2,500 ac-ft, Security 1,500 ac-ft, and Pueblo West 10,000 ac-ft. Pueblo Reservoir has existing capacity to store 42,000 ac-ft of water on an as-available basis and no modifications would be made to the reservoir or dam.

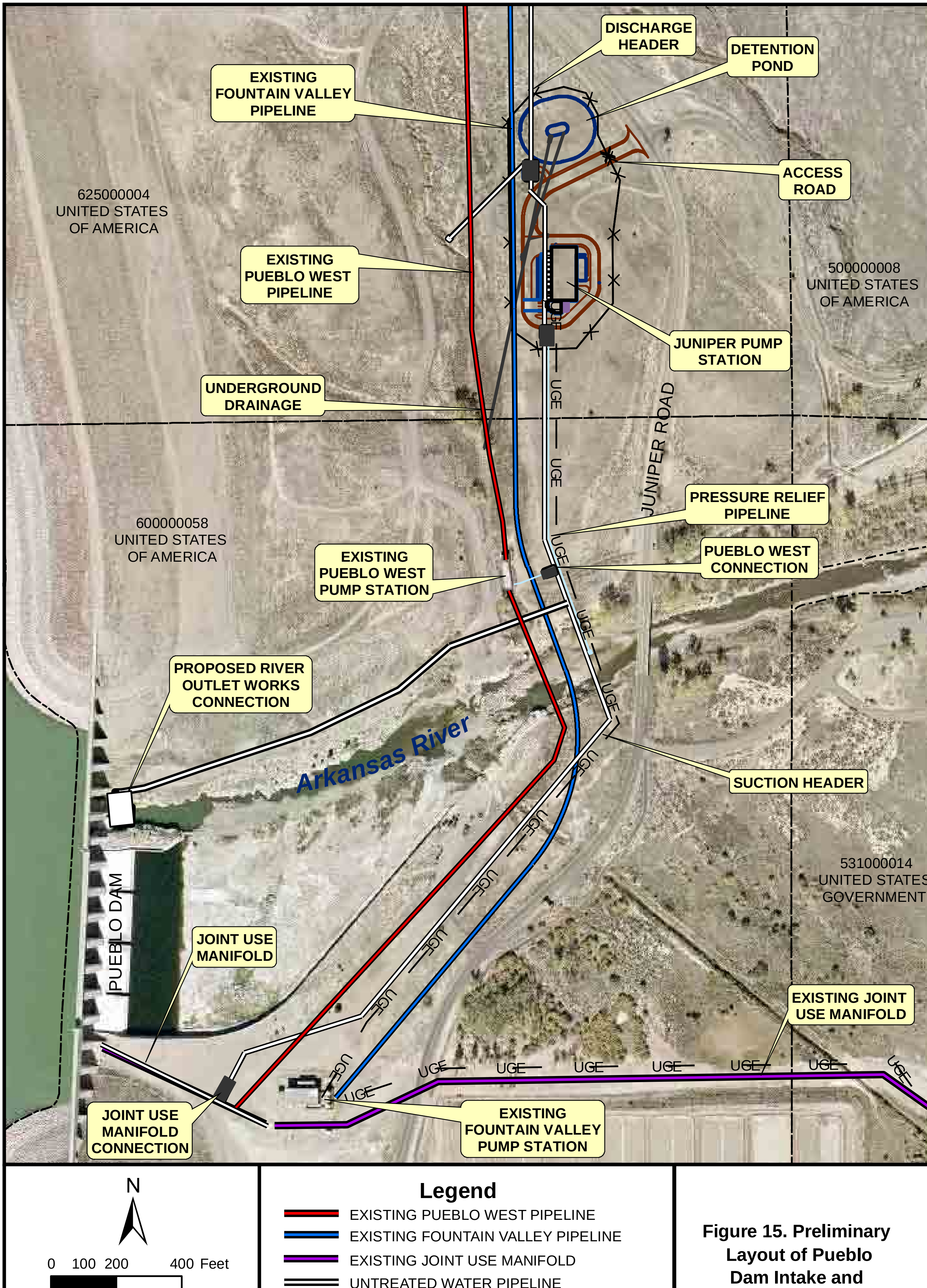
Untreated Water Intake

Untreated water would be obtained through connections with the existing Joint Use Manifold and River Outlet Works at Pueblo Dam (CH2M HILL 2006a). Two connections would be required because the Joint Use Manifold connection would become hydraulically limited in the future when increased demands (by others) are placed on the Joint Use Manifold pipeline. Connections to the River Outlet Works and the Joint Use Manifold would achieve the total required flows from Pueblo Reservoir. The construction sequence of these connections is based on current planning and could change in the future.

A tie-in to the Joint Use Manifold would be constructed at a 120-inch by 78-inch tee connection to the existing Joint Use Manifold (existing Arkansas River intake facility that was used as its main municipal diversion structure, Figure 15). The tie-in structure would consist of an approximate 33-foot by 20-foot concrete vault (buried), which would house the main SDS pipeline isolation valve. From this location, a 78-inch untreated water suction pipeline would head north and cross beneath the Arkansas River. The total length of the 78-inch pipeline would be about 2,200 feet. On the north side of the Arkansas River, a turnout would be constructed for water delivery to the Pueblo West Pump Station. A 78-inch by 36-inch tee connection would be installed. From this point, a 36-inch welded steel pipeline would head west towards the Pueblo West Pump Station and tie into an existing suction header. The length of the 36-inch pipeline from the turnout to Pueblo West Pump Station would be about 140 feet.

Connection to the Joint Use Manifold would require substantial coordination with Reclamation and other manifold users. The total construction time for the tie-in would be about seven days; however, the actual required shutdown time may be less. Prior to the shutdown, the contractor would prefabricate a tee with a shut-off valve on the branch. The pipeline would then be shutdown, drained to the Arkansas River, cut, and the fabricated tee welded into place and the mortar lining repaired. Construction would be scheduled for a 24- to 36-hour period on a weekend between November and February to correlate with a low water demand period. During this shutdown, existing users of the manifold could obtain water in the same manner that was used successfully when the Joint Use Manifold was shut down in 2000.

The Pueblo Board of Water Works' Whitlock water treatment plant, which receives water through the Joint Use Manifold, may have two options during the shutdown period. The first would be to fill all available water storage tanks to their maximum capacity before shutdown and to draw them down during the shutdown. The second would be to use its existing Arkansas River intake facility that was used as its main municipal diversion structure



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Source: (see text)

Legend

- EXISTING PUEBLO WEST PIPELINE
- EXISTING FOUNTAIN VALLEY PIPELINE
- EXISTING JOINT USE MANIFOLD
- UNTREATED WATER PIPELINE
- ACCESS ROADS
- UGE — UNDERGROUND ELECTRIC
- PARCELS OWNED BY OTHERS

Figure 15. Preliminary Layout of Pueblo Dam Intake and Juniper Pump Station.

prior to 2000 and continues to be used occasionally. FVA and Pueblo West, which receive water through the Joint Use Manifold, do not have alternative intake facilities. Colorado Springs would obtain water from its other sources while the other FVA customers and Pueblo West would use well water and would fill available water storage tanks to their maximum capacity prior to the shutdown and draw them down during the shutdown.

A tie-in to the River Outlet Works would include connecting a 72-inch, welded steel pipeline from the River Outlet Works to the 78-inch pipeline constructed for the Joint Use Manifold tie-in. This connection would be located upstream of the 30-inch turnout to Pueblo West Pump Station. The length of the 72-inch pipeline would be about 1,500 feet.

Beyond the turnout to Pueblo West, the 78-inch pipeline would be reduced to a 72-inch pipeline that would connect to the proposed Juniper Pump Station (discussed in the next subsection). An 8-inch pressure relief pipeline would be connected to the 72-inch suction pipeline at the pump station. A pressure relief valve would be required to prevent high internal pressures that could result from the SDS pipeline when the pump station is not operational. A vault on the pump station site would house a pressure relief valve. Once outside of the vault, the 8-inch pressure relief pipeline would head south and terminate at the Arkansas River. The length of the 8-inch pressure relief pipeline from the vault to the Arkansas River would be about 850 feet.

Untreated Water Conveyance

The untreated water conveyance for the Participants' Proposed Action would consist of a 53-mile pipeline and three pump stations. Pump stations would be located east of Pueblo Dam (Juniper Pump Station), near Williams Creek east of Fountain (Williams Creek Pump Station), and adjacent to Upper Williams Creek Reservoir (Upper Williams Creek Pump Station).

The untreated water pipeline (66-inch diameter) would begin at the Juniper Pump Station and head north toward a new terminal storage reservoir in upper Williams Creek southeast of Colorado Springs. The pipeline would then continue north to a new water treatment plant east of Colorado Springs. At Bradley Road, southeast of Colorado Springs, this pipeline would head east for about 4.5 miles, connecting to the reservoir. The pipeline (increased to 72-inch diameter) would then resume at the dam and head west from the reservoir along the same general alignment. Because the terminal storage reservoir would not be constructed until the second phase of the SDS Project (Figure 8), the 66-inch and 72-inch segments of the untreated water pipeline would be connected with a forebay near Bradley Road. The pipeline reach between the Juniper Pump Station and Williams Creek Pump Station is referred to as the "Western Untreated Water Pipeline" (Figure 14).

The Juniper Pump Station would be on the north side of the Arkansas River, just northeast of the Pueblo West Pump Station, between Juniper Road and Spillway Road (CH2M HILL 2005g). This pump station would be similar to the Highway 115 pump stations described in Section 2.2.1.1). Power would be supplied through one of two new underground or overhead electrical transmission lines that would connect existing Black Hills Corporation lines south of the Arkansas River to the Juniper Pump Station site. An electric substation would probably not be required at this site. A buried fiber optic line supporting telecommunications for the Juniper Pump Station would be extended from the untreated water pipeline to the existing FVA surge tank at the top of bluffs overlooking the Arkansas

River. Construction and restoration for this line would be similar to that described for pipelines (Section 2.5.3).

The Williams Creek Pump Station would be about 4.7 miles south of Squirrel Creek Road and 2.9 miles east of Old Pueblo Road. Pump station facilities would be similar to those described for the No Action pump stations (CH2M HILL 2003b, 2003c). A 135-foot diameter forebay, sized for 2.5 million gallons, also would be constructed. Municipal water and sanitary sewer service are not available at this site. Consequently, an untreated water tap would be used for non-potable purposes, well water used for drinking water, and a septic system used for sanitary wastes. Power would be supplied by Mountain View Rural Electric Association through a connection to existing Tri State Generation and Transmission Association electrical transmission lines located adjacent to the Williams Creek Pump Station site.

The Upper Williams Creek Pump Station would be southwest of Upper Williams Creek Reservoir. Power would be supplied through a connection to an existing Tri State Generation and Transmission Association electrical transmission line located adjacent to the Upper Williams Creek Pump Station site.

Terminal Storage Reservoir

A new terminal storage reservoir would be constructed southeast of Colorado Springs east of the intersection of Marksheffel Road and Bradley Road on Williams Creek (Figure 16). Construction of the reservoir would require relocation of about 2 miles of Bradley Road east of Marksheffel Road. The Upper Williams Creek Reservoir (referred to as "Reservoir No. 16" in some earlier SDS Project documents) would be able to store 30,500 ac-ft of water (28,000 ac-ft active storage and 2,500 ac-ft dead storage).

The dam and reservoir area would occupy about 950 acres. A buffer about 1,000 feet around the normal water surface elevation would be acquired for water quality protection (CH2M HILL 2005b). The maximum water surface elevation would be about 5,997 feet above sea level, or 120 feet deep, for normal operations. Releases would be made to pass native flows from the Williams Creek basin, including flood flows. Recreational uses such as boating, fishing, hiking, and picnicking are proposed for this facility. Specific facilities to support these uses have not been defined.

The reservoir would be formed by construction of an earthfill embankment (CH2M HILL 2007f). A main dam across Williams Creek would be about 7,600 feet long with a maximum height of 113 feet above the downstream streambed. The dam core would be constructed of clayey material produced by processing alluvium from the reservoir site. Upstream and downstream shells and stability berms would be constructed of surficial materials and weathered bedrock from the site. The construction staging area would be within the reservoir site. Annual seepage is estimated to be up to 830 ac-ft (1.15 cfs).

A multilevel outlet works would be located through the main dam along the west side of Williams Creek. The outlet works would be configured to deliver up to 180 mgd (anticipated buildout) to the water treatment plant on a sustained basis and to make releases to Williams Creek to meet the Colorado State Engineer's criteria for reservoir drawdown (based on dam safety) and stormwater release (based on water rights). A spillway would not be constructed because the reservoir would be sized to fully contain the Probable Maximum Flood. Although the reservoir would provide incidental flood control benefits, it would not be operated as a flood control reservoir. Power would be supplied to the dam and adjacent

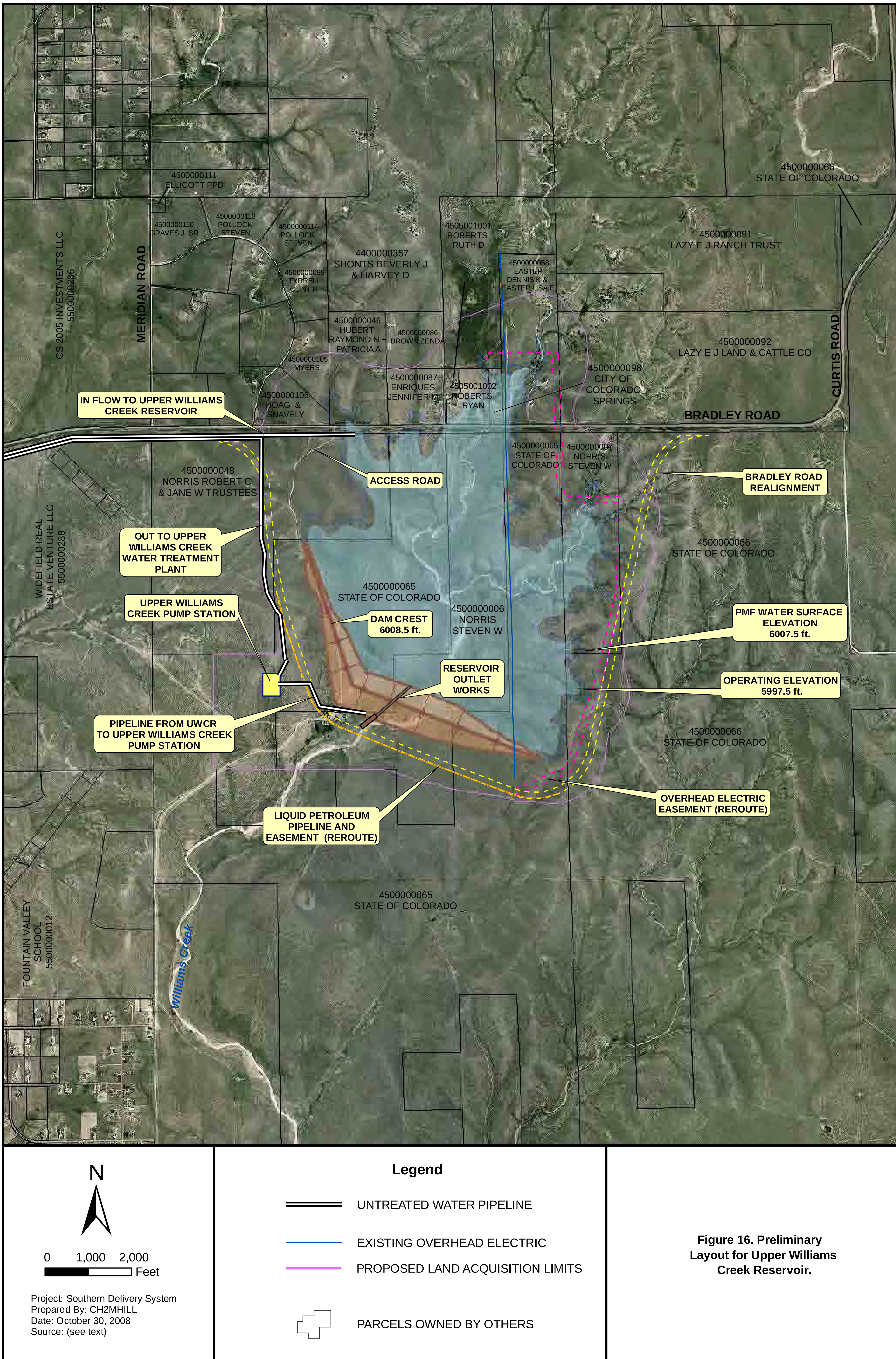

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Figure 16. Preliminary Layout for Upper Williams Creek Reservoir.

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pump station by Mountain View Rural Electric Association through a connection to an existing Tri State Generation and Transmission Association electrical transmission line located adjacent to the reservoir site.

A 2-mile long segment of Bradley Road would be rerouted to the south of Upper Williams Creek Reservoir. The new 4-mile long segment would be designed to comply with Defense Access Road requirements. A 1.5-mile long segment of a liquid petroleum pipeline would be routed south and west of the dam.

Water Treatment Plant

The water treatment plant for this alternative would be located near the intersection of U.S. 24 and Colorado 94. The components of the water treatment plant would be similar to those of the No Action Alternative (Section 2.2.1.1) except the treatment facilities layout would be adapted to the available space and the contours at the Upper Williams Creek Water Treatment Plant site (Figure 17). No open bodies of water would be present at the site.

Treated Water Conveyance

A network of buried pipelines (24- to 54-inch diameter) would be constructed to convey treated water from the water treatment plant to Colorado Springs and Security. For Colorado Springs, a pipeline would head north from the Upper Williams Creek Water Treatment Plant along the east side of Marksheffel Road, possibly with a segment following an existing Colorado Interstate Gas Company natural gas pipeline, and connect to Colorado Springs' existing water distribution system at Stetson Hills Boulevard. A second segment of the Colorado Springs Treated Water Pipeline would head west from Marksheffel Road, along Constitution Avenue, and connect to Colorado Springs' existing water distribution system near Powers Boulevard.

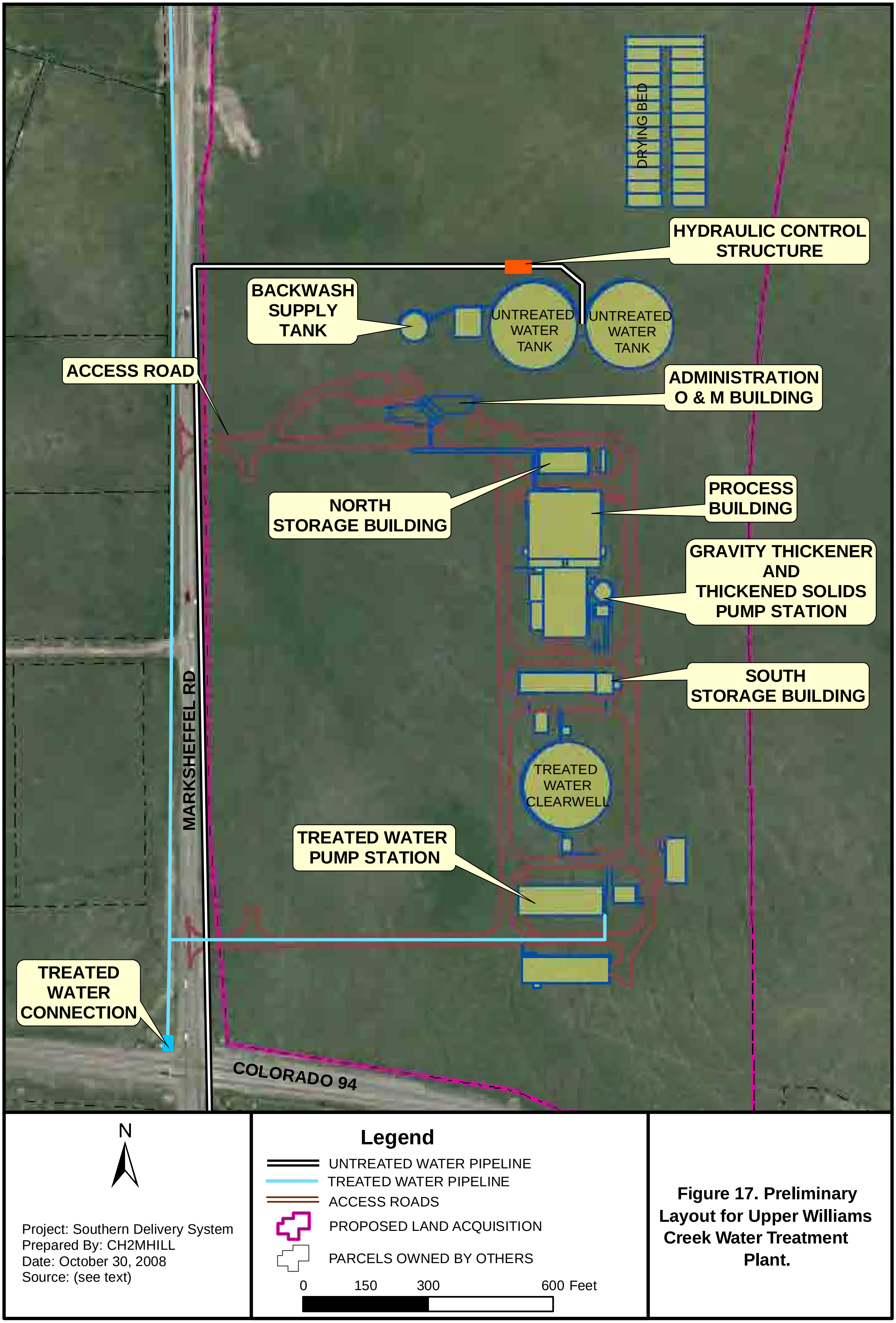
Security would receive treated water by constructing a connection to Colorado Springs' existing water distribution system. Two 12-inch diameter buried pipelines would be constructed along Drennan Road and connect to Security's water distribution system. One pipeline would originate at the intersection of Drennan Road and Hancock Expressway and head southeast for about 0.1 mile to Daredevil Drive. The second pipeline would originate at the intersection of Drennan Road and Powers Boulevard and head west for about 0.3 mile to Via Tierra Drive. Security would fund one pipeline and Colorado Springs would fund the other.

Fountain would receive treated water through a connection to the existing FVA system. About 200 feet of 18-inch diameter buried pipeline would be constructed to connect the existing FVA pipeline to Fountain's Southwest Reservoir (a storage tank). Treated water would enter Fountain's water distribution system from this tank. To accommodate Fountain's delivery of SDS Project water through the FVA, Colorado Springs would administratively trade ("swap") an equal amount of capacity in the FVA for capacity in the SDS untreated water pipeline and water treatment plant.

Pueblo West also would use its existing treated water conveyance system and would not require new construction.

Return Flow Reservoir

Return flow storage for this alternative would be the same as that of the No Action Alternative (Section 2.2.1.1). A new reservoir would be constructed at Williams Creek.



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Source: (see text)

Figure 17. Preliminary Layout for Upper Williams Creek Water Treatment Plant.

Return Flow Conveyance

Return flow conveyance for this alternative would be the same as that of the No Action Alternative (Section 2.2.1.1).

Non-structural

The principal non-structural components of the Participants' Proposed Action would be:

- Long-term Excess Capacity Contracts – The Project Participants would negotiate one or more long-term excess capacity contracts with Reclamation for storage of 42,000 ac-ft of non-Fry-Ark water in Pueblo Reservoir. The duration of these contracts would be up to 40 years.
- Long-term Conveyance Contracts – Project Participants would negotiate one or more contracts with Reclamation for 96 mgd of conveyance non-Fry-Ark water through Pueblo Reservoir facilities (Joint Use Manifold and River Outlet Works). The duration of these contracts would be up to 40 years.
- Long-term Exchange Contract – Colorado Springs would negotiate a contract with Reclamation to exchange up to 10,000 ac-ft of water between Pueblo Reservoir and the Upper Basin (Twin Lakes and Turquoise Lake) storage annually. The duration of this contract would be up to 40 years.
- Pueblo Flow Management Program – Colorado Springs and Fountain would comply with the requirements of the PFMP in accordance with the terms and conditions of the May 2004 six-party Regional Intergovernmental Agreement (described in Section 3.2.6.1). Pueblo West and Security are not signatories to the PFMP agreement and would not be required to comply with the program's requirements.
- Upper Arkansas Voluntary Flow Management Program – Compliance with the UAVFMP target flows would not be required.
- Restoration-of-Yield Storage – Colorado Springs and Fountain would maintain ROY storage in the lower Arkansas River Basin through a contract with the Holbrook Reservoir and Canal Company. Up to 6,200 ac-ft of space in existing Holbrook Reservoir would be made available to ROY storage on a space-available basis. This space would be used for storage of reusable return flows that could not be diverted or stored elsewhere. Holbrook Reservoir is the only ROY storage site presently known.
- Fountain Valley Authority Connection Approval – An agreement between Fountain and Colorado Springs, and approval by Reclamation, would be needed to allow an administrative trade of SDS untreated water pipeline capacity for capacity in the FVA system.
- Chilcotte Ditch Conveyance Contract – An agreement between Colorado Springs and the Chilcotte Ditch Company would be needed to convey Colorado Springs return flows through the existing Chilcotte Ditch.

2.2.2.2 Schedule

The Joint Use Manifold intake, untreated water conveyance, water treatment plant (50-mgd capacity), and treated water conveyance (booster pump station 50-mgd capacity) would be constructed between 2009 and 2012 (CH2M HILL 2008a). Upper Williams Creek Reservoir would be constructed between 2015 and 2017. Between 2021 and 2024, the Pueblo Dam River Outlet Works intake, Williams Creek Reservoir, and return flow conveyance would be constructed and the capacity of the water treatment plant would be increased to 109 mgd. The treated water connection to the Highline Zone (Appendix A) also would be added during this time.

2.2.2.3 Cost, Energy Use, and Yield

Total capital cost for the Participants' Proposed Action is estimated to be about $1.091 billion (CH2M HILL 2008a) (Table 5). Total operations and maintenance cost between 2012 and 2046 is estimated to be about $651 million. The distribution of costs among Participants for this and all other alternatives is discussed in Section 3.15). The average and peak year construction workforce for each phase of construction is summarized in Table 9.

To meet 2046 water demands, average energy use would be 671 MW·h/d (CH2M HILL 2008b). Firm yield and SMAPD for each Project Participant are summarized in Table 10.

Table 9. Participants' Proposed Action Construction Workforce.

Construction Workforce (employees/day)	Phase I (2009-2012)	Phase II (2015-2017)	Phase III (2021-2024)
Average	669	190	173
Peak Year	849	190	415

Table 10. Yield for Participants' Proposed Action at 2046 Demands.

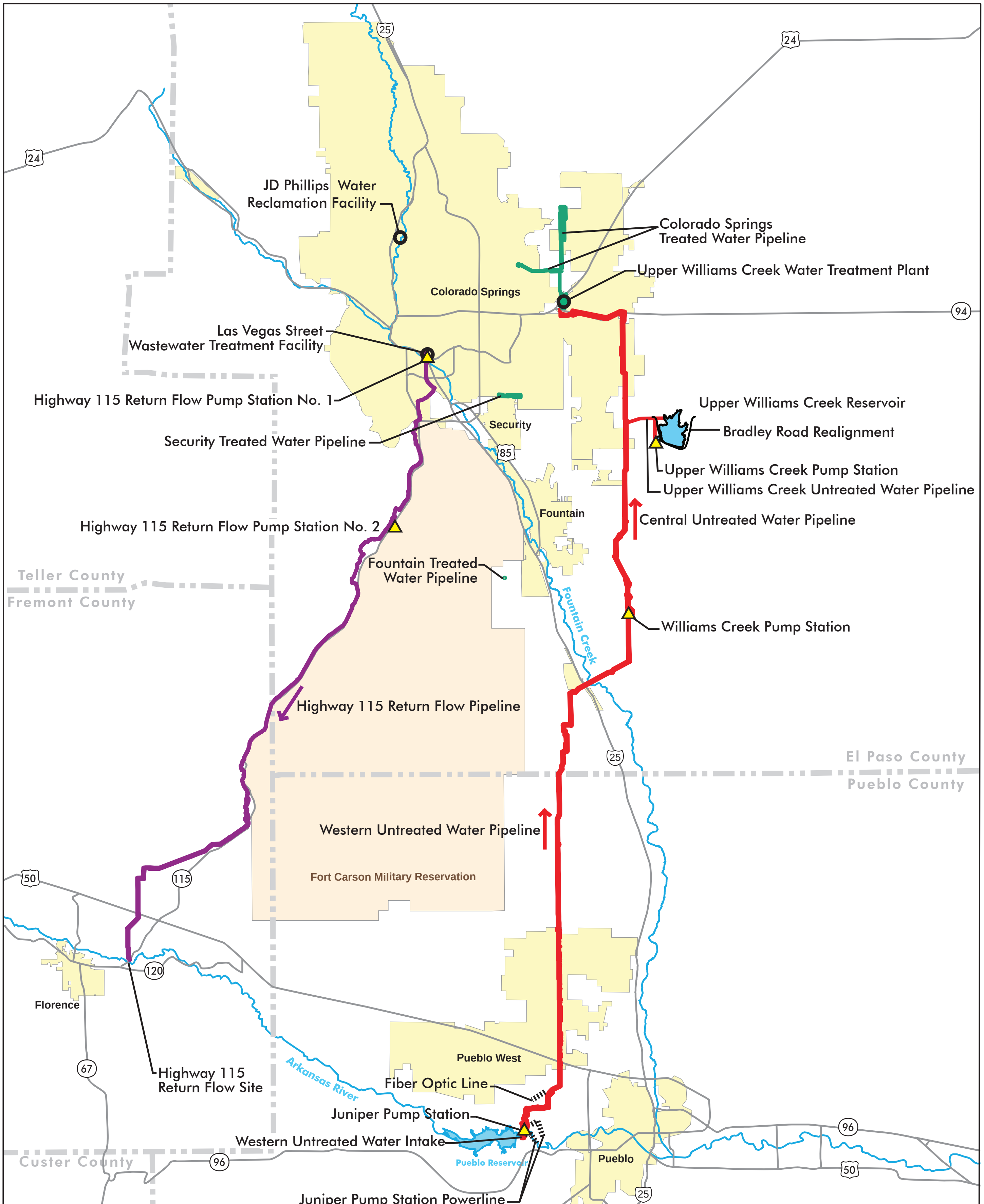
Participant	Firm Yield (ac-ft)	SMAPD (ac-ft)
Colorado Springs	38,000	47,800
Fountain	2,500	2,500
Security	1,400	1,500
Pueblo West	500	1,100

Source: Reclamation 2007a (Colorado Springs); Black & Veatch 2004 (Fountain); Harding 2004 (Security); Higgins 2005 (Pueblo West).

2.2.3 Wetland Alternative

The Wetland Alternative was designed to minimize wetland disturbance. This alternative uses a terminal storage reservoir site that would permanently disturb the least amount of wetlands and it eliminates the need for a new return flow reservoir. This alternative also was originally developed to disturb the least total surface area of land. However, due to subsequent refinement of the alternatives, the Arkansas River Alternative would disturb about 68 acres of total surface area less than the Wetland Alternative.

Untreated water would be diverted from Pueblo Reservoir, conveyed to a new reservoir or water treatment plant on upper Williams Creek, treated, and distributed to the Participants' customers (Figure 18). Colorado Springs' reusable return flows would be diverted from Fountain Creek near its existing wastewater treatment plants and piped to the Arkansas River near Colorado 115. These flows would not be exchanged down Fountain Creek. By conveying Colorado Springs' reusable return flows to a location upstream of Pueblo Reservoir, this alternative avoids the need for a new return flow reservoir such as the proposed Williams Creek Reservoir and attendant wetland effects. The following subsections describe this alternative in more detail. Construction and restoration methods for all alternatives are described in Section 2.5 and any alternative-specific methods are described below. Operational characteristics for all alternatives are described in Appendix D.



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Untreated Water Conveyance
Treated Water Conveyance
Return Flow Conveyance
Reservoir
Powerline
Pump Station
Water Treatment Plant
Wastewater Treatment Plant (Not Part of SDS)

0 3 6 Miles

N

Figure 18. Wetland Alternative.

2.2.3.1 Components

Structural

Regulating Storage
Regulating storage for this alternative would be in Pueblo Reservoir, the same as that of the Participants' Proposed Action (Section 2.2.2.1).

Untreated Water Intake
The untreated water intake for this alternative would be the same as that of the Participants' Proposed Action (Section 2.2.2.1).

Untreated Water Conveyance
The untreated water conveyance for this alternative would be the same as that of the Participants' Proposed Action (Section 2.2.2.1).

Terminal Storage Reservoir
Terminal storage for this alternative would be the same as that of the Participants' Proposed Action (Section 2.2.2.1). A new reservoir would be constructed at upper Williams Creek.

Water Treatment Plant
The water treatment plant for this alternative would be the same as that of the Participants' Proposed Action (Section 2.2.2.1). A new treatment plant would be constructed near the intersection of U.S. 24 and Colorado 94.

Treated Water Conveyance
The treated water conveyance for this alternative is the same as that of the Participants' Proposed Action (Section 2.2.2.1).

Return Flow Reservoir
A new return flow reservoir would not be constructed under this alternative. Rather, Pueblo Reservoir, without modification, would be used to store Colorado Springs' reusable return flows.

Return Flow Conveyance
Colorado Springs' reusable return flows would be collected in Colorado Springs and conveyed via a pipeline to the Arkansas River near Florence, about 20 miles upstream of Pueblo Reservoir (CH2M HILL 2005h, 2005i). Reusable return flows from two sources would be collected. Reusable flows from Colorado Springs' J.D. Phillips Water Reclamation Facility (J.D. Phillips WRF) and Las Vegas Street Wastewater Treatment Facility (LVSWWTF) would be collected and conveyed to the Fountain Mutual Irrigation Ditch.

The Fountain Mutual Irrigation Ditch is an existing canal that can divert water from Fountain Creek and deliver it to users located near Widefield, Security, and Fountain. Water is diverted from Fountain Creek using a concrete and grouted rock dam. Flow at the far east side of the creek enters the Fountain Mutual Irrigation Ditch headgates. Flow is fed into the canal by gravity and meanders for about 1 mile through the LVSWWTF. Downstream of the plant's outfall, flows can be split, with a portion returning to Fountain Creek and a portion remaining in the canal.

Collection and Intake
An 85-mgd intake would be constructed in the canal immediately downstream of the flow split structure. The intake facility would include fish and trash screens as well as a pre-sedimentation basin with mechanical solids removal equipment. Improvements to the Fountain Mutual Irrigation Ditch from the

existing diversion structure to the new intake facility would be needed to provide capacity for existing flows and the return flows. These improvements would consist of concrete lining the section of ditch and replacing the existing gates at the flow split structure as detailed in Section 2.5.4. An existing flow measurement device also would be replaced.

Conveyance to Arkansas River

Reusable return flows collected at the proposed intake on the Fountain Mutual Irrigation Ditch would be conveyed to the Arkansas River through a pipeline and two pump stations. The first pump station (Return Flow Pump Station No. 1) would be constructed adjacent to the intake on the Fountain Mutual Irrigation Ditch.

A buried pipeline ranging from 54 to 72 inches in diameter, depending upon terrain and hydraulic pressure, would be constructed to convey return flows to the Arkansas River at the Colorado 115 bridge. This 38-mile-long pipeline would originate at the Return Flow Pump Station No. 1 and would generally follow Nevada Avenue and Colorado 115. An energy dissipation structure would be constructed at the return flow site to minimize effects on the stream channel (Figure 19).

A booster pump station would be constructed to lift the return flow to a hydraulic high point located in Fremont County. From the hydraulic high point, return flows would flow under hydrostatic pressure to the return flow location at the Arkansas River. The booster pump station (Return Flow Pump Station No. 2) would be located about 0.25 mile south of the intersection of Old Canyon City Road and Colorado 115. Both pump stations would have an 85-mgd capacity and be similar to those described for the Highway 115 Untreated Water Pump Stations No. 2 and No. 3 (Section 2.2.1.1), although slightly larger. Power would be supplied through a connection to existing Colorado Springs Utilities electrical transmission line located adjacent to both sites. About 4.5 miles of new electrical line would be added to existing poles to support the increased load.

Non-structural

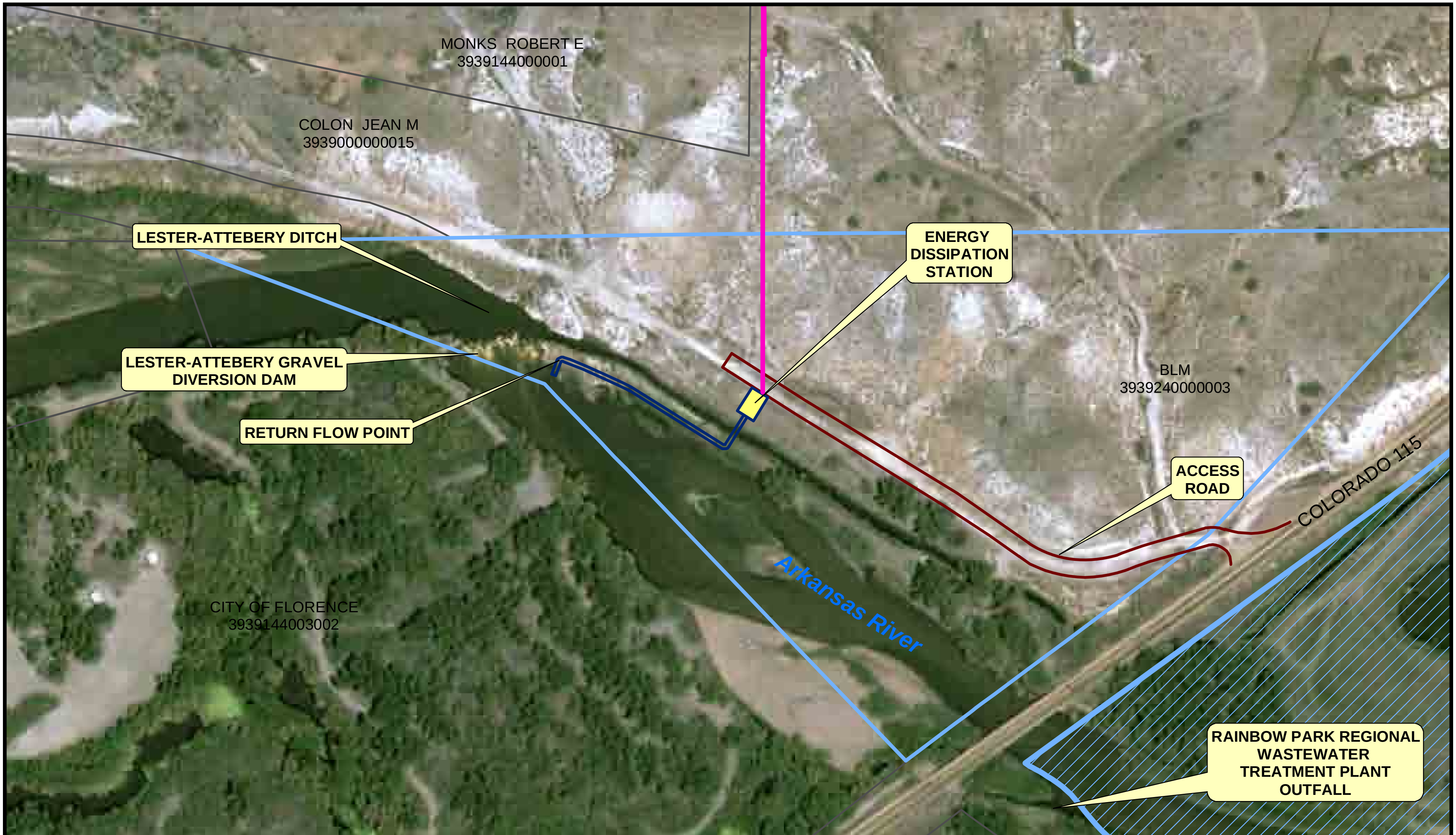
The principal non-structural components of this alternative would be the same as those of the Participants' Proposed Action with a few exceptions. An agreement between Colorado Springs and the Chilcotte Ditch Company would not be needed because Colorado Springs would not convey return flows through the existing Chilcotte Ditch. Colorado Springs would participate in the UAVFMP in this alternative.

2.2.3.2 Schedule

The construction schedule would be the same as that of the Participants' Proposed Action (Section 2.2.2.2) except for the return flow components (CH2M HILL 2008a). The return flow conveyance would be constructed between 2009 and 2012.

2.2.3.3 Cost, Energy Use, and Yield

Total capital cost for the Wetland Alternative is estimated to be about $1.243 billion (CH2M HILL 2008a). Total operations and maintenance cost between 2012 and 2046 is estimated to be about $867 million. The distribution of costs among Participants for this and all other alternatives is discussed in Section 3.15). The average and peak year construction workforce for each phase of construction is summarized in Table 11.



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N

0 200 400 Feet

Legend

- RETURN FLOW PIPELINE
- BLM - BLUE HERON ACQUISITION
- BLM - BLUE HERON RECREATION & PUBLIC PURPOSES ACT LAND
- PARCELS OWNED BY OTHERS

Figure 19. Preliminary Layout of Highway 115 Return Flow Site.

To meet 2046 water demands, average energy use would be 979 MW·h/d (CH2M HILL 2008b). Firm yield and SMAPD for each Project Participant are summarized in Table 12. For an explanation about why firm yield is larger than the SMAPD for this alternative, refer to Figure 20.

Table 11. Wetland Alternative Construction Workforce.

Construction Workforce (employees/day)	Phase I (2009-2012)	Phase II (2015-2017)	Phase III (2021-2024)
Average	1,085	210	103
Peak Year	1,403	210	246

Table 12. Yield for Wetland Alternative at 2046 Demands.

Participant	Firm Yield (ac-ft)	SMAPD (ac-ft)
Colorado Springs	70,500	64,200
Fountain	2,500	2,500
Security	1,400	1,500
Pueblo West	500	1,100

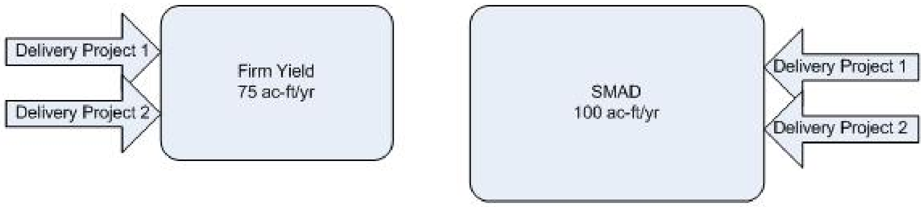
Source: Reclamation 2007a (Colorado Springs); Black & Veatch 2004 (Fountain); Harding 2004 (Security); Higgins 2005 (Pueblo West).

2.2.4 Arkansas River Alternative

The Arkansas River Alternative was designed to address significant issues about maximizing low flows in the Arkansas River through Pueblo and minimizing water quality effects on the lower Arkansas River. Concerns identified during scoping are associated with minimum flows through Pueblo for recreational uses. Minimum streamflows in the Arkansas River through Pueblo would be maximized by diverting water from the Arkansas River downstream of Pueblo, and returning treated return flows in a pipeline to the Arkansas River above Pueblo. Additionally, conveying return flows through a pipeline, rather than down Fountain Creek, is intended to minimize water quality concerns associated with erosion and sedimentation in Fountain Creek, which would affect water quality downstream in the lower Arkansas River. Untreated water would be stored in Pueblo Reservoir, released to the Arkansas River from the dam, diverted from the Arkansas River upstream of Fountain Creek, stored in a new reservoir on Jimmy Camp Creek, treated, and distributed to the Participants' customers. Colorado Springs' reusable return flows would be piped from its existing and future wastewater treatment plants to the Arkansas River near Colorado 115, and would not be exchanged down Fountain Creek (Figure 21). Pueblo West would not participate in the SDS Project infrastructure if this alternative were chosen, but would still receive additional storage in Pueblo Reservoir. The following subsections describe this alternative in more detail. Construction and restoration methods for all alternatives are described in Section 2.5 and any alternative-specific methods are described below. Operational characteristics for all alternatives are described in Appendix D.

**Why is the Firm Yield greater than the
Simulated Mean Annual Project Delivery (SMAPD) for this Alternative?**

To illustrate, consider a water provider with the Delivery Projects 1 and 2.

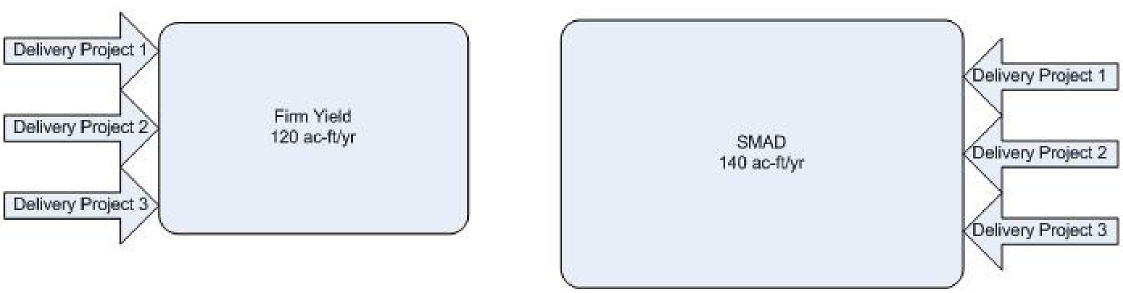


Existing Condition

System firm yield is the amount of water that can be delivered to a water provider's customers in a "dry" year before system shortages occur. It is the "worst-case" scenario. The provider's water system has a firm supply of 75 ac-ft/yr, which is supplied by Delivery Project 1 and Delivery Project 2.

System Simulated Mean Annual Deliveries (SMAD) is the amount of water that can be delivered to a water provider's customers in an "average" year before system shortages occur. It is the more likely scenario. The provider's water system has a SMAD of 100 ac-ft/yr, which is supplied by Delivery Project 1 and Delivery Project 2.

The provider has now proposed to build new Delivery Project 3. The provider's firm yield and SMAD with the new delivery project is calculated using historical river records and projected demands. Because Delivery System 3 may provide opportunities for different operation of Delivery Projects 1 and 2, the yield of Delivery System 3 is not calculated independently, but is calculated as the amount the provider's system yield, or total water deliveries is increased. The yield can only increase up to the projected demand level, (i.e., what would not be used is not delivered).



Future Condition

The firm yield of Delivery System 3 is
120 – 75 = 45 ac-ft/yr

The SMAPD of Delivery System 3 is
140 – 100 = 40 ac-ft/yr

Because the water provider's SMAD is increased by only 40 ac-ft/yr, but the water provider's firm yield is increased by 45 ac-ft/yr with the addition of Delivery Project 3, the firm yield of Delivery Project 3 is greater than the SMAPD.

For the seven alternatives analyzed in this EIS, those alternatives that do not require many water exchanges generally have a higher firm yield than SMAPD.

Figure 20. Comparison of Firm Yield and SMAPD using a Hypothetical Water Provider.

2.2.4.1 Components

Structural

Regulating Storage

Regulating storage for this alternative would be in Pueblo Reservoir, the same as that of the Participants' Proposed Action (Section 2.2.2.1). Pueblo Reservoir, without modification, would be used.

Untreated Water Intake

A new, 78-mgd diversion dam and intake would be constructed in the Arkansas River immediately upstream of the confluence with Fountain Creek (Figure 22). The diversion structure would consist primarily of a concrete sill and inflatable rubber dam that would cross the river (CH2M HILL 2003a). The design would be similar to that of the Highway 115 Untreated Water Intake in Colorado Springs' No Action Alternative (Section 2.2.1.1). Combined, the sill and dam, when inflated, would be about 2.5 feet above the streambed elevation. A concrete sluiceway would be constructed along the south bank of the river and streamflows would flow into screened bays with sedimentation basins. The intake would include stainless steel fish screens with 0.069-inch openings. Depending on regulatory requirements, the sediment would either be pumped back to the river or pumped to drying beds for dewatering and later disposal. A computer rendering of the Arkansas River intake is provided in Figure 23.

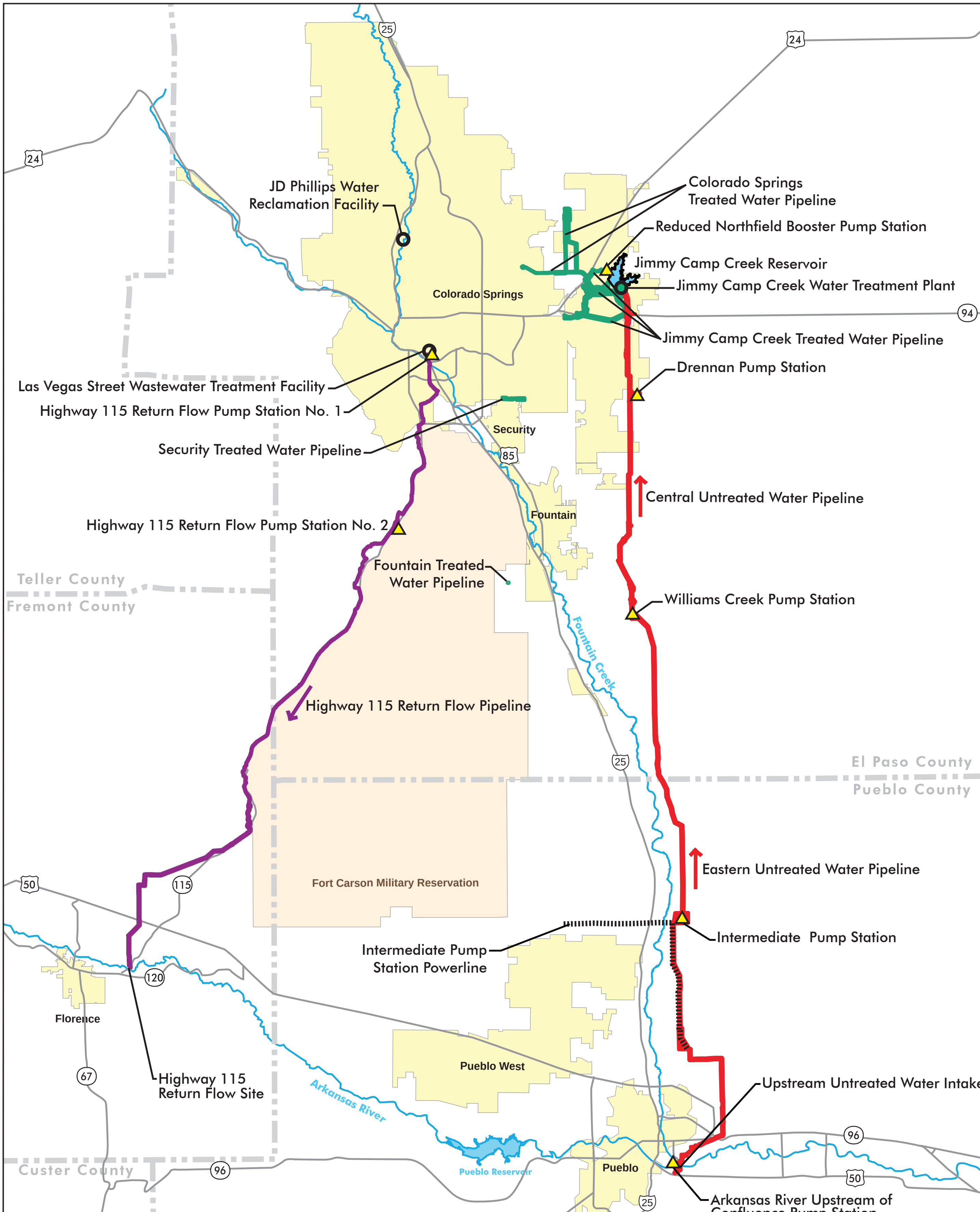
Untreated Water Conveyance

The untreated water conveyance for the Arkansas River Alternative would consist of four pump stations and about 46 miles of pipeline. Pump stations would be located adjacent to the Arkansas River in Pueblo (Arkansas River Upstream of Confluence Pump Station, or ARUCPS), on Overton Road north of Pueblo (Intermediate Pump Station), and on Drennan Road in Colorado Springs. The Williams Creek Pump Station described for the Participants' Proposed Action (Section 2.2.2.1) also would be included.

The untreated water pipeline would begin at the ARUCPS and head north toward a terminal storage reservoir and water treatment plant at Jimmy Camp Creek. This welded-steel pipeline would be 66 inches in diameter, about 46 miles long, and capable of conveying 78 mgd of untreated water. The pipeline reach between the ARUCPS and Williams Creek Pump Station is referred to as the "Eastern Untreated Water Pipeline." From the Williams Creek Pump Station north, the untreated water conveyance alignment would be the same as that of the No Action Alternative (Section 2.2.1.1) except that the Drennan Pump Station would be included.

The ARUCPS would be on the south bank of the Arkansas River, between the Burlington Northern Santa Fe Railroad and Colorado 227 (Figure 22). Structures for this 78-mgd facility (CH2M HILL 2003a) would be similar to those described for the Highway 115 Untreated Water Pump Stations No. 2 and No. 3 (Section 2.2.1.1) except that municipal water and sanitary sewer service are available at this site. Power would be supplied through a connection to existing Black Hills Corporation (formerly Aquila Energy, Inc.) electrical transmission lines located south of the pump station site. About 0.5 mile of new poles and conductors would be installed.

The Intermediate Pump Station would be located on the east side of Overton Road about 1 mile south of Apelt Ranch Road. Structures for this 78-mgd facility would be similar to those described for the Williams Creek Pump Station (Section 2.2.2.1). Power would be supplied through two new powerlines



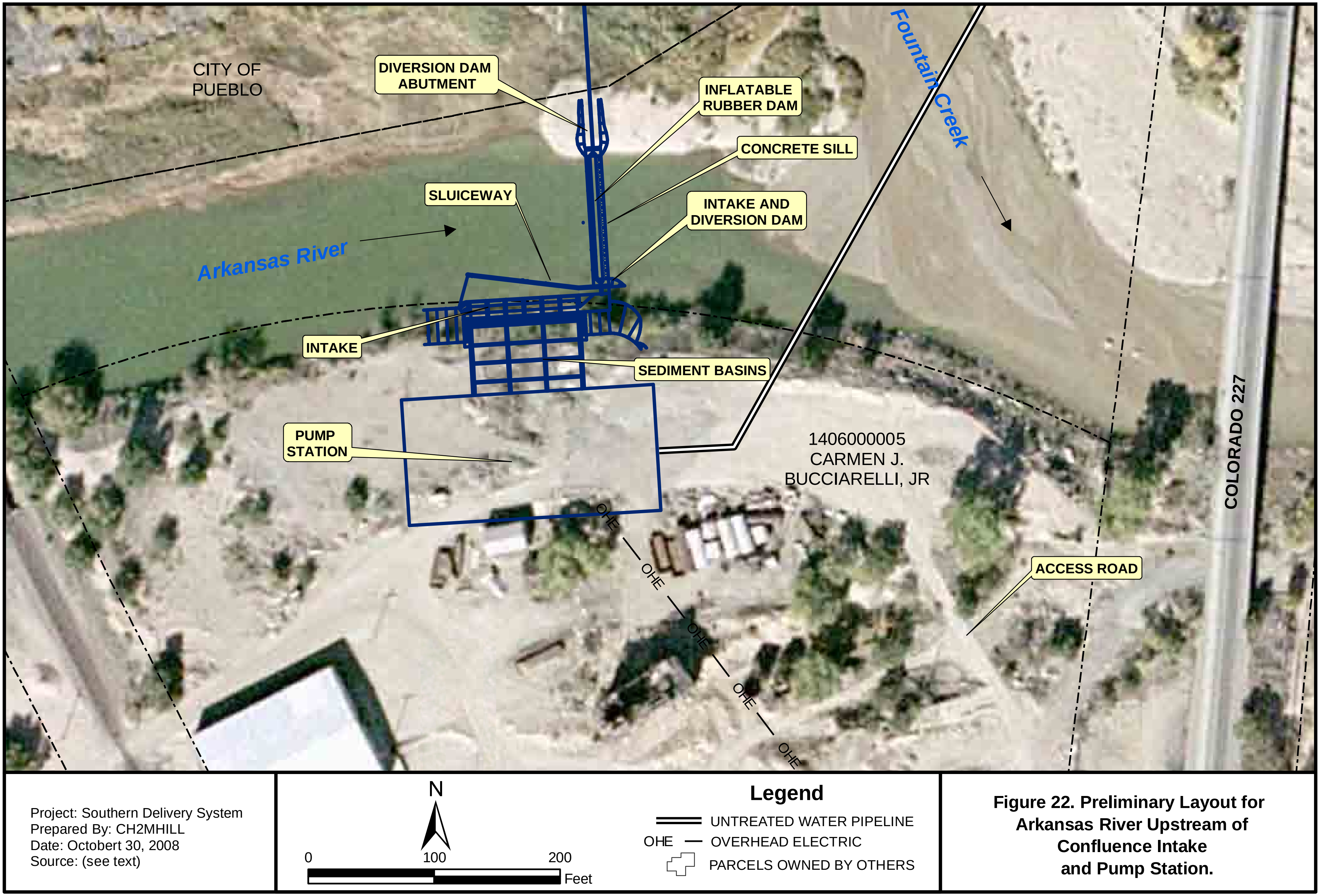
Untreated Water Conveyance
Treated Water Conveyance
Return Flow Conveyance
Reservoir
Powerline
Pump Station
Water Treatment Plant
Wastewater Treatment Plant (Not Part of SDS)

0 3 6 Miles

N

Project: Southern Delivery System
Prepared By: ERO Resources Corp.
Date: 9/18/08

Figure 21. Arkansas River Alternative.



Project: Southern Delivery System
Prepared By: CH2MHILL
Date: Octobert 30, 2008
Source: (see text)

Figure 22. Preliminary Layout for Arkansas River Upstream of Confluence Intake and Pump Station.

Figure 23. Computer Rendering of Typical Arkansas River Intake.

Source: CH2M HILL 2003a.

connecting to existing Black Hills Corporation (formerly Aquila Energy, Inc.) electrical transmission lines. The first powerline would connect to a transmission line in Pueblo about 0.75 mile north of Walking Stick Boulevard and generally follow the Eastern Untreated Water Conveyance to the pump station. The second powerline would connect to a transmission line north of Pueblo West and head eastward for about 5 miles across I-25 to the pump station. Both powerlines would consist of aboveground structures including wooden "H" towers or poles and new conductors.

The Drennan Pump Station would be along Drennan Road about 2 miles north from the intersection of Drennan Road and Horizon View Drive and 0.25 mile south from the intersection of Drennan Road and Mockingbird Lane. Pump station structures would be similar to those described for the Williams Creek Pump Station (2.2.2.1) (CH2M HILL 2003b, 2003c). Power would be supplied through a connection to existing Colorado Springs Utilities electrical transmission line located adjacent to the Drennan Pump Station site.

Terminal Storage Reservoir

Terminal storage for this alternative would be the same as that of the No Action Alternative (Section 2.2.1.1). A new reservoir would be constructed at Jimmy Camp Creek.

Water Treatment Plant

The water treatment plant for this alternative would be the same as that of the No Action Alternative (Section 2.2.1.1). A new treatment plant would be constructed adjacent to Jimmy Camp Creek Reservoir. An ultraviolet disinfection process may be added due to the presence of urban runoff in the source water (CH2M HILL 208a).

Treated Water Conveyance

The treated water conveyance for Colorado Springs would be the same as that of the No Action Alternative (Section 2.2.1.1). For Security and Fountain, treated water conveyance would be the same as that of the Participants' Proposed Action (Section 2.2.2.1).

Return Flow Reservoir

A new return flow reservoir would not be constructed within the Fountain Creek Basin under this alternative. Rather, Pueblo Reservoir, without modification, would be used to store Colorado Springs' reusable return flows.

Return Flow Conveyance

The return flow conveyance for this alternative would be the same as that of the Wetland Alternative (Section 2.2.3.1). Colorado Springs' reusable return flows would be collected in Colorado Springs and conveyed via a pipeline to the Arkansas River near Florence, about 20 miles upstream of Pueblo Reservoir.

Non-structural

The principal non-structural components of this alternative would be the same as those of the Participants' Proposed Action (Section 2.2.2.1) with a few exceptions. Colorado Springs and Fountain would not participate in the PFMP, because the untreated water intake would not be from Pueblo Dam. One or more Conveyance Contracts with Reclamation would not be required because there would not be a connection to Pueblo Dam. Additionally, an agreement between Colorado Springs and the Chilcotte Ditch Company would not be needed because Colorado Springs would not convey return flows through the existing Chilcotte Ditch. Colorado Springs would participate in the UAVFMP in this alternative.

2.2.4.2 Schedule

The construction schedule would be the same as that of the Participants' Proposed Action (Section 2.2.2.2) except for the return flow components (CH2M HILL 2008a). The return flow conveyance would be constructed between 2009 and 2012.

2.2.4.3 Cost, Energy Use, and Yield

Total capital cost for the Arkansas River Alternative is estimated to be about $1.239 billion (CH2M HILL 2008a). Total operations and maintenance cost between 2012 and 2046 is estimated to be about $919 million. The distribution of costs among Participants for this and all other alternatives is discussed in Section 3.15. The average and peak year construction workforce for each phase of construction is summarized in Table 13.

Table 13. Arkansas River Alternative Construction Workforce.

Construction Workforce (employees/day)	Phase I (2009-2012)	Phase II (2015-2017)	Phase III (2021-2024)
Average	1,103	190	100
Peak Year	1,425	190	241

To meet 2046 water demands, average energy use would be 1,050 MW·h/d (CH2M HILL 2008b). Firm yield and SMAPD for each Project Participant are summarized in Table 14. For an explanation about why firm yield is larger than the SMAPD for this alternative, refer to Figure 20.

Table 14. Yield for Arkansas River Alternative at 2046 Demands.

Participant	Firm Yield (ac-ft)	SMAPD (ac-ft)
Colorado Springs	70,500	64,100
Fountain	2,500	2,500
Security	1,400	1,500
Pueblo West	500	1,100

Source: Reclamation 2007a (Colorado Springs); Black & Veatch 2004 (Fountain); Harding 2004 (Security); Higgins 2005 (Pueblo West).

2.2.5 Fountain Creek Alternative

The Fountain Creek Alternative is designed to address significant issues concerning erosion, sedimentation, and water quality effects of return flows on Fountain Creek. Return flows from the return storage reservoir would be conveyed in a pipeline, rather than down Fountain Creek. In addition, by choosing a terminal storage reservoir site without marine shale present, water quality effects on Fountain Creek may be less.

Untreated water would be stored in Pueblo Reservoir, diverted from Pueblo Dam, stored in a new reservoir on Jimmy Camp Creek, treated, and distributed to the Participants' customers (Figure 24). Colorado Springs' reusable return flows would be stored in a new reservoir on Williams Creek. Water delivered to the Arkansas River for exchanges would be conveyed in a pipeline to the mouth of

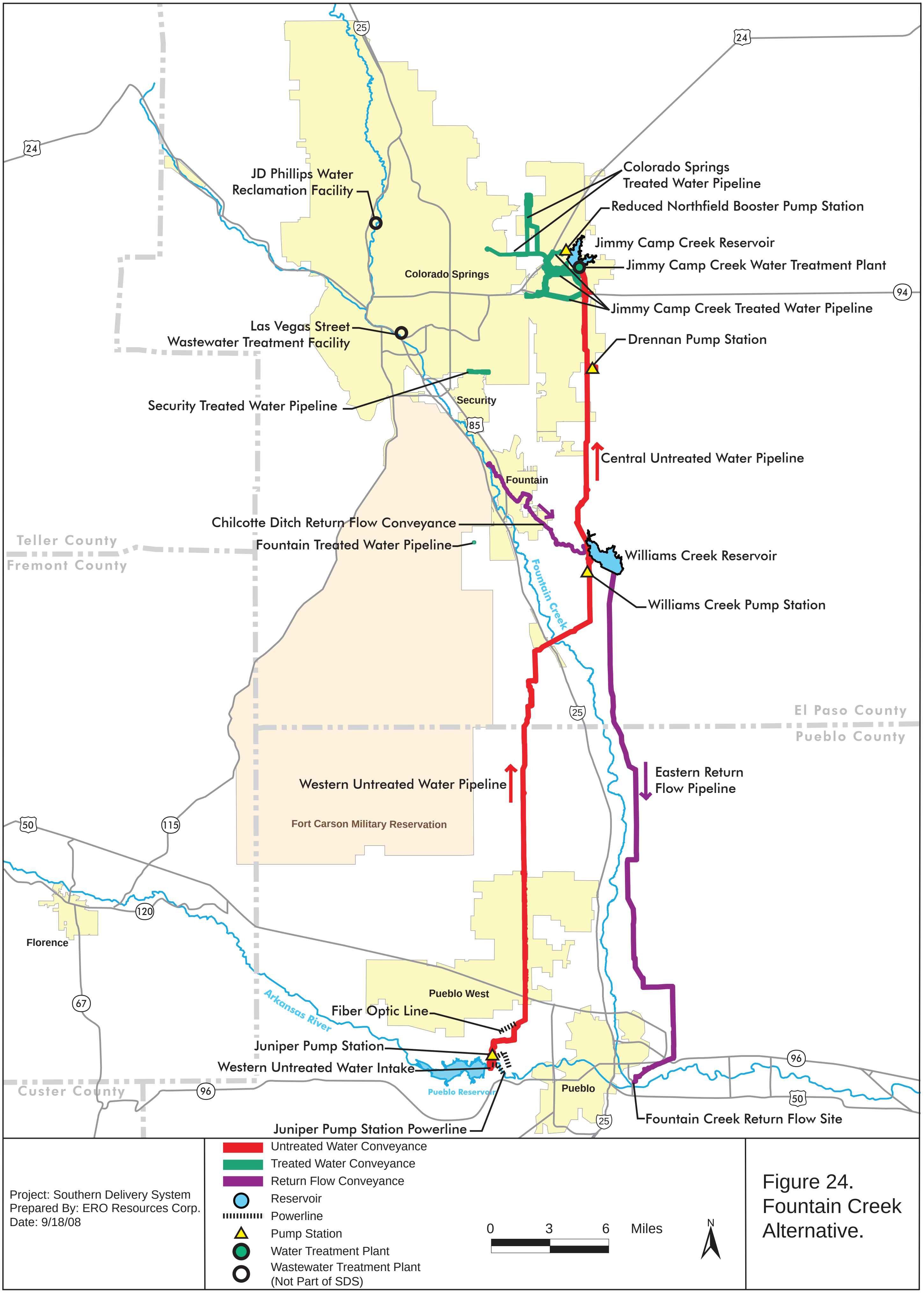


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Figure 24. Fountain Creek Alternative.

Fountain Creek, instead of down Fountain Creek. The following subsections describe this alternative in more detail. Construction and restoration methods for all alternatives are described in Section 2.5 and any alternative-specific methods are described below. Operational characteristics for all alternatives are described in Appendix D.

2.2.5.1 Components

Structural

Structural components of the Fountain Creek Alternative would be similar to the Participants' Proposed Action (Section 2.2.2.1) with a few exceptions. First, like the No Action Alternative (Section 2.2.1.1), terminal storage and water treatment would be at the Jimmy Camp Creek Reservoir site. Next, the untreated water conveyance would not be routed to and from the Upper Williams Creek Reservoir site but would include the Drennan Pump Station. Lastly, a 72-inch diameter (300 cfs capacity) pipeline would be constructed to convey return flow releases from Williams Creek Reservoir to the mouth of Fountain Creek (CH2M HILL 2006b). This 30-mile-long pipeline would originate at the Williams Creek Reservoir dam, parallel Meridian/Overton Road to a location just south of the Piñon Road intersection, where the alignment would head southeast around the City of Pueblo. The alignment would then continue along Portland Avenue then south along Colorado 227 to the Fountain Creek return flow location (Figure 24). An energy dissipation structure would be constructed at the return flow site to minimize effects on the stream channel.

Non-structural

The principal non-structural components of this alternative would be the same as those of the Participants' Proposed Action (Section 2.2.2.1) with one exception. Colorado Springs would participate in the UAVFMP in this alternative.

2.2.5.2 Schedule

The construction schedule would be the same as that of the Participants' Proposed Action (Section 2.2.2.2) except for the return flow storage and conveyance components (CH2M HILL 2008a). Williams Creek Reservoir and return flow conveyance would be constructed between 2009 and 2012. Construction of these components would be accelerated relative to the Participants' Proposed Action. To minimize potential effects on Fountain Creek, these components probably would be in place when the alternative would begin operation in 2012.

2.2.5.3 Cost, Energy Use, and Yield

Total capital cost for the Fountain Creek Alternative is estimated to be about $1.248 billion (CH2M HILL 2008a). Total operations and maintenance cost between 2012 and 2046 is estimated to be about $672 million. The distribution of costs among Participants for this and all other alternatives is discussed in Section 3.15). The average and peak year construction workforce for each phase of construction is summarized in Table 15.

Table 15. Fountain Creek Alternative Construction Workforce.

Construction Workforce (employees/day)	Phase I (2009-2012)	Phase II (2015-2017)	Phase III (2021-2024)
Average	1,013	185	198
Peak Year	1,300	185	238

To meet 2046 water demands, average energy use would be 686 MW·h/d (CH2M HILL 2008b). Firm yield and SMAPD for each Project Participant are presented in Table 16.

Table 16. Yield for Fountain Creek Alternative at 2046 Demands.

Participant	Firm Yield (ac-ft)	SMAPD (ac-ft)
Colorado Springs	42,000	54,400
Fountain	2,500	2,500
Security	1,400	1,500
Pueblo West	500	1,100

Source: Reclamation 2007a (Colorado Springs); Black & Veatch 2004 (Fountain); Harding 2004 (Security); Higgins 2005 (Pueblo West).

2.2.6 Downstream Intake Alternative

Some residents of Pueblo and the lower Arkansas River valley expressed an interest in the Participants diverting and treating water from the Arkansas River below Fountain Creek. The Downstream Intake Alternative addresses this with an alternative that uses an untreated water intake downstream of Fountain Creek. With some exceptions (discussed below), the structural components of this alternative match those of the No Action Alternative.

Untreated water would be stored in Pueblo Reservoir, released from the dam and then diverted from the Arkansas River downstream of Fountain Creek, stored in a new reservoir on Jimmy Camp Creek, treated, and distributed to the Participants' customers. Colorado Springs' reusable return flows would be stored in a new reservoir on Williams Creek prior to exchange down Fountain Creek (Figure 25). Pueblo West would not participate in the SDS Project infrastructure if this alternative were chosen, but would still receive additional storage in Pueblo Reservoir. The following subsections describe this alternative in more detail. Construction and restoration methods for all alternatives are described in Section 2.5 and any alternative-specific methods are described below. Operational characteristics for all alternatives are described in Appendix D.

2.2.6.1 Components

Structural

Regulating Storage

Regulating storage for this alternative would be the same as that of the Participants' Proposed Action (Section 2.2.2.1). Pueblo Reservoir, without modification, would be used.

Untreated Water Intake

A new, 78-mgd diversion dam and intake would be constructed on the Arkansas River immediately downstream of the confluence with Fountain Creek. The diversion structure (Downstream Untreated Water Intake) would be similar to that described for the Arkansas River Alternative (Section 2.2.4.1).

Untreated Water Conveyance

The untreated water conveyance for the Downstream Intake Alternative would be the same as that for the Arkansas River Alternative (Section 2.2.4.1) except that the first pump station would be located on the east side of Colorado 227.

Terminal Storage Reservoir

Terminal storage for this alternative would be the same as that of the No Action Alternative (Section 2.2.1.1). A new reservoir would be constructed at Jimmy Camp Creek.

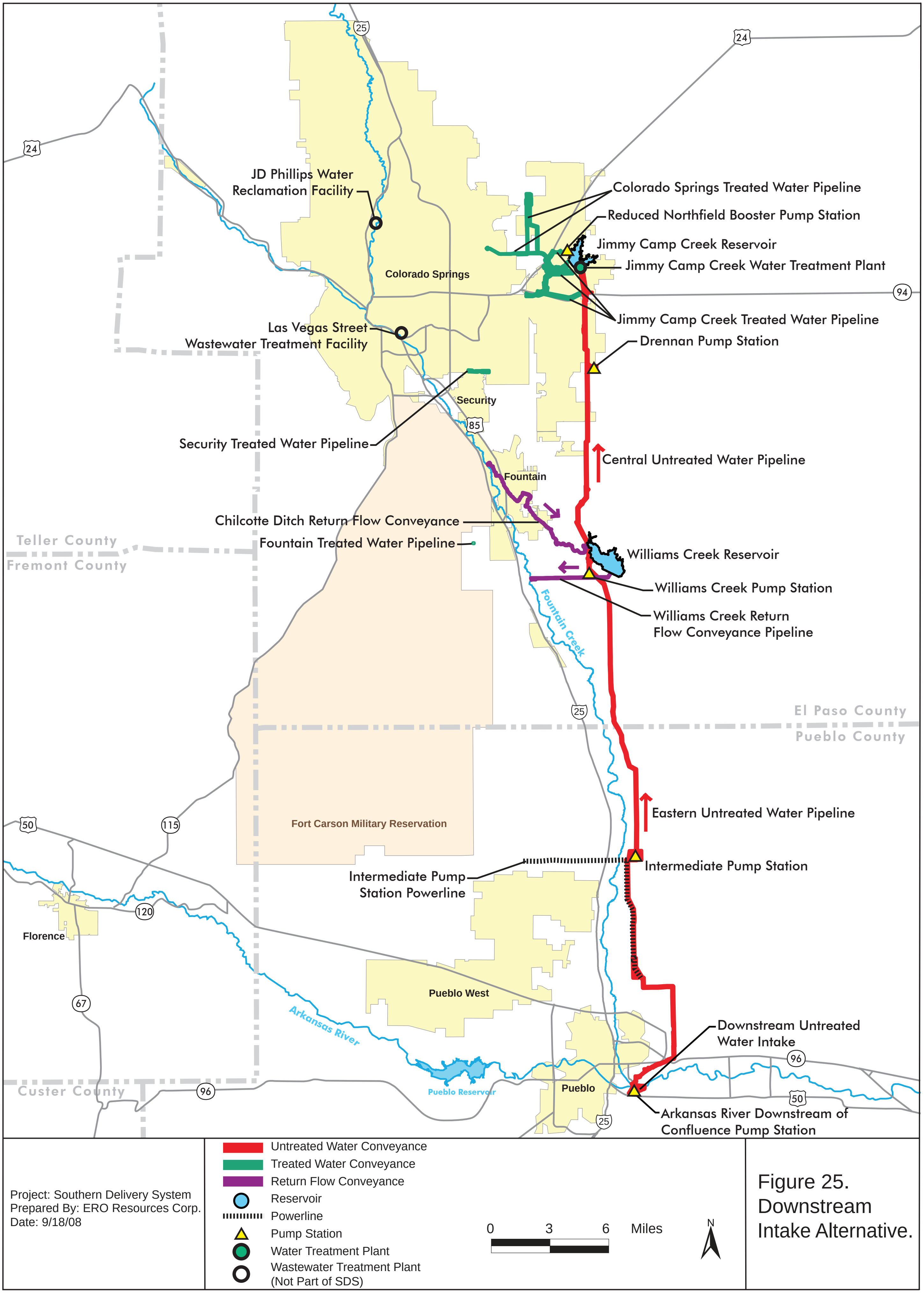

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Figure 25. Downstream Intake Alternative.

Water Treatment Plant

A new treatment plant would be constructed adjacent to Jimmy Camp Creek Reservoir. A reverse osmosis process, with brine (a treatment waste stream) recovery, would be added to treat 50 percent of the flows (CH2M HILL 2007g). This type of treatment would be needed to reduce salinity levels in the diverted lower Arkansas River water to a level comparable to that which would be supplied by the Participants' Proposed Action.

The waste stream would be processed through mechanical evaporation (equivalent to boiling). The vapor from this process would be recovered and blended with the treated water, resulting in about 3 percent of total treatment loss. This mechanical evaporation process would generate about 7,500 cubic yards per year of concentrated solids at 2046 water demands. These wastes would probably be disposed in the existing Ash Disposal Area at Colorado Springs' Clear Spring Ranch.

Treated Water Conveyance

The treated water conveyance for Colorado Springs would be the same as that of the No Action Alternative (Section 2.2.1.1). For Security and Fountain, treated water conveyance would be the same as that of the Participants' Proposed Action (Section 2.2.2.1).

Return Flow Reservoir

Return flow storage for this alternative would be the same as that of the No Action Alternative (Section 2.2.1.1). A new reservoir would be constructed at Williams Creek.

Return Flow Conveyance

The return flow conveyance for this alternative would be the same as that of the No Action Alternative (Section 2.2.1.1).

Non-structural

The principal non-structural components of this alternative would be the same as those of the Participants' Proposed Action with a few exceptions. Colorado Springs and Fountain would not participate in the PFMP because the untreated water intake would not be from Pueblo Dam. Conveyance Contracts with Reclamation would not be needed because there would not be a connection to Pueblo Dam. Colorado Springs would participate in the UAVFMP in this alternative.

2.2.6.2 Schedule

The construction schedule would be the same as that of the Participants' Proposed Action (Section 2.2.2.2) (CH2M HILL 2008a).

2.2.6.3 Cost, Energy Use, and Yield

Total capital cost for the Downstream Intake Alternative is estimated to be about $1.274 billion (CH2M HILL 2008a). Total operations and maintenance cost between 2012 and 2046 is estimated to be about $1.169 billion. The distribution of costs among Participants for this and all other alternatives is discussed in Section 3.15). The average and peak year construction workforce for each phase of construction is summarized in Table 17.

To meet 2046 water demands, average energy use would be 1,410 MW·h/d (CH2M HILL 2008b). Firm yield and SMAPD for each Project Participant are summarized in Table 18. For an explanation about why firm yield is

Table 17. Downstream Intake Alternative Construction Workforce.

Construction Workforce (employees/day)	Phase I (2009-2011)	Phase II (2015-2017)	Phase III (2021-2024)
Average	774	190	230
Peak Year	958	190	552

larger than the SMAPD for this alternative refer to Figure 20.

Table 18. Yield for Downstream Intake Alternative at 2046 Demands.

Participant	Firm Yield (ac-ft)	SMAPD (ac-ft)
Colorado Springs	64,500	61,700
Fountain	2,500	2,500
Security	1,400	1,500
Pueblo West	500	1,100

Source: Reclamation 2007a (Colorado Springs); Black & Veatch 2004 (Fountain); Harding 2004 (Security); Higgins 2005 (Pueblo West).

2.2.7 Highway 115 Alternative

The Highway 115 Alternative was designed to address public and Participant interest in an Action Alternative that follows the Colorado 115 corridor for water conveyance. This alternative would generally follow an existing highway corridor for pipeline alignments and would avoid land disturbance in Pueblo County.

Untreated water would be stored in Pueblo Reservoir, exchanged upstream and then diverted from the Arkansas River at the Lester & Attebery Ditch, stored in a new reservoir on Jimmy Camp Creek, treated, and distributed to the Participants' customers (Figure 26). Colorado Springs' reusable return flows would be stored in a new reservoir on Williams Creek prior to exchange down Fountain Creek. Pueblo West would not participate in the SDS Project infrastructure if this alternative were chosen, but would still receive additional storage in Pueblo Reservoir. The following subsections describe this alternative in more detail. Construction and restoration methods for all alternatives are described in Section 2.5 and any alternative-specific methods are described below. Operational characteristics for all alternatives are described in Appendix D.

2.2.7.1 Components

Structural

Regulating Storage

Regulating storage for this alternative would be the same as that of the Participants' Proposed Action (Section 2.2.2.1). Pueblo Reservoir, without modification, would be used.

Untreated Water Intake

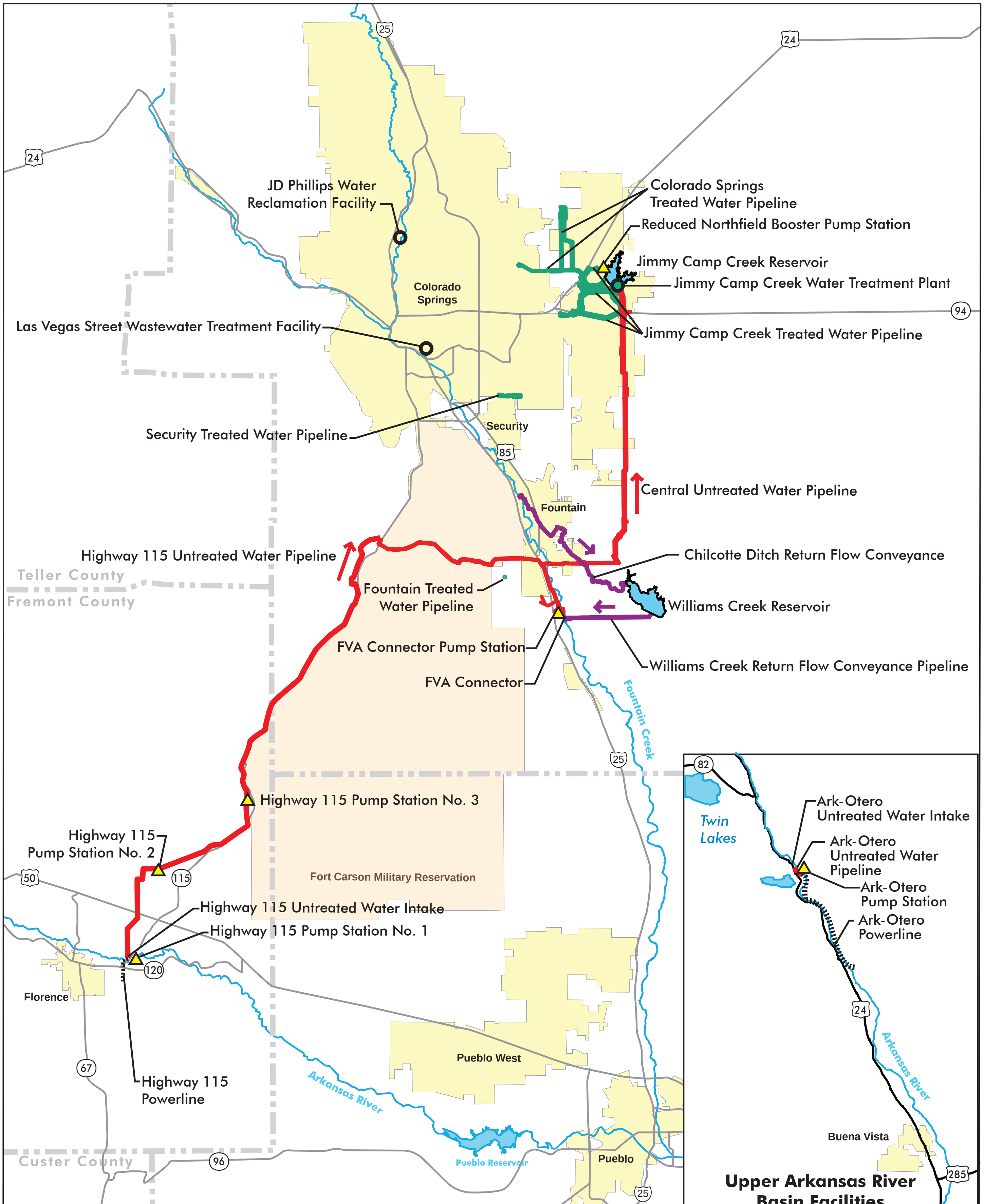
The untreated water intake for this alternative would be the same as that of the No Action Alternative (Section 2.2.1.1) except sized to 78 mgd capacity. Water would be diverted from the Arkansas River near Florence, and Colorado Springs' existing Ark-Otero Intake would be modified.

Untreated Water Conveyance

The main untreated water conveyance for this alternative would be the same as that of the No Action Alternative (Section 2.2.1.1) except sized to 78 mgd capacity (66-inch diameter). A connection from the existing FVA pipeline to the proposed Highway 115 Untreated Water Pipeline would be added to maximize flow in the FVA pipeline, which would increase Colorado Springs' delivery capabilities. Also, the Ark-Otero Intake would be upgraded to help facilitate exchanges for Colorado Springs, which would be capable of conveying 68-mgd of untreated water to the Otero Pump Station.

Terminal Storage Reservoir

Terminal storage for this alternative would be the same as that of the No Action Alternative (Section 2.2.1.1). A new reservoir would be constructed at Jimmy Camp Creek.



Untreated Water Conveyance
Treated Water Conveyance
Return Flow Conveyance
Reservoir
Powerline
Pump Station
Water Treatment Plant
Wastewater Treatment Plant (Not Part of SDS)

0 3 6 Miles

N

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Figure 26. Highway 115 Alternative.

Water Treatment Plant
The water treatment plant for this alternative would be the same as that of the No Action Alternative (Section 2.2.1.1). A new treatment plant would be constructed adjacent to Jimmy Camp Creek Reservoir.

Treated Water Conveyance
The treated water conveyance for Colorado Springs would be the same as that of the No Action Alternative (Section 2.2.1.1). For Security and Fountain, treated water conveyance would be the same as that of the Participants' Proposed Action (Section 2.2.2.1).

Return Flow Reservoir
Return flow storage for this alternative would be the same as that of the No Action Alternative (Section 2.2.1.1). A new reservoir would be constructed on Williams Creek.

Return Flow Conveyance
Return flow conveyance for this alternative would be the same as that of the No Action Alternative (Section 2.2.1.1).

Non-structural
The principal non-structural components of this alternative would be the same as those of the Participants' Proposed Action (Section 2.2.2.1) with a few exceptions. One or more long-term excess capacity storage contracts for use of Pueblo Reservoir would be required with Reclamation. One or more Conveyance Contracts with Reclamation would not be needed because there would not be a connection to Pueblo Dam. Colorado Springs and Fountain would not participate in the PFMP, because the untreated water intake would not be from Pueblo Dam. Colorado Springs would participate in the UAVFMP in this alternative.

2.2.7.2 Schedule
The construction schedule would be the same as that of the Arkansas River conveyance portion of the No Action Alternative (Section 2.2.1.5).

2.2.7.3 Cost, Energy Use, and Yield
Total capital cost for the Highway 115 Alternative is estimated to be about $1.213 billion (CH2M HILL 2008a). Total operations and maintenance cost between 2012 and 2046 is estimated to be about $671 million. The distribution of costs among Participants for this and all other alternatives is discussed in Section 3.15). The average and peak year construction workforce for each phase of construction is summarized in Table 19.

To meet 2046 water demands, average energy use would be 680 MW·h/d (CH2M HILL 2008b). Firm yield and SMAPD for each Project Participant are summarized in Table 20.

Table 19. Highway 115 Alternative Construction Workforce.

Construction Workforce (employees/day)	Phase I (2009-2012)	Phase II (2015-2017)	Phase III (2021-2026)
Average	927	0	191
Peak Year	1,193	0	404

Table 20. Yield for Highway 115 Alternative at 2046 Demands.

Participant	Firm Yield (ac-ft)	SMAPD (ac-ft)
Colorado Springs	34,000	43,200
Fountain	2,500	2,500
Security	1,400	1,500
Pueblo West	500	1,100

Source: Reclamation 2007a (Colorado Springs); Black & Veatch 2004 (Fountain); Harding 2004 (Security); Higgins 2005 (Pueblo West).

2.3 Alternatives Considered But Eliminated

The alternatives screening process discussed in Section 2.1.3 identified a number of options for project components that Reclamation considered but eliminated from detailed analysis. Options that were eliminated did not meet the purpose and need of the Participants' Proposed Action, were not technically, economically, or logistically practical or feasible, had less favorable environmental characteristics, or were prohibitively greater in cost than other alternatives. This section summarizes the options considered and the basis for their elimination. A detailed discussion of the alternatives analysis process and each option that was considered is presented in the Alternatives Analysis report and addendum (Reclamation 2006a, 2007a). New components, options, or alternatives suggested during public review of the DEIS and Supplemental Information Report were evaluated using the same process (Appendices B and C).

Some public comments on the DEIS questioned the propriety of the Participants' need to perfect and deliver their existing Arkansas Basin water rights. Reclamation has determined that this need is reasonable. The role of the water rights need in the alternatives development and evaluation process was reviewed for the Supplemental Information Report and this FEIS. This need was not an important factor in selecting alternatives for detailed evaluation. All alternatives eliminated from consideration based on water rights use were or would have been eliminated based on other criteria. No alternative has been eliminated based solely on the need of the Participants to perfect and deliver their existing Arkansas River Basin water rights. Similarly, no alternative was retained solely because it could perfect and deliver existing water rights.

2.3.1 Regulating Storage

Eleven options were considered for regulating storage, including the proposed use of long-term excess capacity space in Pueblo Reservoir. The ten other options were new reservoirs on Tennessee Creek (Tennessee Creek Reservoir), the Arkansas River (Elephant Rock Reservoir), or at an unspecified location west of Florence (as suggested by the public during DEIS review), enlargement of existing reservoirs (Turquoise Lake, Clear Creek Reservoir, or Brush Hollow), or existing storage (Lake Henry, Lake Meredith, Great Plains Reservoirs, or gravel lakes).

Pueblo Reservoir long-term excess capacity space was the only option retained for detailed analysis. Except for the Clear Creek Reservoir enlargement and Great Plains Reservoirs options, the other options were eliminated because of effects on wetlands or streams, inadequate storage capacity, or cost. Pueblo Reservoir would require no modification (i.e., enlargement) for the project. Enlargement of Clear Creek Reservoir would require several million cubic yards of additional embankment and disturb several hundred acres. Additionally, use of Clear Creek Reservoir for the SDS Project would require construction of an additional intake, pump station, and pipeline to withdraw water from the Arkansas River and convey it to storage. Enlargement of Clear Creek Reservoir was eliminated as a regulating storage option due to substantially greater anticipated environmental effects relative to using Pueblo Reservoir. The use of Great Plains Reservoirs would not meet most or all projected future demands because exchanges from that system would yield substantially less water than the Participants' Proposed Action.

2.3.2 Untreated Water Intake and Conveyance

The Participants proposed to use the Western Untreated Water Pipeline alignment to convey untreated water from the Joint Use Manifold combined with the Pueblo Dam River Outlet Works to terminal storage or a water treatment plant near Colorado Springs. Seventeen options were considered for untreated water intake, including the Participants' Proposed Action. Intake locations ranged from the upper Arkansas River near Turquoise Lake (including enlarging the existing Homestake pipeline or installing a parallel pipeline) to along the lower Arkansas River near Lake Henry or Lake Meredith. Four intake locations and three associated conveyance alignments were retained: Joint Use Manifold combined with the Pueblo Dam River Outlet Works, Upstream [of Fountain Creek on the Arkansas River] Untreated Water Intake, Downstream [of Fountain Creek on the Arkansas River] Untreated Water Intake, and the Highway 115 Untreated Water Intake. Several intake options at Pueblo Dam were eliminated from detailed study in this FEIS because of inadequate conveyance capacity or similar anticipated environmental effects as the Participants' Proposed Action. Intake options and associated conveyance in the upper and lower Arkansas River were eliminated because of the streamflow effects of water diversion in the upper Arkansas River, long conveyance pipelines, or cost.

2.3.3 Terminal Storage and Water Treatment Plant

In the Participants' Proposed Action, untreated water would be conveyed initially to a new water treatment plant near the intersection of U.S. 24 and Colorado 94. When storage would be needed to meet maximum day demands, Upper Williams Creek Reservoir would be added. Because the terminal storage would be a large permanent facility, Reclamation considered numerous options for it, which are summarized in Table 21. The area evaluated for a new terminal storage reservoir ranged from the Palmer Divide on the north; the foothills west of Colorado Springs to an elevation of about 7,600 feet (all elevations in this section use the North American Vertical Datum of 1988) to the south side of Cheyenne Mountain and then generally the eastern boundary of Fort Carson on the west; the El Paso County line on the south; and about 18 miles east of Colorado Springs on the east, where topographic conditions were unsuitable for reservoir siting. The rationale for the evaluation area is presented in the SDS Terminal Storage and Exchange Reservoir Site Analysis, Phase II Report (Black & Veatch 2005b).

After the initial screening, all but ten of the new terminal storage reservoir options and all seven gravel pit options were eliminated because of inadequate capacity. Two of the new reservoir options were eliminated because of land use conflicts on Fort Carson. One location near Corral Bluffs (east of the Jimmy

Table 21. Type and Number of Options for Terminal Storage.

Option Type	Number of Options Considered
New reservoir	33†
Enlargement of existing reservoirs	3
Existing gravel pits	7
Aquifer storage and recovery	2
Water tanks	1

†A new reservoir at an unspecified location west of Florence was suggested by the public during review of the DEIS. This concept was evaluated for this FEIS using screening results for the Brush Hollow Enlargement option.

Source: Reclamation 2006a.

Camp Creek Reservoir site) was eliminated because of concerns about long-term dam stability. One option that consisted of a floating cover on a new reservoir to minimize evaporation was eliminated because of unproven technology. Two of the options requiring enlargement of existing reservoirs were eliminated because of wetland effects. For example, enlarging Rampart Reservoir would require inundation of about 37 acres of wetlands. One option requiring enlargement of an existing reservoir was eliminated because of inadequate capacity. Neither of the two aquifer storage and recovery options would provide adequate capacity; a slightly smaller new reservoir would still be needed. A water tank option was eliminated because it was inconsistent with standard industry practices.

After initial screening, options that were retained were screened on the basis of six environmental considerations: surface area disturbance, wetland area disturbance, annual evaporation, marine shale inundation and surficial geology downstream (a potential water quality concern), embankment volume, and distance to nearest Colorado Springs delivery point. Three options—Jimmy Camp Creek Reservoir, Reservoir No. 2 (north of Colorado Springs in the Black Forest area), and Upper Williams Creek Reservoir (originally named Reservoir No. 16)—were retained for further consideration after environmental screening. The Reservoir No. 1 option (north of Colorado Springs in the Black Forest area) was eliminated because of the comparatively greater surface disturbance, wetlands, evaporation, embankment volume, greater distance to Colorado Springs' nearest delivery point, and the presence of numerous homes compared to the Reservoir No. 2 option. The Reservoir No. 5 option (northeast of Colorado Springs near Peyton) was eliminated because the wetland analysis identified 30 acres of wetlands, exceeding the 25-acre criterion for significant issues screening. The Reservoir No. 17 option (southeast of Colorado Springs near the Upper Williams Creek Reservoir site) was eliminated because of the comparatively greater wetland disturbance and greater marine shale presence. The Williams Creek Reservoir option was eliminated because it had the highest surface disturbance acreage, evaporative loss, and marine shale acreage. The Brush Hollow Enlargement option (in Fremont County near Penrose) was eliminated because of marine shale and wetlands acreage. This option had the second highest marine shale acreage (737 acres, 100 percent of inundation and dam area); exceeding the next closest option by about 300 acres. Local streams with similar surficial geology exhibit relatively high selenium and salinity concentrations. This option had the second highest wetland acreage (26 acres estimated), exceeding the next lowest option by about 10 acres. Additionally, use of Brush Hollow Reservoir would not provide additional terminal storage capacity near the locations of the anticipated future demands, and therefore would not meet the purpose and need of the project. After environmental screening, one reservoir option (Reservoir No. 2) was eliminated because of cost.

2.3.4 Return Flow Storage and Conveyance

An analysis similar to the screening for terminal storage was completed for return flow storage and conveyance. The area evaluated for a new return flow storage reservoir ranged from south of Colorado Springs on the north, the foothills west of Colorado Springs to an elevation of about 7,600 feet to the south side of Cheyenne Mountain and then generally the eastern boundary of Fort Carson to the Arkansas River on the west; the Arkansas River on the south; and about 18 miles east of Colorado Springs on the east, where topographic conditions were unsuitable for reservoir siting. The rationale for the evaluation area is presented in the SDS Terminal Storage and Exchange Reservoir Site Analysis, Phase II Report (Black & Veatch 2005b).

Thirty options for return flow storage, including the proposed Williams Creek Reservoir, were evaluated. Some of the options included not developing a new return flow storage reservoir, but using Pueblo Reservoir for storage. Of the 30 options, 20 were eliminated at the initial screening step; 15 were eliminated because of inadequate storage capacity. Two options were eliminated because of land use conflicts with Fort Carson, and the other three options were eliminated because of wetland effects or legal constraints. A modification to one option that would convey return flows to Turkey Creek (a tributary to Pueblo Reservoir) was eliminated based on environmental concerns and cost.

After initial screening, options that were retained were screened on the basis of five environmental considerations: surface disturbance, wetland disturbance, marine shale inundation, surficial geology immediately downstream, and embankment volume. The Williams Creek Reservoir, Big Johnson Reservoir Enlargement, Reservoir No. 17, and Reservoir No. 26 (north of Pueblo West), and the Pueblo Reservoir options were retained for further consideration. The Reservoir No. 16, No. 17, and No. 19 (near the Upper Williams Creek Reservoir site) options are all located southeast of Colorado Springs and all would require long (over 30 miles) return flow conveyances. The Reservoir No. 17 and No. 19 options partially overlap and thus are mutually exclusive. The Reservoir No. 19 option was eliminated because of the comparatively greater surface disturbance, wetlands, and marine shale than the Reservoir No. 17 option. The Reservoir No. 16 option was not retained for return flow storage because it was retained as a terminal storage option. The Reservoir No. 27 option (north of Pueblo near Piñon) was eliminated because of comparatively larger wetland disturbance and more marine shale inundation than the Reservoir No. 26 option.

After environmental screening, three options (Reservoir No. 17 with two conveyance options and a pipeline to Pueblo Reservoir without a new reservoir in the Fountain Creek Basin) were eliminated because of cost. Lastly, the option of Williams Creek Reservoir with a bi-directional pipeline between Fountain Creek and the reservoir and Reservoir No. 26 with two different conveyance options was eliminated during scoping issues screening. These options had higher costs relative to other options that addressed scoping themes equally well.

2.3.5 Indirect Potable Reuse Alternatives

During scoping and other meetings, the public expressed an interest in an alternative with water reuse. Reclamation developed and analyzed several potential alternatives that included substantial water reuse (Reclamation 2007a).

Six indirect potable reuse alternatives were evaluated. Each of the reuse alternatives would involve reuse by Colorado Springs only, and not the other Participants. Reuse is the intentional diversion of water that is at least partially composed of treated wastewater and subsequently treated for use. Indirect reuse indicates that there is no direct connection between a wastewater effluent discharge point and the reuse water treatment point. Potable reuse refers to water that is reused for human consumption.

In addition to the six reuse alternatives, the Downstream Intake Alternative was considered as a possible reuse alternative. The Downstream Intake Alternative includes a water intake on the Arkansas River downstream of Fountain Creek, resulting in a portion of Colorado Springs' reusable return flows captured by the intake. Reclamation determined, however, that the portion of Colorado Springs' water supply that would originate from reuse would be relatively small. About 16 percent of the overall supply would be from Colorado Springs' reusable return flows. As a result, the Downstream Intake Alternative was not considered as a reuse alternative, although it was retained for detailed evaluation in this FEIS.

The six reuse alternatives considered were various combinations of Colorado Springs' Fountain Creek reusable return flow diversions, storage of reuse water, and treatment of reuse water. To provide a water supply that would be protective of human health, each of the reuse alternatives would include advanced water treatment including at least a portion of the reuse water treated using reverse osmosis. Reverse osmosis would pass reuse water through a membrane that would effectively remove contaminants including salinity. Each of the reuse alternatives also would use blending of reuse water with an Arkansas River water supply from Pueblo Reservoir. This results in a water supply of about half reuse water and half Arkansas River water.

The reuse alternatives were screened using the same process described for other components, with additional screening criteria for reclaimed water treatment effectiveness added.

Each reuse alternative passed the screening criteria for substantial logistical, technical, or environmental deficiencies, general environmental characteristics, reclaimed water treatment effectiveness, and purpose and need screening. However, none of the reuse alternatives passed the cost screening criteria. To pass the cost screening, the cost of delivering untreated water supply to meet projected demands would need to be less than $25,000 per ac-ft/year of firm yield and $21,000 per ac-ft/year of SMAPD (Section 2.1.5). The cost for reuse alternatives ranged from $50,000 to $61,000 per ac-ft/year of firm yield and $43,000 to $53,000 per ac-ft/year of SMAPD. However, none of the reuse alternatives passed the cost screening criteria described in Section 2.1.3. Additionally, none of the reuse alternatives better responded to significant issues from public scoping (Section 2.1.1) than the alternatives that were selected to address those issues (Section 2.1.3). As a result, none of the reuse alternatives were carried forward for detailed analysis in this FEIS.

2.3.6 Flood Control and Related Options

During the public meetings on the alternatives, three options relating to flood or stormwater control on Fountain Creek were identified. These options were subjected to the alternatives screening process and subsequently eliminated from detailed analysis.

One option would integrate potable reuse of reusable streamflows with a new reservoir on Fountain Creek that would capture return, storm, or flood flows for reuse and flood control. The other two options involved storage of storm or flood flows in return flow reservoirs or implementing other flood control projects. As an individual option, the flood control reservoir on Fountain Creek had substantial logistical, technical, and environmental deficiencies that justified its elimination in the first step of the screening process. However, all three of the flood control options were carried through the remainder of the screening process and analyzed regarding purpose and need and cost criteria, and regarding their impacts on factors identified during scoping. The analysis identified significant issues regarding purpose and need and with the lack of existing water rights to support flood control alternatives on Fountain Creek. These options also had potential adverse environmental impacts and cost. A more detailed discussion of the flood control proposals is presented in the Alternatives Analysis report (Reclamation 2006a).

Even if it were desirable to integrate stormwater or flood control into the proposed water supply project, consideration of one of these alternatives would presuppose the results and recommendations of the Fountain Creek Watershed Study being conducted by the Corps. That study is intended to characterize hydrologic, hydraulic, and geomorphic conditions of the watershed and make recommendations to address storm water and flood control issues in the basin. Colorado Springs recently created a stormwater enterprise (Section 3.1.3.1), which is also intended to address stormwater issues in portions of the Fountain Creek Basin.

Because flood control is not a purpose of the proposed SDS Project, the flood control options did not go forward for detailed analysis. However, Reclamation recognizes that flooding on Fountain Creek is a serious regional issue and recommends that efforts to develop a regional solution continue.

2.3.7 Summary of Alternatives Identified by the Public

During the public scoping, alternatives review, and DEIS review processes, additions, deletions, and modifications to the alternatives were proposed. These suggestions were evaluated using the same sequential screening process that was used to select the alternatives that were proposed for detailed evaluation in the FEIS. Proposals that were retained after screening were considered in conjunction with the alternatives that were previously proposed for detailed evaluation in the FEIS and a final set of alternatives was selected. All other options and alternatives were eliminated from further consideration. Table 22 presents a summary of options and alternatives identified by the public and the associated screening results. Several of these options were discussed in the previous paragraphs detailing the screening. More detailed discussion of these options is presented in the Alternatives Analysis report and addendum (Reclamation 2006a, 2007a), and in Reclamation's responses to comments on the DEIS (Appendix B).

Table 22. Alternatives Identified by the Public.

Proposed Option/Alternative	Major Screening Considerations and Result
Regulating Storage Options	
Brush Hollow Reservoir Enlargement or an unspecified new reservoir west of Florence	Option eliminated based on less favorable environmental characteristics, with cost issues also identified
Great Plains Reservoirs	Option eliminated based on purpose and need criteria
Proposed Intake and Conveyance Options	
Western Slope, possibly with a pipeline from South Park to terminal storage, including the proposed Central Colorado Project	Option eliminated based on substantial logistical, technical, or environmental deficiencies, less favorable environmental characteristics, and purpose and need criteria, with cost issues also identified
Wyoming or Utah and pipeline to terminal storage, including the proposed Flaming Gorge Project	Option eliminated based on substantial logistical, technical, or environmental deficiencies, less favorable environmental characteristics, and purpose and need criteria
Canada or Alaska and pipeline to terminal storage	Option eliminated based on substantial logistical, technical, or environmental deficiencies, less favorable environmental characteristics, and purpose and need criteria
Twin Lakes and pipeline to terminal storage, including enlarging the existing Homestake (Otero) pipeline or installing a parallel pipeline	Option eliminated based on less favorable environmental characteristics also, a multi-year shut-down to enlarge the capacity of the existing pipeline would not be feasible
Arkansas River at Buena Vista and pipeline to terminal storage using gravity	Option eliminated based on less favorable environmental characteristics, with substantial logistical, technical, or environmental deficiencies also identified
Arkansas River at Cotopaxi and pipeline to terminal storage using gravity	Option eliminated based on significantly less favorable environmental characteristics, with cost issues also identified
East side of Fountain Creek and Arkansas River confluence and pipeline to terminal storage	Option already retained
Arkansas River at Boone and pipeline to terminal storage	Option eliminated based on less favorable environmental characteristics
Fort Lyon Ditch and pipeline to terminal storage with storage in Great Plains Reservoirs	Option eliminated based on, less favorable environmental characteristics, and purpose and need criteria
Avoid Walker Ranch area	Option already retained
Use recycled water in all alternatives	Option retained for potential later consideration in alternatives based on effects analyses
Limit geographic area to Colorado Springs	Option already retained
Proposed Terminal Storage and Water Treatment Plan Options	
Brush Hollow Reservoir Enlargement or an unspecified new reservoir west of Florence	Option eliminated based on less favorable environmental characteristics, purpose and need, and cost criteria
Reservoir west of Colorado Springs	Option eliminated based on substantial logistical, technical, or environmental deficiencies
Proposed Return Flow Storage and Conveyance Option	
Pipeline to Arkansas River near Penrose included in Downstream Intake Alternative	Option eliminated based on cost issues
Turkey Creek for return flow conveyance [assumed to begin at Highway 115 crossing of Turkey Creek, with elimination of pipeline discharge to Arkansas River near Penrose]	Option eliminated based on less favorable environmental characteristics, with cost issues also identified

Proposed Option/Alternative	Major Screening Considerations and Result
Proposed Return Flow Storage and Conveyance Options (continued)	
Return flow pipeline discharge at Pueblo Reservoir	Option eliminated based on cost issues
Return flow pipeline parallel to untreated water pipeline	Option eliminated based on cost issues
Return flow pipeline discharge below Pueblo Reservoir	Option eliminated based on cost issues and incorporation into another option
Return flow pipeline discharge at confluence of Arkansas River and Fountain Creek	Option using untreated and treated water components of the Fountain Creek Alternative, Williams Creek Reservoir for return flow storage, and a return flow pipeline to Fountain Creek at the confluence with the Arkansas River was retained for further consideration
Return flow pipeline discharge near Pueblo wastewater treatment plant	Option eliminated based on cost issues and purpose and need criteria
Install taps on return flow pipeline for use by agricultural producers along Fountain Creek	Option eliminated based on purpose and need criteria
Construct two or more reservoirs [assumed to be in the Fountain Creek Basin] that would be alternately drained and sediment removed for fertilizer	Option eliminated due to environmental and purpose and need criteria
Construct a series of holding ponds [assumed to be in the Fountain Creek Basin]	Option eliminated based on substantial logistical, technical, or environmental deficiencies
Other Alternatives	
Untreated water intake on the Arkansas River downstream of Fountain Creek in conjunction with a return flow pipeline to the Arkansas River near (upstream or downstream) the intake	Alternative eliminated based on based on cost issues
Indirect Potable Reuse • Direct diversion, storage in Williams Creek Reservoir, pre- and post-blending RO treatment • Riverbank filtration wells, Alluvial Aquifer storage, RO treatment (2 configurations) • Riverbank filtration wells, surface storage in Williams Creek Reservoir, RO treatment (2 configurations)	Alternatives eliminated based on cost criteria
Flood Control Proposals • Flood control reservoir on Fountain Creek with potable reuse • Capture flood flows in return flow reservoirs • Other flood control projects	Options eliminated based on environmental, purpose and need, and cost criteria

2.4 Elements Common to All Alternatives Analyzed

This section describes the elements common to all alternatives, including conservation, non-potable water development, improvements to existing infrastructure, land acquisition, and regulatory requirements and permitting.

Continuing water resource planning has reduced Colorado Springs' per person usage (compared to similar areas). Non-potable water development is anticipated to account for 13 percent of future water delivered. Aggressive block pricing and education and incentive programs are also key elements of all alternatives.

Other elements common to all alternatives include land acquisition, construction and restoration, and phased construction and implementation. These elements are discussed in the subsections below. Operational characteristics for all alternatives are described in Appendix D.

The demand forecast for all alternatives shows the need for additional water delivery capacity by 2012. Construction phasing schedules for each alternative are described in Section 2.2 and shown in Figure 8.

2.4.1 Participants' Conservation Programs

Conservation is common to all of the alternatives analyzed for the SDS Project. For each Participant, conservation is being implemented independently of the project.

The Participants use metering, education and increasing rate structures to encourage water customers within the project area to use water efficiently. Each Participant is fully metered. The Colorado Springs system has been fully metered since the 1940s, followed by Fountain in the 1960s, Pueblo West in the 1970s, and Security in 2003. Metering causes water customers to pay for what they actually use as opposed to paying a flat rate for water. Metering provides an economic incentive to use water efficiently.

The Participants offer education to water customers within the project area. Education takes on many forms but includes advertising, billing inserts, brochures, classes, community events, counseling, demonstration gardens, educational materials, events, fact sheets, free seminars, newsletters, school programs, speakers, tours, and web site information. A strong commitment to education has resulted in comparatively low water use per capita throughout the project area.

Increasing rate structures, also called tiered rate structures, encourage conservation by increasing the cost of water with increasing use. Tiered rate structures provide an economic incentive to customers to use water efficiently. Along with metering and education, the tiered rate structures have been considered in calculating projected future demands. Design of tiered rate structures will be evaluated by Participants on an ongoing basis as demands and expectations change throughout each Participant's service area.

The Participants will continue to develop and expand conservation programs that are consistent with state regulations, operational needs, and community values within the project area. Individual programs for each Participant are described in more detail in Appendix A. These programs are submitted to Reclamation as required by the Reclamation Reform Act. Any long-term contract with Reclamation would have a requirement to continue to submit conservation programs to Reclamation.

Although water conservation alone cannot meet future needs, water conservation is one of four components to meet projected future demands through 2046. Other components include the SDS project, nonpotable water development, and improvements to existing infrastructure.

2.4.2 Improvements to Existing Infrastructure

All Participants will continue to maintain and improve their existing water systems. Through systematic, preventative maintenance programs, the Participants will seek to minimize both planned and unplanned outages of their water supply systems including water pipelines, pump stations, reservoirs, and treatment plants. Continuing regular maintenance and replacement of component systems will ensure the performance and extend the life of this existing infrastructure. For example, within the last 6 years, Colorado Springs has completed a major upgrade to one of its existing pipeline delivery systems, expanded treated water storage at its largest existing water treatment plant, upgraded and expanded ground water treatment systems, and extended reclaimed, nonpotable water delivery to one of its power plants for cooling water.

Colorado Springs uses its RMS 2000 database to schedule predictive and preventive maintenance activities at facilities such as water pipelines, pump stations, reservoirs, and treatment plants that comprise the water infrastructure. Work orders are prescheduled in the database and when maintenance activities come due, operations staff is notified electronically to carry out those activities. Work orders are generated describing the facilities where work is to be conducted, instructions for completing the work, and planned dates of completion. Once staff has completed the maintenance activity associated with a work order, they enter pertinent information in the respective work order to close it out. That information is used to plan, schedule, and scope subsequent maintenance activities. Capital improvements for Colorado Springs' system are identified through master plans and routine maintenance, planned through a 10-year major capital budgeting process, and implemented to coincide with identified needs. Colorado Springs plans to use the same process to maintain the SDS Project as it uses to maintain the rest of the water infrastructure (Riley 2007).

The other Participants use similar processes to manage the maintenance and improvement of their water systems. As part of its comprehensive water master plan, Fountain adopted a capital improvement plan that prescribes over $200 million in investments in its system over the next 40 years, including treatment, new source of supply such as wells, and acquisition of water rights. Security uses a systematic approach to improve its existing water system and is continuing the program of rebuilding and upgrading one well per year. Pueblo West has made electrical improvements to its pump station and has plans to enhance the river intake pump station in the coming year.

Improvements to existing infrastructure also will provide some amount of interim redundancy and increased reliability. However, as demands increase in the future, there will be a need for new increments of redundancy in order to meet demands when currently, existing systems must be taken out of service for repairs and maintenance.

2.4.3 Land Acquisition

Land for project facilities and their construction (rights-of-way) would be acquired in two ways: easements and fee title purchases.

Application of these approaches is described below.

2.4.3.1 Easements

Easements would be obtained from public and private entities for SDS Project facilities such as new pipelines, open channel conveyances, powerlines, and access roads. The Project Participants would obtain permanent and temporary easements to allow construction, operation, and maintenance of project facilities. On federal lands, such as Fort Carson, BLM, or Reclamation land, the Project Participants would obtain a special use permit or similar authorization for facility construction, operation, and maintenance in lieu of an easement.

Permanent easements would be about 100 feet wide for linear facilities. However, widths would vary depending upon site-specific conditions such as avoiding existing facilities or conformance to property boundaries. An additional temporary (construction) easement about 50 feet wide (150 feet wide total) would be acquired to provide space for equipment operation and staging areas during construction. Except where a road or other above ground structure was built, the land surface within the easements would be restored after construction as described in Section 2.5.

Ownership of land in permanent easement areas would remain in the name of the easement conveyor. Prior uses could continue, except for permanent structures or uses that would interfere with SDS Project facility operation and maintenance. The property owner would be responsible for maintaining the easement. The Project Participants would be permitted to enter permanent easement areas to operate, maintain, and replace facilities. Landowners would be compensated for loss of use or opportunity associated with permanent easements.

For temporary easements, prior uses could resume after construction was complete. The Project Participants would not have permanent access to these areas. Landowners would be compensated for the temporary loss of use or opportunity associated with temporary construction easements.

2.4.3.2 Fee Title Purchases

Land for SDS Project facilities such as wells, new pipelines, untreated water intakes, pump stations, water treatment plants, and reservoirs would be obtained by the Project Participants through fee title purchases. Fee title means the purchase of land, free and clear of encumbrances. Ownership would transfer from the present owner to the Project Participants. Any improvements within the area acquired would be relocated or licensed to remain. Public and private entities would be compensated at market value for land used for the SDS Project facilities. On federal lands, in lieu of fee title purchase, the Project Participants would obtain a special use permit or similar authorization for facility construction, operation, and maintenance.

2.4.4 Additional Regulatory Requirements and Permitting

2.4.4.1 General Requirements

Compliance with applicable permits, regulations, and laws is an element of all alternatives. In addition to NEPA, several other federal statutes involve management of resources within the SDS Project study area to ensure the preservation and protection of natural and cultural resources. The following federal statutes were used to guide the preparation of the FEIS:

- American Indian Religious Freedom Act

- Archaeological and Historic Preservation Act
- Archeological Resources Protection Act
- Clean Air Act
- Clean Water Act
- Endangered Species Act
- Farmland Protection Policy Act
- Fish and Wildlife Coordination Act
- Historic Sites, Buildings and Antiquities Act
- Migratory Bird Treaty Act
- National Historic Preservation Act
- Executive Order 11593, Protection and Enhancement of the Cultural Environment, May 13, 1971
- Executive Order 11988, Flood Plain Management, May 24, 1977
- Executive Order 11990, Protection of Wetlands, May 24, 1977
- Executive Order 11991, Protection and Enhancement of Environmental Quality, March 5, 1970
- Executive Order 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations, February 11, 1994
- Executive Order 13007, Indian Sacred Sites, May 24, 1996
- Executive Order 13112, Invasive Species, February 3, 1999

Implementation of any SDS alternative would require an array of federal, state, and local permits and approvals. Table 23 summarizes the major permitting requirements for the Action Alternatives; however, it is not an all-inclusive list. The No Action Alternative would require many of the same permits and approvals, but would not require any major federal action by Reclamation. None of the Action Alternatives would require the Participants to obtain new water rights because the Action Alternatives were all developed to use the existing water rights portfolios.

2.4.4.2 Arkansas River Compact

The water in the Arkansas River is apportioned between Colorado and Kansas according to the 1948 Arkansas River Compact (Colorado Revised Statutes, Title 37, Article 69, Section 37-69-101). In general, the Compact divides water in the Arkansas River inflows to John Martin Reservoir between Colorado (60 percent) and Kansas (40 percent). Details of provisions in Article V of the compact, which describe of flow apportionment, are presented in the Water Resources Technical Report (MWH 2007a). The 1980 Operating Principles provide for storage accounts in John Martin Reservoir and release of water from those accounts for Colorado and Kansas water users. If the reservoir pool is depleted, and Colorado is required to administer priorities below John Martin Reservoir, then Kansas is not entitled to water flowing into the reservoir (CWCB 2002).

Colorado and Kansas have been in litigation regarding the Arkansas River since the early 1900s. Recent decisions by the Supreme Court have lead to the appointment of a “Special Master” and the promulgation of well rules by Colorado that limit the amount of well pumping in the lower Arkansas River Basin to bring Colorado into compliance with the Compact. Settlement negotiations and compliance monitoring are ongoing.

The Office of the State Engineer is required to administer provisions of interstate water compacts within Colorado (Colorado Revised Statutes, Title 37, Article 80, Sections 37-80-102 and 37-80-104), including the provisions

Table 23. Selected Federal, State, and Local Permits or Approvals Potentially Required for the SDS Project.

Permits, Stipulations, or Approvals	Purpose
Bureau of Reclamation	
Execution of Contracts (Reclamation Project Act 43 CFR 427)	To allow the Project Participants to use Reclamation facilities to store, convey, or exchange water.
Special Use Permit or Similar Authorization	To allow activities on Reclamation lands.
Approval	To allow an administrative trade of SDS untreated water pipeline capacity for FVA system capacity between Fountain and Colorado Springs.
U.S. Fish and Wildlife Service	
Section 7 Consultation (Endangered Species Act 50 CFR 402)	To ensure that the proposed project would not jeopardize the continued existence of threatened or endangered species, or result in the destruction or modification of critical habitat.
U.S. Army Corps of Engineers	
Section 404 Permit (Clean Water Act 33 CFR 320)	To allow the Project Participants to discharge dredged or fill material into waters of the U.S., including wetlands.
U.S. Army Fort Carson	
Special Use Permit or Similar Authorization	To allow activities on Fort Carson lands.
Bureau of Land Management	
Special Use Permit or Similar Authorization	To allow activities on BLM lands.
Colorado Department of Public Health and Environment	
401 Certification (Clean Water Act 40 CFR 121)	To certify that any activity requiring a federal license or permit that may result in any discharge into waters of the U.S. would not cause or contribute to a violation of state surface water quality standards.
Colorado Discharge Permit System	To allow Project Participants to discharge pollutants from a point source into waters of the U.S., such as stormwater or construction dewatering.
Advisory Council on Historic Preservation	
Section 106 Review (National Historic Preservation Act 36 CFR 800)	To consult with the Colorado Office of Archeology and Historic Preservation, Native American tribes, and the Advisory Council on Historic Preservation.
Pueblo or Chaffee County	
HB1041 Permit	To allow Project Participants to construct project components within Pueblo County or Chaffee County.
El Paso or Fremont County	
Land Use Approval	To allow Project Participants to construct project components within El Paso County or Fremont County.

of the Arkansas River Compact. The hydrologic analysis performed as part of this FEIS makes assumptions regarding streamflow requirements that are needed at the Las Animas gage to meet Arkansas River Compact requirements. Additionally, all water proposed to be diverted into SDS Project facilities, and subsequently used in both the yield and effects analyses, results from water rights that have been adjudicated by Colorado Water Court, and thus, are consistent with the Arkansas River Compact. However, ultimately, it is the responsibility of the Colorado State Engineer to ensure that operations of the selected alternative meet the requirements of the Arkansas River Compact.

2.4.4.3 Local Land Use Permitting

Local land use permitting is of particular interest for the proposed SDS Project. Local governments were authorized by the State of Colorado to adopt 1041 Regulations through the adoption of HB-1041 in 1974. The 1041 Regulations authorize counties to adopt Regulations for Areas and Activities of State Interest, which include establishment of new communities, siting of municipal water and wastewater facilities, siting and selection of airports and highway systems, and protection of significant wildlife habitat. The 1041 Regulations are intended to allow for public input and to require mitigation for impacts that may result from a proposed activity. Within the SDS Project study area, Pueblo County and Chaffee County have adopted 1041 regulations. El Paso and Fremont counties do not have 1041 regulations; however, each has a land use approval process that would be followed in any alternative with facilities in each county's jurisdiction. Reclamation's identification of an Agency Preferred Alternative (Section 2.7) does not affect the authority that other agencies would have over the project. Required permitting of the Participants' Proposed Action as well as several other Action Alternatives through Pueblo County's 1041 regulations introduces uncertainty regarding the ability of the Participants to implement these alternatives. Although this FEIS was coordinated with several agencies and addresses Reclamation's NEPA requirements, it may not directly address all requirements of the Pueblo County 1041 regulations. The relationship of the proposed SDS Project to Pueblo County's 1041 regulations was the subject of litigation between Colorado Springs and Pueblo County (Colorado Springs v. Pueblo County 2007a, 2007b, 2007c, 2007d). This area of controversy was not considered in the development of alternatives (Section 2.1.2), which was substantially completed prior to adoption of the current Pueblo County 1041 regulations in late 2005, and prior to the ensuing litigation between those parties. The Participants submitted an application for a 1041 to Pueblo County in August 2008. The county's review of that application is in progress.

2.5 Construction and Restoration Methods Common to All Activities

This section describes construction and restoration methods common among alternatives (CH2M HILL 2004). Alternative-specific methods were discussed in the alternatives sections above.

2.5.1 Ground Water Wells

Ground water wells would be installed as part of the No Action Alternative (Colorado Springs, Fountain, and Security) and at pump station sites that lack municipal water service. For each well, a drilling rig would bore a hole to the desired well depth and a well casing would be installed. The well would then be developed by withdrawing water to clear sediment and other debris associated with the installation process. A pump and supporting controls would then be installed. Other installation activities would use the same general construction and restoration methods as described below for pipelines (Section

2.5.3). However, all activities would be performed in accordance with conditions contained in any well installation permits as well as any other applicable permits.

2.5.2 Intakes

The Action Alternatives and Colorado Springs' and portion of the No Action Alternative would include one or more untreated water intakes on the Arkansas River. These facilities would consist of either a pipeline connection to existing structures at Pueblo Dam or a new or modified river intake. Pueblo West's intake in the No Action Alternative has already been approved by Reclamation, and is not discussed in this section. Although the configuration, size, and location of these facilities would differ somewhat among alternatives, the construction and restoration methods would be comparable.

Intakes involving connections to existing structures at Pueblo Dam would use the same general construction and restoration methods as described below for pipelines (Section 2.5.3). However, all activities would be performed in accordance with conditions contained in any federal special use permits or similar authorizations as well as any other applicable permits. Some concrete work and installation of flow control and measurement equipment also would be required.

For new intakes on the Arkansas River, a cofferdam would be constructed to dewater portions of the river as needed to allow construction. Flows would be allowed to pass by the construction area so that there would be no effect on downstream flows during construction. The cofferdam would likely be constructed in two phases. The first phase would include dewatering and construction of the sluiceway, intake, sedimentation basin, and a portion of the diversion dam sill. The second phase would include construction of the remainder of the diversion dam sill. The two cofferdams would overlap to allow construction of a full strength joint at the selected location. The full length of the diversion dam sill would later be dewatered to allow installation of an inflatable rubber dam. The work would be performed during the low flow season and coordinated with Reclamation's operations at Pueblo Dam. A reinforced concrete diversion dam sill, sluiceway, intake structure, and sediment basin would be installed. At some sites, the intake and sediment basin would likely be integrated with an adjacent pump station structure. Riprap and geotextile material would be installed along the banks of the river to provide erosion protection.

2.5.3 Pipelines

Construction and restoration methods for untreated water, treated water, and return flow pipelines would be similar and follow general construction techniques. The open trench method would be used for most of the pipeline construction. Cross street and driveway pavements would be cut and temporarily covered during pipeline construction to maintain access. Pipe segments would be delivered to the site. The trench would then be excavated. The excavated material would be used for pipe backfill where suitable. Unsuitable material would be disposed of off-site.

Blasting or other specialized equipment may be required to excavate rock. It is expected that blasting would be necessary near the Jimmy Camp Creek Reservoir site and in the northern vicinity of Pueblo Reservoir. If blasting was required, all blasting operations, including transportation, storage, and handling of explosives and blasting materials would comply with county, state, and federal regulations.

The pipe segments would be lowered into place in the trench and welded together to form one continuous pipeline. Cathodic protection would be installed to protect the pipe from corrosion. The pipe zone (the area from the bottom of the trench up to 12 inches above the top of the pipe) would be filled with controlled low-strength material. Controlled low-strength material is a cement-like substance designed to stabilize the pipe to prevent movement. After the controlled low-strength material has hardened sufficiently, the remainder of the trench would be filled with the trench excavation material and compacted. In roadways and other public use areas, open trenches would be covered with steel plates during periods when no active construction is occurring.

Typically, trenchless construction would be used to cross beneath U.S. or state highways, county highways and roadways within developed areas, major roadways within developed areas of any city, railroads, and rivers and major streams. Trenchless construction techniques would involve excavating underground from an entrance pit to a receiving pit to avoid disturbing surface features between the two pits. These techniques would minimize disturbance and allow continued use of the feature that is being crossed. Each entrance pit would be about 15-feet wide by 50-feet long; receiving pits would be about 10-feet wide by 20-feet long. During final design of the pipelines, discussions with agencies that maintain or own the crossing features would be required to establish the definite need for trenchless crossings.

An energy dissipation structure, consisting principally of concrete or other suitable material, would be constructed at the outflow of any return flow pipelines flowing into the Arkansas River or Fountain Creek.

After backfill and all construction work are competed, the contractor would provide quality control of pipeline construction through visual inspection.

In general, maintenance roads would not be built along pipelines. A permanent access road would be constructed from Squirrel Creek Road south to the Williams Creek Pump Station along the untreated water pipeline. Easements (permanent and temporary) would be used for access during construction. Post-construction access along the pipelines would be accomplished by 4-wheel drive vehicle within the permanent easements. Culverts may be installed at small creeks or dry channels to allow for 4-wheel drive access. Gates (12 feet wide) would be installed where fences cross the permanent easement.

Blowoffs would be installed in each of the untreated, treated, and return flow pipelines to allow for drainage of the pipeline for maintenance and repairs. Pipeline blowoffs would be located at hydraulic low spots, stream channels, or other drainageways where possible. Discharge from blowoffs located at stream channels would flow directly into the associated drainageways as channel flow. Some blowoffs, however, may be located in upland areas due to extended distances between channels or drainageways. Drainage from blowoffs located in upland areas would occur as overland flow between the blowoff and the nearest drainageway. Blowoffs would be designed in such a manner that use of the blowoff valves for maintenance or emergency uses would not adversely affect upland soil stability or channel stability at or downstream of the valves. Best management practices would be used to control the discharge from the blowoff valves.

The maximum flow rate for the blowoff valves, when used for regular maintenance or for emergency drainage of any SDS Project pipeline (untreated water, treated water, or return flow), would not exceed the channel forming discharge for the drainage directly downstream of each valve. The channel forming discharge for the drainages associated with each blowoff valve would be approximated using a regression equation for the 2-year return interval peak discharge developed by the U.S. Geological Survey (Vaill 2000), or obtained from previous drainage studies. For blowoffs located in upland areas, the maximum flow rate would be less than that which causes soil erosion.

Outflow from blowoff valves located in urban areas would be directed toward streets or storm drains where possible and allowed under local regulations. Where streets or storm drains are not available or their use is not permitted, an energy dissipation structure would be designed for the area where the outflow from each blowoff valve would be released. The structure would prevent erosion resulting from discharge from the blowoff valve. Blowoff valve outflow downstream of the energy dissipation structure would be monitored during operation of the blowoff valves to verify that upland soil and channel erosion are not occurring downstream of the energy dissipation structures. If erosion was occurring, additional upland soil protection and/or channel protection would be installed, or the allowable blowoff valve flow rate would be reduced.

Pipeline construction, excluding revegetation, would typically require two to four weeks per mile. Construction in difficult areas, such as rock, could require eight to ten weeks per mile.

2.5.4 Conveyance Channels

Existing irrigation ditches would be used to convey Colorado Springs' reusable return flows under all alternatives. Existing ditches that would be modified to handle increased flows would include the Chilcotte Ditch and Fountain Mutual Irrigation Ditch, depending upon the alternative. Modifications of these ditches would vary by alternative and may include increasing the capacity, installing flow control or measurement structures, and extensions. Unless otherwise specified in the alternative-specific sections of this chapter, construction and restoration of the ditch modifications would consist of the following activities (CH2M HILL 2005f).

Channels requiring extension or reshaping would be excavated. The ditch would be backfilled with compacted soil and then excavated using a trapezoidal design template. Soil removed by the canal template would be used as fill for the next reach of ditch. An underdrain, imported compacted granular fill, and reinforced concrete lining would be installed (Figure 27). Existing headgates, pipelines, or siphons would be replaced to achieve the conveyance capacity needed for the alternative. Drop structures, trash racks, and perimeter fencing would be installed as needed for public safety protection.

Trenchless construction (Section 2.5.2) would generally be used to cross beneath U.S. or state highways, county highways and roadways, major roadways within developed areas of any city, railroads, and rivers and major streams. Maintenance roads exist along each of the potentially affected ditches. These roads would be extended along any ditch extensions constructed as part of the SDS Project.

2.5.5 Reservoirs

All alternatives include one terminal storage reservoir and some alternatives include a return flow reservoir. Although the function, size, and location of these facilities would differ somewhat among alternatives, the construction and restoration methods would be similar (GEI 2005a, 2005b; CH2M HILL 2007f). Reservoir design and construction would be conducted in accordance with applicable state requirements and permits.

Before dam construction, temporary and permanent access roads would be established. Any existing power lines within the reservoir's flood pool would be relocated by installing new power poles or towers and conductors within an alignment defined for the specific reservoir site. The stream would be diverted and de-watered as needed to allow construction. Baseflows would be conveyed in a pipe through the construction area. Stormflows would be managed through cofferdams that route flows away from active construction areas.

Dam foundation, spillway chute, and outlet works areas would be excavated and prepared for construction. Blasting or other specialized equipment may be required to excavate rock. If blasting is required, all blasting operations, including transportation, storage, and handling of explosives and blasting materials would comply with county, state, and federal regulations. Embankment materials would be obtained from borrow pit excavation or blasting within the reservoir normal pool area and would be stockpiled and processed (e.g., crushed) on-site. Materials such as riprap, filter drain sand, and concrete mix would be hauled from off-site sources and installed. A main earthen embankment and any wing or saddle dams would be constructed.

A concrete spillway would be constructed, which would consist of an intake structure, discharge chute, and stilling basin. An outlet works would be constructed, which would consist of an intake tower and access bridge, an intake structure and conduit, a discharge conduit to an upper valve vault, a stream release conduit to a lower valve vault, and, for terminal storage reservoirs, a water treatment plant conduit from the upper valve vault to the water treatment plant. Mechanical and electrical equipment for the outlet works and controls would be installed.

Upstream embankment slopes would be protected using riprap or soil-cement,

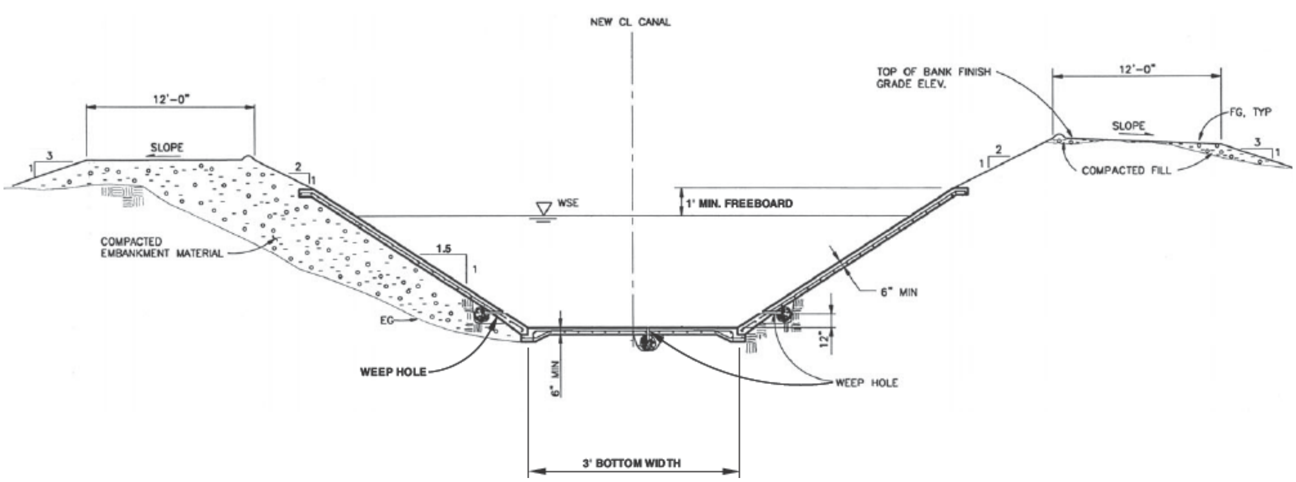


Figure 27. Typical Cross Section of Ditch Improvements.

Note: CL – centerline, EG – existing ground surface, ELEV – elevation, FG – finished ground surface, MIN – minimum, TYP – typical, WSE – water surface elevation.

Source: CH2M HILL 2005f.

depending on final design considerations. Riprap would be imported from off-site sources. Downstream embankment slopes would be vegetated with native seed to reduce the potential for erosion and to match the existing vegetation.

At terminal storage reservoirs, recreational facilities such as visitor information stations, trails, boat ramps and access, parking, and restrooms would be constructed. The quantities, locations, and layouts of these facilities have not yet been defined. Colorado Springs through its Parks and Recreation Department would construct, operate, and maintain these facilities.

Disturbed areas outside the reservoir's normal pool would be restored and revegetated to conditions similar to pre-construction conditions. The restored area would be similar to the native vegetation. Additionally, the downstream face of the dam would be vegetated. Colorado Springs Utilities (n.d.) Site Design Guidelines would be used for landscaping.

2.5.6 Power Supplies

All alternatives would require power supplies to operate pump stations, treatment plants, reservoir valving, and other equipment. Power supplies would consist of two primary types: new transmission lines or connections to existing supplies. Footings for new power poles or towers would be installed and the power poles or towers would be erected. Conductors would be hung on the new poles or towers and connected to the power source and SDS Project facility. Some conductors may be placed underground. Power supply information in this FEIS is based on conceptual design. The final location and configuration of any new electrical transmission facilities would be determined by the power supplier rather than Reclamation or the Project Participants. These decisions by the power suppliers would determine whether electrical substations would be required at SDS Project facilities.

2.5.7 Utility and Transportation Relocations

Some existing utilities (e.g., water, sewer, natural gas, liquid petroleum, electric, telephone, and other cables or conduits) would require relocation under any of the alternatives. All affected utilities would not be identified until final design. Additionally, Bradley Road in the vicinity of the Upper Williams Creek Reservoir site would require relocation under the Participants' Proposed Action and Wetland Alternative.

Utility and roadway relocations would generally occur during construction of an SDS Project facility rather than as an independent activity. Site clearing, grading, dewatering, excess material disposal, and restoration methods would be the same as those for the SDS Project facility being constructed. Utility service outages would be minimized and affected persons would be notified of planned outages. Utility relocations would be designed in accordance with the requirements of the affected utility company and standard engineering practices. New roadways would be designed and constructed in accordance with requirements of the agency responsible for each road.

2.5.8 Construction Impact Mitigation Measures

Detailed mitigation planning would advance when the final Preferred Alternative is identified in a ROD and is designed. The general construction mitigation envisioned with implementation of any of the alternatives is described below. Measures to avoid, minimize, or mitigate adverse environmental impacts are identified in the individual resource sections of Chapter 3 and compiled in Chapter 5.

Construction mitigation measures would be prepared in a Construction Management Plan (CMP). The CMP would be refined during final design for the first phase of the project and further refined during subsequent design phases. The purpose of the CMP is to address plans to avoid, minimize, and mitigate impacts to the communities in the project corridor from construction activities. A summary of measures that are part of the Project Participants' design is provided below.

- Project facilities would be designed to match the architectural character of the surrounding area in which they are sited.
- Construction sites and procedures would be selected to avoid wetlands and other sensitive environmental resources to the extent practicable.
- Construction would typically occur between 7:00 A.M. and 7:00 P.M., Monday through Friday. However, some short-term or specialty operations would require 24-hour construction.
- Vehicular traffic, associated with SDS Project construction and operations, is described in Chapter 3 (Section 3.21).
- Perimeter fencing would be installed at all construction sites for security and public safety. Clearing would be performed in accordance with applicable permits and with conditions contained in right-of-way agreements or federal special use permits.
- Vegetation and obstacles would be cleared as necessary to allow safe and efficient use of construction equipment.
- Debris from right-of-way preparation (e.g., vegetation, rock, and building materials) would be disposed in accordance with applicable regulations, permits, or agreements.
- Materials that could not be reused in construction of the new facilities would be hauled to a commercial landfill or other suitable facility in accordance with applicable regulations.
- Riprap and sand would be obtained from commercial quarries or other suitable sources.
- Concrete and other construction materials would be obtained from commercial suppliers or other appropriate sources.
- Extra material, such as soil excavated, but unsuitable for use as construction backfill material, would be disposed. Disposal of remaining spoil material would be the responsibility of the construction contractor and could include hauling to an offsite landfill, selling or giving the material to another user, or spreading the excess material on the site, as agreed to by the Project Participants and the property owner.
- Ground water encountered in excavations would be handled in accordance with requirements of construction dewatering permits. Generally, ground water would be collected and pumped into a temporary retention pond or land application system or routed to appropriate storm drains. At some locations, water would be discharged to a stream or river after treatment to control turbidity. Water produced during ground water well development or pipeline draining would be handled in a similar manner.
- Topsoil would be removed and stored on-site for use during backfill and

revegetation. The site would be graded to establish appropriate contours for facility construction and to provide safe and efficient machinery movement and operation.

- After minor surface settlement has occurred, the topsoil removed earlier would be replaced and the site would be landscaped or revegetated.
- Sites close to developed areas would be landscaped to match the general character of the area in which it is sited in accordance with Colorado Springs Utilities (n.d.) Site Design Guidelines.
- Outlying areas would be revegetated consistent with pre-disturbance conditions and monitored for successful reestablishment. A revegetation specialist, through consultation with the Natural Resources Conservation Service and landowner, would determine the proper seed mix.
- All private property affected by project construction would be restored to a condition comparable to the pre-construction condition.

2.6 Summary of Environmental Consequences

Chapter 3 fully discloses the environmental effects of the alternatives. Table 24 summarizes those effects. Chapter 3 presents in-depth discussions of direct, indirect, and cumulative effects and quantifies these effects whenever possible. Mitigation measures for substantive effects are also described in the resource-specific sections of Chapter 3 and compiled in Chapter 5.

2.7 Identification of Preferred Alternative

The environmental and technical evaluations performed as part of the FEIS indicate that all six of the Action Alternatives are reasonable. Reclamation compared all of the alternatives in terms of how well they addressed the 10 public scoping issues (Section 2.1.1) and other relevant environmental and non-environmental issues identified by Reclamation during the FEIS process, including energy use and estimated costs. Based upon these considerations, Reclamation has identified the Participants' Proposed Action as the Agency Preferred Alternative. Subject to contract negotiations, Reclamation would enter into excess capacity contracts with the Participants for use of Fry-Ark facilities, issue a special use permit or other agreement to connect to Fry-Ark facilities, and allow an "administrative swap" of FVA water associated with SDS Project deliveries. These contracts and approvals would allow the Project Participants to construct and operate the Participants' Proposed Action alternative in a manner that is consistent with that evaluated in the FEIS, except under emergency conditions. Additional environmental commitments that would be required to implement the Participants' Proposed Action alternative are identified in Chapter 5.

All alternatives would have adverse environmental effects. When coupled with the proposed mitigation measures described in this FEIS, the Participants' Proposed Action would result in similar or fewer environmental effects when compared to the other alternatives. Additionally, this alternative would have the lowest total project cost and lowest energy use requirements, resulting in the lowest greenhouse gas emissions, of any Action Alternative. All of the Action Alternatives were developed to address specific environmental issues or meet public interest objectives. However, the other alternatives would have adverse environmental effects on other resources, would have a higher total cost, and would require at least as much or substantially more energy than the Participants' Proposed Action.

This FEIS describes the environmental effects of the alternatives analyzed, and identifies an Agency Preferred Alternative based on how well the alternatives address the significant issues identified during scoping, the environmental effects of the alternatives, and other technical factors, including economic and engineering considerations. A final Agency Preferred Alternative that is selected for implementation will be identified in a ROD. Because it would cause the least damage to the biological and physical environment, Reclamation has determined that the Participants' Proposed Action is the environmentally preferred alternative.

Table 24. Summary of Direct and Indirect Effects.

Resources, Effect Indicators, and Geographical Areas	No Action Alternative	Effects of Action Alternatives Compared to No Action (Percent Change in Effect Compared to No Action Alternative is Given in Parenthesis)					
		Participants' Proposed Action	Wetland Alternative	Arkansas River Alternative	Fountain Creek Alternative	Downstream Intake Alternative	Highway 115 Alternative
Surface Water Hydrology							
Average Annual Streamflow							
1) Homestake Creek at Gold Park (Existing = 20 cfs)	1) 20 cfs	1) 19 cfs (-3%)	1) 19 cfs (-2%)	1) 19 cfs (-2%)	1) 19 cfs (-3%)	1) 19 cfs (-3%)	1) 20 cfs (-4%)
2) Roaring Fork above Difficult Creek near Aspen (Existing = 75 cfs)	2) 69 cfs	2) 73 cfs (5%)	2) 73 cfs (6%)	2) 73 cfs (6%)	2) 72 cfs (5%)	2) 73 cfs (6%)	2) 70 cfs (1%)
3) Ivanhoe Creek near Nast (Existing = 6 cfs)	3) 5 cfs	3) 5 cfs (3%)	3) 5 cfs (5%)	3) 5 cfs (5%)	3) 5 cfs (4%)	3) 6 cfs (8%)	3) 5 cfs (1%)
4) Lake Creek below Twin Lakes (Existing = 172 cfs)	4) 235 cfs	4) 172 cfs (-27%)	4) 169 cfs (-28%)	4) 169 cfs (-28%)	4) 172 cfs (-27%)	4) 171 cfs (-27%)	4) 241 cfs (2%)
5) Arkansas River near Wellsville (Existing = 677 cfs)	5) 685 cfs	5) 678 cfs (-1%)	5) 674 cfs (-2%)	5) 674 cfs (-2%)	5) 678 cfs (-1%)	5) 677 cfs (-1%)	5) 682 cfs (0%)
6) Arkansas River at Portland (Existing = 766 cfs)	6) 703 cfs	6) 769 cfs (9%)	6) 858 cfs (22%)	6) 858 cfs (22%)	6) 768 cfs (9%)	6) 767 cfs (9%)	6) 692 cfs (-2%)
7) Arkansas River above Pueblo (Existing = 631 cfs)	7) 562 cfs	7) 547 cfs (-3%)	7) 635 cfs (13%)	7) 717 cfs (27%)	7) 547 cfs (-3%)	7) 627 cfs (11%)	7) 552 cfs (-2%)
8) Fountain Creek at Security (Existing = 170 cfs)	8) 234 cfs	8) 235 cfs (0%)	8) 141 cfs (-40%)	8) 141 cfs (-40%)	8) 235 cfs (0%)	8) 236 cfs (1%)	8) 235 cfs (0%)

Resources, Effect Indicators, and Geographical Areas	No Action Alternative	Effects of Action Alternatives Compared to No Action (Percent Change in Effect Compared to No Action Alternative is Given in Parenthesis)					
		Participants' Proposed Action	Wetland Alternative	Arkansas River Alternative	Fountain Creek Alternative	Downstream Intake Alternative	Highway 115 Alternative
9) Fountain Creek at Pueblo (Existing = 188 cfs)	9) 249 cfs	9) 253 cfs (2%)	9) 168 cfs (-3%)	9) 168 cfs (-3%)	9) 171 cfs (-31%)	9) 256 cfs (3%)	9) 254 cfs (2%)
10) Jimmy Camp Creek at Fountain (Existing = 2 cfs)	10) 8 cfs	10) 8 cfs (0%)	10) 8 cfs (0%)	10) 8 cfs (0%)	10) 8 cfs (0%)	10) 8 cfs (0%)	10) 8 cfs (0%)
11) Williams Creek at Mouth (ungaged) (Existing = 0 cfs)	11) 0 cfs	11) 0 cfs (0%)	11) 0 cfs (0%)	11) 0 cfs (0%)	11) 0 cfs (0%)	11) 0 cfs (0%)	11) 0 cfs (0%)
12) Arkansas River near Avondale (Existing = 971 cfs)	12) 961 cfs	12) 951 cfs (-1%)	12) 953 cfs (-1%)	12) 953 cfs (-1%)	12) 956 cfs (-1%)	12) 949 cfs (-1%)	12) 955 cfs (-1%)
13) Arkansas River near Las Animas (Existing = 321 cfs)	13) 310 cfs	13) 310 cfs (0%)	13) 313 cfs (1%)	13) 314 cfs (1%)	13) 312 cfs (1%)	13) 309 cfs (0%)	13) 309 cfs (0%)
Average Annual Reservoir Storage Volume							
1) Homestake Reservoir (Existing = 18,800 ac-ft)	1) 15,600 ac-ft	1) 15,800 ac-ft (1%)	1) 16,400 ac-ft (5%)	1) 16,500 ac-ft (6%)	1) 15,500 ac-ft (-1%)	1) 16,100 ac-ft (3%)	1) 17,200 ac-ft (10%)
2) Total Fry-Ark Reservoirs (Twin, Turquoise and Pueblo) (Existing = 372,700 ac-ft)	2) 350,800 ac-ft	2) 348,300 ac-ft (-1%)	2) 356,200 ac-ft (2%)	2) 358,300 ac-ft (2%)	2) 351,400 ac-ft (0%)	2) 344,200 ac-ft (-2%)	2) 345,400 ac-ft (-2%)
3) Total Colorado Canal (Existing = 31,900 ac-ft)	3) 32,600 ac-ft	3) 27,900 ac-ft (-14%)	3) 26,200 ac-ft (-20%)	3) 26,100 ac-ft (-20%)	3) 29,500 ac-ft (-10%)	3) 29,500 ac-ft (-10%)	3) 33,500 ac-ft (3%)
4) Holbrook Reservoir (Existing = 3,400 ac-ft)	4) 3,700 ac-ft	4) 3,000 ac-ft (-19%)	4) 2,900 ac-ft (-22%)	4) 2,900 ac-ft (-22%)	4) 3,000 ac-ft (-19%)	4) 2,900 ac-ft (-22%)	4) 3,000 ac-ft (-19%)

Resources, Effect Indicators, and Geographical Areas	No Action Alternative	Effects of Action Alternatives Compared to No Action (Percent Change in Effect Compared to No Action Alternative is Given in Parenthesis)					
		Participants' Proposed Action	Wetland Alternative	Arkansas River Alternative	Fountain Creek Alternative	Downstream Intake Alternative	Highway 115 Alternative
Ground Water Hydrology							
Maximum Change in Alluvial Ground Water Level[1] 1) Arkansas River above Pueblo 2) Fountain Creek below Janitell Road 3) Fountain Creek at Security	1) -0.1 ft (Negligible) 2) 0.2 ft (Negligible) 3) -3.4 ft (Moderate)	1) -0.1 ft (Negligible) 2) <0.1 ft (Negligible) 3) 2.5 ft (Major, but negligible relative to Existing Conditions)	1) 0.1 ft (Negligible) 2) -0.4 ft (Negligible) 3) 2.1 ft (Major, but negligible relative to Existing Conditions)	1) 0.3 ft (Negligible) 2) -0.4 ft (Negligible) 3) 2.1 ft (Major, but negligible relative to Existing Conditions)	1) -0.1 ft (Negligible) 2) <0.1 ft (Negligible) 3) 2.5 ft (Major, but negligible relative to Existing Conditions)	1) 0.1 ft (Negligible) 2) <0.1 ft (Negligible) 3) 8.6 ft (Major, but negligible relative to Existing Conditions)	1) -0.1 ft (Negligible) 2) <0.1 ft (Negligible) 3) 2.5 ft (Major, but negligible relative to Existing Conditions)
4) Fountain Creek near Fountain	4) -16.5 ft (Major)	4) 10.1 ft (Major, but negligible relative to Existing Conditions)	4) 11.4 ft (Major, but negligible relative to Existing Conditions)	4) 12.4 ft (Major, but negligible relative to Existing Conditions)	4) 11.4 ft (Major, but negligible relative to Existing Conditions)	4) 19.1 ft (Major, but negligible relative to Existing Conditions)	4) 11.7 ft (Major, but negligible relative to Existing Conditions)
5) Fountain Creek near Piñon 6) Fountain Creek at Pueblo	5) 0.3 ft (Negligible) 6) 0.2 ft (Negligible)	5) <0.1 ft (Negligible) 6) <0.1 ft (Negligible)	5) -0.4 ft (Negligible) 6) -0.3 ft (Negligible)	5) -0.4 ft (Negligible) 6) -0.3 ft (Negligible)	5) -0.4 ft (Negligible) 6) -0.3 ft (Negligible)	5) 0.1 ft (Negligible) 6) <0.1 ft (Negligible)	5) <0.1 ft (Negligible) 6) <0.1 ft (Negligible)

[1] Maximum change in alluvial ground water levels is the greatest effect to the depth to ground water near a surface stream. Negative change results in a lower ground water depth, while positive change results in a higher ground water depth.

Resources, Effect Indicators, and Geographical Areas	No Action Alternative	Effects of Action Alternatives Compared to No Action (Percent Change in Effect Compared to No Action Alternative is Given in Parenthesis)					
		Participants' Proposed Action	Wetland Alternative	Arkansas River Alternative	Fountain Creek Alternative	Downstream Intake Alternative	Highway 115 Alternative
7) Jimmy Camp Creek at Fountain 8) Williams Creek at Williams Creek Reservoir	7) 0.4 ft (Negligible) 8) 20 ft (Major)	7) <0.1 ft (Negligible) 8) <0.1 ft (Negligible)	7) <0.1 ft (Negligible) 8) -20 ft (Major, but negligible relative to Existing Conditions)	7) <0.1 ft (Negligible) 8) -20 ft (Major, but negligible relative to Existing Conditions)	7) <0.1 ft (Negligible) 8) <0.1 ft (Negligible)	7) <0.1 ft (Negligible) 8) <0.1 ft (Negligible)	7) <0.1 ft (Negligible) 8) <0.1 ft (Negligible)
Change in Mean Denver Basin Aquifer Ground Water Levels[2] 1) Denver Aquifer 2) Arapahoe Aquifer 3) Laramie-Fox Hills Aquifer	1) -48 ft 2) -129 ft 3) -39 ft	1) 0 ft (-100%) 2) 23 ft (-118%) 3) 21 ft (-154%)	1) 0 ft (-100%) 2) 23 ft (-118%) 3) 21 ft (-154%)	1) 0 ft (-100%) 2) 23 ft (-118%) 3) 21 ft (-154%)	1) 0 ft (-100%) 2) 23 ft (-118%) 3) 21 ft (-154%)	1) 0 ft (-100%) 2) 23 ft (-118%) 3) 21 ft (-154%)	1) 0 ft (-100%) 2) 23 ft (-118%) 3) 21 ft (-154%)

[2] Change in mean Denver Basin Aquifer ground water levels is the mean effect on the depth to ground water in the Denver Basin Aquifers. Negative change results in a lower ground water depth, while positive change results in a higher ground water depth.

Resources, Effect Indicators, and Geographical Areas	No Action Alternative	Effects of Action Alternatives Compared to No Action (Percent Change in Effect Compared to No Action Alternative is Given in Parenthesis)					
		Participants' Proposed Action	Wetland Alternative	Arkansas River Alternative	Fountain Creek Alternative	Downstream Intake Alternative	Highway 115 Alternative
Water Quality							
General Western Slope Water Quality 1) Western Slope Streams and Homestake Reservoir Streams	1) Negligible effect	1) Same as No Action Alternative	1) Same as No Action Alternative	1) Same as No Action Alternative	1) Same as No Action Alternative	1) Same as No Action Alternative	1) Same as No Action Alternative
Specific Conductance [3] 1) Arkansas River at Portland (Existing = 630 µS/cm) 2) Arkansas River above Pueblo (Existing = 650 µS/cm) 3) Arkansas River at Moffat Street (Existing = 790 µS/cm) 4) Fountain Creek at Janitell (Existing = 850 µS/cm) 5) Fountain Creek at Fountain (Existing = 1,100 µS/cm)	1) 490 µS/cm 2) 680 µS/cm 3) 790 µS/cm 4) 940 µS/cm – adverse agricultural 5) 1,200 µS/cm	1) 610 µS/cm (24%) 2) 660 µS/cm (-3%) 3) 810 µS/cm (3%) 4) 930 µS/cm (-1%) 5) 1,200 µS/cm (0%)	1) 720 µS/cm (47%) 2) 750 µS/cm (10%) – adverse municipal & agricultural 3) 820 µS/cm (4%) 4) 1,000 µS/cm (6%) 5) 1,400 µS/cm (17%)	1) 720 µS/cm (47%) 2) 750 µS/cm (10%) – adverse municipal & agricultural 3) 790 µS/cm (0%) 4) 1,000 µS/cm (6%) 5) 1,400 µS/cm (17%)	1) 610 µS/cm (24%) 2) 660 µS/cm (-3%) 3) 800 µS/cm (1%) 4) 930 µS/cm (-1%) 5) 1,400 µS/cm (17%)	1) 630 µS/cm (29%) 2) 680 µS/cm (0%) 3) 810 µS/cm (3%) 4) 920 µS/cm (-2%) 5) 1,100 µS/cm (-8%)	1) 490 µS/cm (0%) 2) 690 µS/cm (1%) 3) 860 µS/cm (9%) 4) 930 µS/cm (-1%) 5) 1,200 µS/cm (0%)

[3] Specific Conductance shown is the 85th percentile of concentrations that were simulated.

Resources, Effect Indicators, and Geographical Areas	No Action Alternative	Effects of Action Alternatives Compared to No Action (Percent Change in Effect Compared to No Action Alternative is Given in Parenthesis)					
		Participants' Proposed Action	Wetland Alternative	Arkansas River Alternative	Fountain Creek Alternative	Downstream Intake Alternative	Highway 115 Alternative
6) Fountain Creek at Pueblo (Existing = 1,700 μS/cm) 7) Arkansas River near Avondale (Existing = 1,200 μS/cm) 8) Arkansas River at Catlin Dam (Existing = 1,500 μS/cm) 9) Lake Henry and Lake Meredith (Existing = 1,500 μS/cm) Differences less than 10% not considered meaningful (given model uncertainty), shown in grey text. Potential effects to beneficial uses noted.	6) 1,700 μS/cm 7) 1,200 μS/cm 8) 1,500 μS/cm 9) 1,600 μS/cm	6) 1,700 μS/cm (0%) 7) 1,300 μS/cm (8%) 8) 1,500 μS/cm (0%) 9) 1,500 μS/cm (-6%)	6) 2,100 μS/cm (24%) – adverse agricultural 7) 1,300 μS/cm (8%) 8) 1,500 μS/cm (0%) 9) 1,500 μS/cm (-6%)	6) 2,100 μS/cm (24%) – adverse agricultural 7) 1,300 μS/cm (8%) 8) 1,500 μS/cm (0%) 9) 1,500 μS/cm (-6%)	6) 2,100 μS/cm (24%) – adverse agricultural 7) 1,200 μS/cm (0%) 8) 1,500 μS/cm (0%) 9) 1,500 μS/cm (-6%)	6) 1,500 μS/cm (-12%) 7) 1,300 μS/cm (8%) 8) 1,500 μS/cm (0%) 9) 1,500 μS/cm (-6%)	6) 1,600 μS/cm (-6%) 7) 1,200 μS/cm (0%) 8) 1,500 μS/cm (0%) 9) 1,500 μS/cm (-6%)
Salinity Effects on Crop Yield near Rocky Ford and La Junta	No substantial effects	Same as No Action Alternative					

Resources, Effect Indicators, and Geographical Areas	No Action Alternative	Effects of Action Alternatives Compared to No Action (Percent Change in Effect Compared to No Action Alternative is Given in Parenthesis)					
		Participants' Proposed Action	**Wetland Alternative**	**Arkansas River Alternative**	**Fountain Creek Alternative**	**Downstream Intake Alternative**	**Highway 115 Alternative**
Dissolved Selenium[4]							
1) Monument Creek at Bijou Street (Existing = 4 µg/L) (WQS = 4.6 ug/L)	1) 4 µg/L	1) 4 µg/L (0%)	1) 4 µg/L (0%)	1) 4 µg/L (0%)	1) 4 µg/L (0%)	1) 4 µg/L (0%)	1) 4 µg/L (0%)
2) Fountain Creek near Fountain (Existing = 5 µg/L) (WQS = 8.0 µg/L)	2) 5 µg/L	2) 4 µg/L (0%)	2) 4 µg/L (25%)	2) 5 µg/L (25%)	2) 5 µg/L (25%)	2) 4 µg/L (0%)	2) 4 µg/L (0%)
3) Fountain Creek at Pueblo (Existing = 28 µg/L) (WQS = 28.1 µg/L)	3) 23 µg/L	3) 24 µg/L (4%)	3) 34 µg/L (48%)	3) 34 µg/L (48%)	3) 34 µg/L (48%)	3) 21 µg/L (-9%)	3) 22 µg/L (-4%)
4) Arkansas River at Moffat Street (Existing = 33 µg/L) (WQS = 17.4 µg/L)	4) 49 µg/L	4) 59 µg/L (20%)	4) 43 µg/L (-12%)	4) 26 µg/L (-47%)	4) 54 µg/L (10%)	4) 65 µg/L (33%)	4) 70 µg/L (43%)
5) Arkansas River near Avondale (Existing = 16 µg/L) (WQS = 14.1 µg/L)[5]	5) 18 µg/L	5) 20 µg/L (11%)	5) 19 µg/L (6%)	5) 17 µg/L (-6%)	5) 18 µg/L (0%)	5) 17 µg/L (-6%)	5) 19 µg/L (6%)
6) Arkansas River at Catlin Dam (Existing = 12 µg/L) (WQS=4.6 µg/L)	6) 14 µg/L	6) 14 µg/L (0%)	6) 14 µg/L (0%)	6) 12 µg/L (-14%)	6) 14 µg/L (0%)	6) 13 µg/L (-7%)	6) 14 µg/L (0%)

[4] Dissolved selenium shown is 85th percentile of simulated concentrations. Chronic water quality standards (WQS) are shown in the table.
[5] Temporary WQS for dissolved selenium currently apply to the Arkansas River near Avondale and at Catlin Dam locations. The temporary chronic WQS are 14.2 µg/L near Avondale and 15.1 µg/L at Catlin Dam. Future WQS for these locations are unknown.

Resources, Effect Indicators, and Geographical Areas	No Action Alternative	Effects of Action Alternatives Compared to No Action (Percent Change in Effect Compared to No Action Alternative is Given in Parenthesis)					
		Participants' Proposed Action	**Wetland Alternative**	**Arkansas River Alternative**	**Fountain Creek Alternative**	**Downstream Intake Alternative**	**Highway 115 Alternative**
Metals Concentrations 1) Arkansas River at Granite	1) Minor decrease in metal concentration	1) Minor increase in metal concentration (WQS attainment not affected)	1) Minor increase in metal concentration (WQS attainment not affected)	1) Minor increase in metal concentration (WQS attainment not affected)	1) Minor increase in metal concentration (WQS attainment not affected)	1) Minor increase in metal concentration (WQS attainment not affected)	1) Same as No Action Alternative
2) Upper Arkansas River between Portland and Pueblo Reservoir	2) No effect	2) Same as No Action Alternative	2) Slight increase in metal concentration (WQS attainment not affected)	2) Slight increase in metal concentration (WQS attainment not affected)	2) Same as No Action Alternative	2) Same as No Action Alternative	2) Same as No Action Alternative
3) Lower Arkansas River downstream of Fountain Creek	3) Slight increase in total recoverable iron (ambient-based WQS not affected)	3) Slight increase in total recoverable iron (ambient-based WQS not affected)	3) Slight decrease in total recoverable iron	3) Slight decrease in total recoverable iron	3) Slight decrease in total recoverable iron	3) Slight increase in total recoverable iron (ambient-based WQS not affected)	3) Slight increase in total recoverable iron (ambient-based WQS not affected)
Suspended Sediment Concentrations in Fountain Creek (no WQS applies)	Minor increase	Same as No Action Alternative	Minor decrease	Minor decrease	No change from Colorado Springs to Security; minor decrease from Security to Pueblo	Same as No Action Alternative	Same as No Action Alternative

Resources, Effect Indicators, and Geographical Areas	No Action Alternative	Effects of Action Alternatives Compared to No Action (Percent Change in Effect Compared to No Action Alternative is Given in Parenthesis)					
		Participants' Proposed Action	**Wetland Alternative**	**Arkansas River Alternative**	**Fountain Creek Alternative**	**Downstream Intake Alternative**	**Highway 115 Alternative**
Temperature	No substantial changes	Same as No Action Alternative	Minor increase in winter temperature and decrease in summer temperature in Arkansas River near Florence (WQS attainment possibly improved)	Minor increase in winter temperature and decrease in summer temperature in Arkansas River near Florence (WQS attainment possibly improved)	Same as No Action Alternative	Same as No Action Alternative	Same as No Action Alternative
Nutrients Concentrations 1) Arkansas River Florence through Pueblo Reservoir 2) Fountain Creek (WQS attainment not affected by any alternative)	1) No effect 2) Minor increase in nutrient concentrations	Same as No Action Alternative	1) Increase in nutrient concentrations 2) Minor decrease in nutrient concentrations	1) Increase in nutrient concentrations 2) Minor decrease in nutrient concentrations	Same as No Action Alternative	Same as No Action Alternative	Same as No Action Alternative
Algae Growth 1) Arkansas River Florence through Pueblo Reservoir 2) Fountain Creek and Lower Arkansas River (No WQS applies)	1) No effect 2) No effect	Same as No Action Alternative	1) Increase in algae growth 2) Same as No Action Alternative	1) Increase in algae growth 2) Same as No Action Alternative	Same as No Action Alternative	Same as No Action Alternative	Same as No Action Alternative

Resources, Effect Indicators, and Geographical Areas	No Action Alternative	Effects of Action Alternatives Compared to No Action (Percent Change in Effect Compared to No Action Alternative is Given in Parenthesis)					
		Participants' Proposed Action	Wetland Alternative	Arkansas River Alternative	Fountain Creek Alternative	Downstream Intake Alternative	Highway 115 Alternative
Emerging Contaminants[6] 1) Arkansas River Florence through Pueblo Reservoir 2) Fountain Creek (No WQS applies)	1) No effect 2) Minor increase	Same as No Action Alternative	1) Minor increase 2) Minor decrease	1) Minor increase 2) Minor decrease	Same as No Action Alternative	Same as No Action Alternative	Same as No Action Alternative
E. coli[7] 1) Monument Creek at Bijou Street (Existing = 474/100mL) 2) Fountain Creek near Fountain (Existing = 142/100mL) 3) Fountain Creek at Pueblo (Existing = 142/100mL) 4) Arkansas River at Moffat Street (Existing = 26/100mL) 5) Arkansas River near Avondale (Existing = 48/100mL) 6) Arkansas River at Catlin Dam (Existing = 56/100mL)	1) 386/100 mL 2) 133/100 mL 3) 133/100 mL 4) 29/100 mL 5) 56/100 mL 6) 60/100 mL	1) 386/100 mL (0%) 2) 131/100 mL (-2%) 3) 130/100 mL (-2%) 4) 37/100 mL (28%) 5) 56/100 mL (0%) 6) 61/100 mL (2%)	1) 386/100 mL (0%) 2) 146/100 mL (10%) 3) 151/100 mL (14%) 4) 27/100 mL (-7%) 5) 45/100 mL (-20%) 6) 54/100 mL (-10%)	1) 386/100 mL (0%) 2) 146/100 mL (10%) 3) 151/100 mL (14%) 4) 20/100 mL (-31%) 5) 40/100 mL (-29%) 6) 51/100 mL (-15%)	1) 386/100 mL (0%) 2) 129/100 mL (-3%) 3) 134/100 mL (1%) 4) 37/100 mL (28%) 5) 43/100 mL (-23%) 6) 53/100 mL (-12%)	1) 386/100 mL (0%) 2) 139/100 mL (5%) 3) 139/100 mL (5%) 4) 32/100 mL (10%) 5) 55/100 mL (-2%) 6) 59/100 mL (-2%)	1) 386/100 mL (0%) 2) 134/100 mL (1%) 3) 135/100 mL (2%) 4) 43/100 mL (48%) 5) 58/100 mL (4%) 6) 62/100 mL (3%)

[6] Emerging contaminants refer to contaminants found in water that may have human and environmental effects but are not currently regulated by the state and federal government.
[7] *E. coli* shown is the geometric mean of simulated densities.

Resources, Effect Indicators, and Geographical Areas	No Action Alternative	Effects of Action Alternatives Compared to No Action (Percent Change in Effect Compared to No Action Alternative is Given in Parenthesis)					
		Participants' Proposed Action	Wetland Alternative	Arkansas River Alternative	Fountain Creek Alternative	Downstream Intake Alternative	Highway 115 Alternative
(WQS = 126/100mL for all locations)							
Sulfate[8] 1) Arkansas River near Avondale (Existing = 392 mg/L) (Underlying WQS = 250 mg/L; Temporary WQS = 329 mg/L)	1) 399 mg/L	1) 413 mg/L (3%)	1) 416 mg/L (4%)	1) 419 mg/L (5%)	1) 409 mg/L (2%)	1) 417 mg/L (5%)	1) 408 mg/L (2%)
Flood Hydrology and Floodplains							
Change in 2-year Peak Flows[9] 1) Lake Creek	1) No effect	Same as No Action Alternative	1) Same as No Action Alternative	1) Same as No Action Alternative	Same as No Action Alternative	Same as No Action Alternative	Same as No Action Alternative

[8] Sulfate shown is the 85th percentile of simulated concentrations.
[9] Change in peak flow level that has a 50 percent chance of occurring in a given year.

Resources, Effect Indicators, and Geographical Areas	No Action Alternative	Effects of Action Alternatives Compared to No Action (Percent Change in Effect Compared to No Action Alternative is Given in Parenthesis)					
		Participants' Proposed Action	Wetland Alternative	Arkansas River Alternative	Fountain Creek Alternative	Downstream Intake Alternative	Highway 115 Alternative
2) Arkansas River (Portland to Pueblo Reservoir) 3) Fountain Creek (upstream of Williams Creek) 4) Fountain Creek (downstream of Williams Creek) 5) Jimmy Camp Creek 6) Williams Creek 7) Arkansas River (downstream of Fountain Creek) 8) Western Slope Streams	2) No effect 3) No effect 4) 5 to 7% decrease 5) No effect 6) 50% decrease 7) 4% decrease 8) No effect		2) Same as No Action Alternative 3) Same as No Action Alternative 4) 5 to 8% increase (negligible relative to Existing Conditions) 5) Same as No Action Alternative 6) 100% increase (negligible relative to Existing Conditions) 7) 4% increase (negligible relative to Existing Conditions) 8) Same as No Action Alternative	2) Same as No Action Alternative 3) Same as No Action Alternative 4) 5 to 8% increase (negligible relative to Existing Conditions) 5) Same as No Action Alternative 6) 100% increase (negligible relative to Existing Conditions) 7) 4% increase(neg-ligible relative to Existing Conditions) 8) Same as No Action Alternative			

Resources, Effect Indicators, and Geographical Areas	No Action Alternative	Effects of Action Alternatives Compared to No Action (Percent Change in Effect Compared to No Action Alternative is Given in Parenthesis)					
		Participants' Proposed Action	Wetland Alternative	Arkansas River Alternative	Fountain Creek Alternative	Downstream Intake Alternative	Highway 115 Alternative
Change in 10-year Peak Flows[10] 1) Lake Creek 2) Arkansas River (Portland to Pueblo Reservoir) 3) Fountain Creek (upstream of Williams Creek) 4) Fountain Creek (downstream of Williams Creek) 5) Jimmy Camp Creek 6) Williams Creek	1) No effect 2) No effect 3) No effect 4) 7 to 13% decrease 5) No effect 6) 55% decrease	Same as No Action Alternative	1) Same as No Action Alternative 2) Same as No Action Alternative 3) Same as No Action Alternative 4) 8% increase (negligible relative to Existing Conditions) 5) Same as No Action Alternative 6) 119% increase (negligible relative to Existing Conditions)	1) Same as No Action Alternative 2) Same as No Action Alternative 3) Same as No Action Alternative 4) 8 to 15% increase (negligible relative to Existing Conditions) 5) Same as No Action Alternative 6) 122% increase (negligible relative to Existing Conditions)	Same as No Action Alternative	Same as No Action Alternative	Same as No Action Alternative

[10] Change in peak flow level that has a 10 percent chance of occurring in a given year.

Resources, Effect Indicators, and Geographical Areas	No Action Alternative	Effects of Action Alternatives Compared to No Action (Percent Change in Effect Compared to No Action Alternative is Given in Parenthesis)					
		Participants' Proposed Action	**Wetland Alternative**	**Arkansas River Alternative**	**Fountain Creek Alternative**	**Downstream Intake Alternative**	**Highway 115 Alternative**
7) Arkansas River (downstream of Fountain Creek) 8) Western Slope Streams	7) 6% decrease 8) No effect		7) 0 to 6% increase (negligible relative to Existing Conditions) 8) Same as No Action Alternative	7) 6% increase (negligible relative to Existing Conditions) 8) Same as No Action Alternative			
Change in 100-year Peak Flows[11] 1) Lake Creek 2) Arkansas River (Portland to Pueblo Reservoir) 3) Fountain Creek (upstream of Williams Creek)	1) No effect 2) No effect 3) No effect	1) Same as No Action Alternative 2) Same as No Action Alternative 3) Same as No Action Alternative	1) Same as No Action Alternative 2) Same as No Action Alternative 3) Same as No Action Alternative	1) Same as No Action Alternative 2) Same as No Action Alternative 3)Same as No Action Alternative	Same as No Action Alternative	Same as No Action Alternative	Same as No Action Alternative

[11] Change in peak flow level that has a 1 percent chance of occurring in a given year.

Resources, Effect Indicators, and Geographical Areas	No Action Alternative	Effects of Action Alternatives Compared to No Action (Percent Change in Effect Compared to No Action Alternative is Given in Parenthesis)					
		Participants' Proposed Action	Wetland Alternative	Arkansas River Alternative	Fountain Creek Alternative	Downstream Intake Alternative	Highway 115 Alternative
4) Fountain Creek (downstream of Williams Creek)	4) 6 to 8% decrease	4) Same as No Action Alternative	4) 6 to 7% increase (negligible relative to Existing Conditions)	4) 6 to 8% increase (negligible relative to Existing Conditions)			
5) Jimmy Camp Creek	5) 5% decrease	5) 5% increase (negligible relative to Existing Conditions)	5) 5% increase (negligible relative to Existing Conditions)	5) Same as No Action Alternative			
6) Williams Creek	6) 58% decrease	6) 0 to 2% increase (negligible relative to Existing Conditions)	6) 138% increase (negligible relative to Existing Conditions)	6) 138% increase (negligible relative to Existing Conditions)			
7) Arkansas River (downstream of Fountain Creek)	7) 7% decrease	7) 0 to 2% increase (negligible relative to Existing Conditions)	7) 6 to 7% increase (negligible relative to Existing Conditions)	7) 6 to 7% increase (negligible relative to Existing Conditions)			
8) Western Slope Streams	8) No Effect	8) Same As No Action Alternative	8) Same as No Action Alternative	8) Same as No Action Alternative			

Resources, Effect Indicators, and Geographical Areas	No Action Alternative	Effects of Action Alternatives Compared to No Action (Percent Change in Effect Compared to No Action Alternative is Given in Parenthesis)					
		Participants' Proposed Action	**Wetland Alternative**	**Arkansas River Alternative**	**Fountain Creek Alternative**	**Downstream Intake Alternative**	**Highway 115 Alternative**
Change in 100-year Floodplain Stage and Width[12] 1) Fountain Creek Basin 2) Western Slope Streams	1) Reduction in floodplain stage and width downstream of Williams Creek Reservoir 2) No effect	Same as No Action Alternative	1) Increased floodplain stage and width downstream of Williams Creek Reservoir, but negligible relative to Existing Conditions 2) Same as No Action Alternative	1) Increased floodplain stage and width downstream of Williams Creek Reservoir, but negligible relative to Existing Conditions 2) Same as No Action Alternative	Same as No Action Alternative	Same as No Action Alternative	Same as No Action Alternative
Potential for Loss of Life and Damage to Property from Failure of New Dams 1) Colorado Centre Metropolitan District 2) City of Fountain 3) Town of Piñon 4) City of Pueblo	1) Substantial 2) Substantial 3) Substantial 4) Substantial	1) No Effect 2) No Effect 3) Same as No Action Alternative 4) Same as No Action Alternative	1) No Effect 2) No Effect 3) Same as No Action Alternative 4) Same as No Action Alternative	1) Substantial 2) No Effect 3) Same as No Action Alternative 4) Same as No Action Alternative	1) Substantial 2) No Effect 3) Same as No Action Alternative 4) Same as No Action Alternative	1) Substantial 2) No Effect 3) Same as No Action Alternative 4) Same as No Action Alternative	1) Substantial 2) No Effect 3) Same as No Action Alternative 4) Same as No Action Alternative

[12] Change in the depth and area of a flood that has a 1 percent chance of occurring in a given year.

Resources, Effect Indicators, and Geographical Areas	No Action Alternative	Effects of Action Alternatives Compared to No Action (Percent Change in Effect Compared to No Action Alternative is Given in Parenthesis)					
		Participants' Proposed Action	Wetland Alternative	Arkansas River Alternative	Fountain Creek Alternative	Downstream Intake Alternative	Highway 115 Alternative
5) Town of Avondale	5) Negligible	5) Same as No Action Alternative	5) Same as No Action Alternative	5) Same as No Action Alternative	5) Same as No Action Alternative	5) Same as No Action Alternative	5) Same as No Action Alternative
Total Maximum Flood Inundation at New Reservoir Sites 1) Acreage 2) Number of Existing Structures Inundated	1) 2,040 ac (Jimmy Camp Creek and Williams Creek reservoirs) 2) 0	1) 2,210 ac (+8%) (Williams Creek and Upper Williams Creek reservoirs) 2) Same as No Action Alternative	1) 870 ac (-57%) (Upper Williams Creek Reservoir) 2) Same as No Action Alternative	1) 700 ac (-66%) (Jimmy Camp Creek Reservoir) 2) Same as No Action Alternative	Same as No Action Alternative	Same as No Action Alternative	Same as No Action Alternative
Geomorphology							
Geomorphic Effects[13] 1) Lake Creek 2) Arkansas River (Portland to Pueblo Reservoir)	1) Increased streamflow (minor erosion) 2) 1% decrease in baseflow mobile grain size (negligible)	1) Same as No Action Alternative 2) Same as No Action Alternative	1) Same as No Action Alternative 2) 11% increase in baseflow mobile grain size (minor erosion)	1) Same as No Action Alternative 2) 10% increase in baseflow mobile grain size (minor erosion)	1) Same as No Action Alternative 2) 2% increase in baseflow mobile grain size (negligible erosion)	1) Same as No Action Alternative 2) 2% increase in baseflow mobile grain size (negligible erosion)	1) Same as No Action Alternative 2) 3% decrease in baseflow mobile grain size (negligible)

[13] Geomorphic effects are based on multiple indicators such as stream erosion and sedimentation.

Resources, Effect Indicators, and Geographical Areas	No Action Alternative	Effects of Action Alternatives Compared to No Action (Percent Change in Effect Compared to No Action Alternative is Given in Parenthesis)					
		Participants' Proposed Action	Wetland Alternative	Arkansas River Alternative	Fountain Creek Alternative	Downstream Intake Alternative	Highway 115 Alternative
3) Fountain Creek (upstream of Williams Creek)	3) 12 to 17% increase in baseflow mobile grain size (moderate to major erosion)	3) 5% decrease in baseflow mobile grain size (negligible)	3) 17% decrease in baseflow mobile grain size (negligible)	3) 17% decrease in baseflow mobile grain size (negligible)	3) 18% decrease in baseflow mobile grain size (negligible erosion)	3) 7% increase in baseflow mobile grain size (minor erosion)	3) 1% increase in baseflow mobile grain size (negligible erosion)
4) Fountain Creek (downstream of Williams Creek)	4) 9% decrease in peak flow sediment transport capacity (moderate sediment-ation)	4) 4% decrease in baseflow mobile grain size (negligible)	4) 31% decrease in baseflow mobile grain size (major sedimentation)	4) 31% decrease in baseflow mobile grain size (major sedimentation)	4) 32% decrease in baseflow mobile grain size (major sediment-ation)	4) 5% increase in baseflow mobile grain size (negligible)	4) 1% decrease in baseflow mobile grain size (negligible sediment-ation)
5) Jimmy Camp Creek	5) 78% increase in baseflow mobile grain size (major erosion)	5) No Effect	5) 1% increase in peak flow mobile grain size (negligible)	5) Same as No Action Alternative	5) Same as No Action Alternative	5) Same as No Action Alternative	5) Same as No Action Alternative
6) Williams Creek	6) "Sediment hungry" water downstream of Williams Creek Reservoir (minor erosion)	6) Same as No Action Alternative	6) 173% increase in peak flow sediment transport capacity (major erosion, but negligible relative to Existing Conditions)	6) 175% increase in peak flow sediment transport capacity (major erosion, but negligible relative to Existing Conditions)	6) Same as No Action Alternative	6) Same as No Action Alternative	6) Same as No Action Alternative

Resources, Effect Indicators, and Geographical Areas	No Action Alternative	Effects of Action Alternatives Compared to No Action (Percent Change in Effect Compared to No Action Alternative is Given in Parenthesis)					
		Participants' Proposed Action	Wetland Alternative	Arkansas River Alternative	Fountain Creek Alternative	Downstream Intake Alternative	Highway 115 Alternative
7) Arkansas River (downstream of Fountain Creek)	7) 6% decrease in peak flow sediment transport capacity (minor sediment-ation	7) 2% decrease in baseflow mobile grain size (negligible)	7) 4% reduction in baseflow mobile grain size (negligible sedimentation)	7) 5% reduction in baseflow mobile grain size (negligible sedimentation)	7) 2% reduction in baseflow mobile grain size (negligible sediment-ation)	7) 2% reduction in baseflow mobile grain size (negligible sediment-ation)	7) 1% reduction in baseflow mobile grain size (negligible sediment-ation)
8) Western Slope Streams	8) Minor localized erosion downstream of diversion structures	8) Same as No Action Alternative	8) Same as No Action Alternative	8) Same as No Action Alternative	8) Same as No Action Alternative	8) Same as No Action Alternative	8) Same as No Action Alternative
Aquatic Life							
Effect on Fish and Invertebrate Species present in reservoirs (based on multiple habitat characteristics)							
1) Homestake Reservoir	1) Moderate adverse	1) Negligible	1) Negligible	1) Negligible	1) Negligible	1) Negligible	1) Minor beneficial
2) Turquoise Lake	2) Negligible effect	2) Negligible effect	2) Negligible effect	2) Negligible effect	2) Negligible effect	2) Negligible effect	2) Negligible effect
3) Twin Lakes	3) Minor adverse effect	3) Minor beneficial effect	3) Minor beneficial effect	3) Minor beneficial effect	3) Minor beneficial effect	3) Negligible effect	3) Negligible effect
4) Pueblo Reservoir	4) Minor adverse effect	4) Minor adverse effect	4) Minor adverse effect	4) Minor adverse effect	4) Minor adverse effect	4) Moderate adverse effect	4) Minor adverse effect

Resources, Effect Indicators, and Geographical Areas	No Action Alternative	Effects of Action Alternatives Compared to No Action (Percent Change in Effect Compared to No Action Alternative is Given in Parenthesis)					
		Participants' Proposed Action	Wetland Alternative	Arkansas River Alternative	Fountain Creek Alternative	Downstream Intake Alternative	Highway 115 Alternative
5) Jimmy Camp Creek Reservoir	5) Major beneficial effect	5) No reservoir	5) No reservoir	5) Minor adverse effect	5) Minor adverse effect	5) Minor adverse effect	5) Minor adverse effect
6) Upper Williams Creek Reservoir	6) No reservoir	6) Minor adverse effect	6) Minor adverse effect	6) No reservoir	6) No reservoir	6) No reservoir	6) No reservoir
7) Williams Creek Reservoir	7) Major beneficial effect	7) Moderate adverse effect	7) No reservoir (results in major adverse effect)	7) No reservoir (results in major adverse effect)	7) Major adverse effect	7) Major adverse effect	7) Major adverse effect
8) Lake Henry	8) Minor adverse effect	8) Moderate adverse effect	8) Moderate adverse effect	8) Moderate adverse effect	8) Moderate adverse effect	8) Minor adverse effect	8) Minor beneficial effect
9) Lake Meredith	9) Minor adverse effect	9) Moderate adverse effect	9) Moderate adverse effect	9) Moderate adverse effect	9) Moderate adverse effect	9) Moderate adverse effect	9) Minor beneficial effect
10) Holbrook Reservoir	10) Minor adverse effect	10) Moderate adverse effect	10) Moderate adverse effect	10) Moderate adverse effect	10) Moderate adverse effect	10) Moderate adverse effect	10) Moderate adverse effect

Resources, Effect Indicators, and Geographical Areas	No Action Alternative	Effects of Action Alternatives Compared to No Action (Percent Change in Effect Compared to No Action Alternative is Given in Parenthesis)					
		Participants' Proposed Action	Wetland Alternative	Arkansas River Alternative	Fountain Creek Alternative	Downstream Intake Alternative	Highway 115 Alternative
Effect on Fish and Invertebrate Species present in coldwater streams (based on multiple habitat characteristics)							
1) Western Slope Streams excluding Ivanhoe Creek	1) Negligible to minor beneficial	1) Negligible	1) Negligible	1) Negligible	1) Negligible	1) Negligible	1) Negligible
2) Ivanhoe Creek	2) Minor beneficial	2) Minor Adverse	2) Minor Adverse	2) Minor Adverse	2) Minor Adverse	2) Minor Adverse	2) Negligible
3) Lake Fork	3) Minor beneficial effect	3) Minor adverse effect	3) Minor beneficial effect	3) Minor beneficial effect	3) Minor beneficial effect	3) Minor adverse effect	3) Minor adverse effect
4) Lake Creek	4) Minor beneficial effect	4) Moderate adverse effect	4) Moderate adverse effect	4) Moderate adverse effect	4) Moderate adverse effect	4) Moderate adverse effect	4) Moderate beneficial effect
5) Upper Arkansas River	5) Minor beneficial effect to moderate adverse effect	5) Minor beneficial effect to minor adverse effect	5) Moderate beneficial effect to minor adverse effect	5) Moderate beneficial effect to minor adverse effect	5) Minor beneficial effect to minor adverse effect	5) Minor beneficial effect to minor adverse effect	5) Negligible effect to minor adverse effect
6) Arkansas River (Pueblo Reservoir to Wildhorse Creek)	6) Negligible effect	6) Negligible effect	6) Minor adverse effect	6) Minor beneficial effect	6) Negligible effect	6) Minor adverse effect	6) Moderate adverse effect

Resources, Effect Indicators, and Geographical Areas	No Action Alternative	Effects of Action Alternatives Compared to No Action (Percent Change in Effect Compared to No Action Alternative is Given in Parenthesis)					
		Participants' Proposed Action	Wetland Alternative	Arkansas River Alternative	Fountain Creek Alternative	Downstream Intake Alternative	Highway 115 Alternative
Effect on Number and Abundance of Fish and Invertebrate Species present in warmwater streams (based on multiple habitat characteristics)							
1) Lower Arkansas River	1) Negligible effect to moderate adverse effect	1) Negligible effect to minor adverse effect	1) Minor beneficial effect to minor adverse effect	1) Moderate beneficial effect to minor adverse effect	1) Negligible effect to minor adverse effect	1) Negligible effect to minor adverse effect	1) Negligible effect to moderate adverse effect
2) Monument Creek	2) Moderate beneficial effect	2) Minor adverse effect	2) Minor adverse effect	2) Minor adverse effect	2) Minor adverse effect	2) Minor adverse effect	2) Minor adverse effect
3) Fountain Creek	3) Minor to moderate adverse effect	3) Negligible effect to minor adverse effect	3) Minor beneficial effect to moderate adverse effect	3) Minor beneficial effect to moderate adverse effect	3) Minor beneficial effect to negligible effect	3) Minor beneficial effect to negligible effect	3) Minor beneficial effect to moderate adverse effect
4) Jimmy Camp Creek	4) Moderate beneficial effect	4) Negligible effect	4) Negligible effect	4) Negligible effect	4) Negligible effect	4) Negligible effect	4) Negligible effect
5) Williams Creek	5) Minor to beneficial adverse effect	5) Negligible effect	5) Negligible to minor beneficial effect	5) Minor beneficial effect to minor adverse effect	5) Negligible effect	5) Negligible effect	5) Negligible effect

Resources, Effect Indicators, and Geographical Areas	No Action Alternative	Effects of Action Alternatives Compared to No Action (Percent Change in Effect Compared to No Action Alternative is Given in Parenthesis)					
		Participants' Proposed Action	Wetland Alternative	Arkansas River Alternative	Fountain Creek Alternative	Downstream Intake Alternative	Highway 115 Alternative
Wetlands, Waters of the U.S., and Riparian Vegetation							
Acres of Permanent Effects on Jurisdictional Wetlands	7.1 ac	1.4 ac (-80%)	0.6 ac (-92%)	6.4 ac (-10%)	7.6ac (7%)	8.0 ac (13%)	7.1 ac (0%)
Acres of Permanent Effects on Isolated Wetlands	12.0 ac	12.0 ac (0%)	0.8 ac (-93%)	0.4 ac (-97%)	11.9 ac (-1%)	11.7 ac (-3%)	12.0 ac (0%)
Acres of Permanent Effects on Wetlands (Total of Jurisdictional and Isolated)	19.1 ac	13.4 ac (-30%)	1.4 ac (-93%)	6.8 ac (-64%)	19.5 ac (2%)	19.7 ac (3%)	19.1 ac (0%)
Acres of Temporary Effects on Jurisdictional Wetlands	5.4 ac	1.4 ac (-74%)	1.3 ac (-76%)	0.4 ac (-93%)	1.3 ac (-76%)	0.5 ac (-91%)	0.5 ac (-91%)
Acres of Temporary Effects on Isolated Wetlands	1.1 ac	1.5 ac (36%)	4.3 ac (291%)	4.1 ac (273%)	1.0 ac (-9%)	1.3 ac (18%)	1.5 ac (36%)
Acres of Temporary Effects on Wetlands (Total of Jurisdictional and Isolated)	6.5 ac	2.9 ac (-55%)	5.6 ac (-14%)	4.5 ac (-31%)	2.3 ac (-65%)	1.8 ac (-72%)	2.0 ac (-69%)
Miles or Acres of Permanent Effects on Waters of the U.S. 1) Streambed 2) Ditch 3) Pond or Lake	1) 10 miles 2) 6.8 ac 3) 0.2 ac	1) 8 miles (-20%) 2) 6.7 ac (-1%) 3) 0.5 ac (150%)	1) 5 miles (-50%) 2) 0 ac (-100%) 3) 0 ac (-100%)	1) 6 miles (-40%) 2) 0 ac (-100%) 3) 0 ac (-100%)	1) 9 miles (-10%) 2) 6.6 ac (-3%) 3) 0.2 ac (0%)	1) 9 miles (-10%) 2) 6.5 ac (-4%) 3) 0.2 ac (0%)	1) 10 miles (0%) 2) 6.8 ac (0%) 3) 0 ac (-100%)

Resources, Effect Indicators, and Geographical Areas	No Action Alternative	Effects of Action Alternatives Compared to No Action (Percent Change in Effect Compared to No Action Alternative is Given in Parenthesis)					
		Participants' Proposed Action	Wetland Alternative	Arkansas River Alternative	Fountain Creek Alternative	Downstream Intake Alternative	Highway 115 Alternative
Miles or Acres of Temporary Effects on Waters of the U.S. 1) Streambed 2) Ditch 3) Pond or Lake	1) 2 miles 2) 0.3 ac 3) 1.5 ac	1) 1 mile (-50%) 2) 0.2 ac (-33%) 3) 0.6 ac (-60%)	1) 2 miles (0%) 2) 0.5 ac (-67%) 3) 0.6 ac (-60%)	1) 3 miles (50%) 2) 0.5 ac (67%) 3) 1.0 ac (-33%)	1) 2 miles (0%) 2) 0.1 ac (-67%) 3) 0.9 ac (-40%)	1) 1 mile (-50%) 2) 0.2 ac (-33%) 3) 0.9 ac (-40%)	1) 2 miles (0%) 2) 0.4 ac (33%) 3) 1.2 ac (-20%)
Acres of Permanent Effects on Riparian Vegetation 1) Grassland 2) Shrubland 3) Woodland	1) 169 ac 2) 31 ac 3) 19 ac	1) 104 ac (-38%) 2) 57 ac (84%) 3) 20 ac (5%)	1) 12 ac (-93%) 2) 29 ac (6%) 3) 8 ac (-58%)	1) 77 ac (-54%) 2) 3 ac (90%) 3) 5 ac (-74%)	1) 175 ac (4%) 2) 36 ac (-16%) 3) 20 ac (5%)	1) 178 ac (5%) 2) 30 ac (-3%) 3) 22 ac (16%)	1) 169 ac (0%) 2) 30 ac (-3%) 3) 19 ac (0%)
Acres of Temporary Effects on Riparian Vegetation 1) Grassland 2) Shrubland 3) Woodland	1) 36 ac 2) 3 ac 3) 8 ac	1) 38 ac (6%) 2) 4 ac (33%) 3) 6 ac (-25%)	1) 27 ac (-25%) 2) 4 ac (33%) 3) 14 ac (75%)	1) 21 ac (-42%) 2) 1 ac (-67%) 3) 11 ac (38%)	1) 30 ac (-17%) 2) 4 ac (33%) 3) 7 ac (-13%)	1) 31 ac (-14%) 2) 1 ac (-67%) 3) 6 ac (-25%)	1) 30 ac (-17%) 2) 2 ac (-33%) 3) 6 ac (-25%)
Acres of Effects on Montana Method Functional Category Wetlands 1) Category I (highest) 2) Category II 3) Category III 4) Category IV (lowest)	1) 0.5 ac 2) 1.5 ac 3) 22.0 ac 4) 1.6 ac	1) 0 ac (-100%) 2) 2.1 ac (40%) 3) 12.1 ac (-45%) 4) 2.1 ac (31%)	1) 0 ac (-100%) 2) 1.6 ac (7%) 3) 2.7 ac (-88%) 4) 2.7 ac (69%)	1) 0 ac (-100%) 2) 0.2 ac (-87%) 3) 8.6 ac (-61%) 4) 2.4 ac (50%)	1) 0 ac (-100%) 2) 1.9 ac (-27%) 3) 17.9 ac (-19%) 4) 2.0 ac (25%)	1) 0 ac (-100%) 2) 1.7 ac (13%) 3) 18.0 ac (-18%) 4) 1.9 ac (19%)	1) 0 ac (-100%) 2) 0.8 ac (-47%) 3) 18.9 ac (-14%) 4) 1.4 ac (-13%)
Effects on Wetland and Riparian Vegetation on Western Slope Streams	Negligible	Same as No Action Alternative					

Resources, Effect Indicators, and Geographical Areas	No Action Alternative	Effects of Action Alternatives Compared to No Action (Percent Change in Effect Compared to No Action Alternative is Given in Parenthesis)					
		Participants' Proposed Action	Wetland Alternative	Arkansas River Alternative	Fountain Creek Alternative	Downstream Intake Alternative	Highway 115 Alternative
Effects on Wetland and Riparian Vegetation 1) Pueblo Reservoir 2) Lower Arkansas River Reservoirs	1) Negligible 2) Negligible	1) Same as No Action Alternative 2) Same as No Action Alternative					
Vegetation							
Acres of Vegetation Types with Permanent Effects 1) Native Grasslands 2) Native Shrublands 3) Native Woodlands 4) Mixed/Introduced Grasslands 5) Mixed/Introduced Shrublands 6) Mixed/Introduced Woodlands 7) Other Types	1) 1,792 ac 2) 156 ac 3) 201 ac 4) 129 ac 5) 29 ac 6) 15 ac 7) 77 ac	1) 2,384 ac (33%) 2) 47 ac (-70%) 3) 10 ac (-95%) 4) 131 ac (2%) 5) 48 ac (62%) 6) 13 ac (17%) 7) 52 ac (-32%)	1) 1,337 ac (-25%) 2) 53 ac (-66%) 3) 64 ac (-68%) 4) 63 ac (-51%) 5) 20 ac (-32%) 6) <1 ac (-98%) 7) 45 ac (-41%)	1) 886 ac (-51%) 2) 182 ac (16%) 3) 155 ac (-22%) 4) 48 ac (-63%) 5) 4 ac (-86%) 6) 2 ac (-87%) 7) 32 ac (-58%)	1) 1,937 ac (8%) 2) 184 ac (18%) 3) 109 ac (-46%) 4) 129 ac (1%) 5) 48 ac (65%) 6) 13 ac (-11%) 7) 38 ac (-50%)	1) 1,860 ac (4%) 2) 175 ac (12%) 3) 104 ac (-48%) 4) 112 ac (-13%) 5) 38 ac (32%) 6) 18 ac (18%) 7) 34 ac (-55%)	1) 1,791 ac (0%) 2) 156 ac (0%) 3) 201 ac (0%) 4) 129 ac (0%) 5) 30 ac (0%) 6) 15 ac (0%) 7) 76 ac (0%)
Acres of Vegetation Types with Temporary Effects 1) Native Grasslands 2) Native Shrublands 3) Native Woodlands 4) Mixed/Introduced Grasslands 5) Mixed/Introduced Shrublands	1) 1,038 ac 2) 78 ac 3) 155 ac 4) 260 ac 5) 3 ac	1) 642 ac (-38%) 2) 42 ac (-46%) 3) 11 ac (-93%) 4) 150 ac (-43%) 5) 34 ac (1,033%)	1) 802 ac (-23%) 2) 73 ac (-6%) 3) 158 ac (2%) 4) 211 ac (-19%) 5) 35 ac (1,100%)	1) 965 ac (-7%) 2) 182 ac (134%) 3) 155 ac (0%) 4) 185 ac (-29%) 5) 8 ac (167%)	1) 989 ac (-5%) 2) 191 ac (145%) 3) 16 ac (-90%) 4) 163 ac (-37%) 5) 38 ac (1133%)	1) 826 ac (-20%) 2) 147 ac (-89%) 3) 8 ac (-95%) 4) 124 ac (-52%) 5) 6 ac (100%)	1) 837 ac (-19%) 2) 66 ac (-14%) 3) 145 ac (-7%) 4) 159 ac (-39%) 5) 3 ac (0%)

Resources, Effect Indicators, and Geographical Areas	No Action Alternative	Effects of Action Alternatives Compared to No Action (Percent Change in Effect Compared to No Action Alternative is Given in Parenthesis)					
		Participants' Proposed Action	Wetland Alternative	Arkansas River Alternative	Fountain Creek Alternative	Downstream Intake Alternative	Highway 115 Alternative
6) Mixed/Introduced Woodlands 7) Other Types	6) 5 ac 7) 225 ac	6) 0 ac (-100%) 7) 86 ac (-61%)	6) 2 ac (-60%) 7) 148 ac (-33%)	6) 3 ac (-40%) 7) 136 ac (-39%)	6) <1 ac (-80%) 7) 94 ac (-58%)	6) 2 ac (-60%) 7) 80 ac (-64%)	6) 3 ac (-20%) 7) 110 ac (-51%)
Federally Listed Threatened or, Endangered or Candidate Plant Species Affected	None were found in the study area	Same as No Action Alternative					
Acres of Plant Species and Communities of Concern with Permanent Effects 1) Plant Species a. Crandalls rockcress b. Dwarf milkweed c. Golden blazingstar d. Rocky Mountain bladderpod 2) Plant Communities Needle and threadgrass-blue grama grasslands	1.a) 1 ac 1.b) 0 ac 1.c) <1 ac 1.d) 0 ac 2) 15 ac	1.a) 0 ac (-100%) 1.b) <1 ac 1.c) <1 ac (-93%) 1.d) 1 ac 2) 114 ac (660%)	1.a) 0 ac (-100%) 1.b) <1 ac 1.c) <1 ac (-93%) 1.d) 1 ac 2) 114 ac (660%)	1.a) 0 ac (-100%) 1.b) 0 ac 1.c) 0 ac (-100%) 1.d) 0 ac 2) 15 ac (0%)	1.a) 0 ac (-100%) 1.b) <1 ac 1.c) <1 ac (-93%) 1.d) 1ac 2) 15 ac (0%)	1.a) 0 ac (-100%) 1.b) 0 ac 1.c) 0 ac (-100%) 1.d) 0 ac 2) 15 ac (0%)	1.a) 1 ac (0%) 1.b) 0 ac 1.c) <1 ac (0%) 1.d) 0 ac 2) 15 ac (0%)
Acres of Plant Species and Communities of Concern with Temporary Effects 1) Plant Species a. Crandalls rockcress b. Dwarf milkweed c. Golden blazingstar	1.a) 1 ac 1.b) 0 ac 1.c) 0 ac	1.a) 0 ac (-100%) 1.b) 0 ac 1.c) <1 ac	1.a) 0 ac (-100%) 1.b) 0 ac 1.c) <1 ac	1.a) 0 ac (-100%) 1.b) 0 ac 1.c) 0 ac	1.a) 0 ac (-100%) 1.b) 0 ac 1.c) <1 ac	1.a) 0 ac (-100%) 1.b) 0 ac 1.c) 0 ac	1.a) <1 ac (0%) 1.b) 0 ac 1.c) 0 ac

Resources, Effect Indicators, and Geographical Areas	No Action Alternative	Effects of Action Alternatives Compared to No Action (Percent Change in Effect Compared to No Action Alternative is Given in Parenthesis)					
		Participants' Proposed Action	Wetland Alternative	Arkansas River Alternative	Fountain Creek Alternative	Downstream Intake Alternative	Highway 115 Alternative
d. Rocky Mountain bladderpod 2) Plant Communities Needle and threadgrass-blue grama	1.d) 0 ac 2) 68 ac	1.d) 4 ac 2) 1 ac (-98%)	1.d) 4 ac 2) 1 ac (-98%)	1.d) 0 ac 2) 22 ac (-68%)	1.d) 4 ac 2) 22 ac (-68%)	1.d) 0 ac 2) 22 ac (-68%)	1.d) 0 ac 2) 22 ac (-68%)
Noxious Weeds Found in Study Area	Canada Thistle, Field Bindweed, Kochia, Musk Thistle, Saltcedar	Same as No Action Alternative					
Wildlife							
Acres of Permanent Effects on Federally Listed Threatened and Endangered Species Habitat 1) Canada Lynx 2) Preble's (occupied habitat) 3) Mexican Spotted Owl (critical habitat)	1) No effect 2) 0 ac 3) 45 ac	1) Same as No Action Alternative 2) 0 ac 3) 0 ac (-100%)	1) Same as No Action Alternative 2) 0 ac 3) 45 ac (0%)	1) Same as No Action Alternative 2) 0 ac 3) 45 ac (0%)	1) Same as No Action Alternative 2) 0 ac 3) 0 ac (-100%)	1) Same as No Action Alternative 2) 0 ac 3) 0 ac (-100%)	1) Same as No Action Alternative 2) 0 ac 3) 45 ac (0%)
Acres of Temporary Effects on Federally Listed Threatened and Endangered Species Habitat							

Resources, Effect Indicators, and Geographical Areas	No Action Alternative	Effects of Action Alternatives Compared to No Action (Percent Change in Effect Compared to No Action Alternative is Given in Parenthesis)					
		Participants' Proposed Action	**Wetland Alternative**	**Arkansas River Alternative**	**Fountain Creek Alternative**	**Downstream Intake Alternative**	**Highway 115 Alternative**
1) Canada Lynx 2) Preble's (occupied habitat) 3) Mexican Spotted Owl	1) Temporary displacement from about 6 miles of movement corridors in low-use areas 2) 50 ac 3) 77 ac	1) No effect 2) 0 ac (-100%) 3) 0 ac (-100%)	1) No effect 2) 0 ac (-100%) 3) 93 ac (21%)	1) No effect 2) 0 ac (-100%) 3) 96 ac (25%)	1) No effect 2) 0 ac (-100%) 3) 0 ac (-100%)	1) No effect 2) 0 ac (-100%) 3) 0 ac (-100%)	1) Same as No Action Alternative 2) 0 ac (-100%) 3) 77 ac (0%)
Acres of Permanent Effects on Colorado Threatened and Endangered Species and Species of Concern 1) Black-tailed Prairie Dog 2) Western Burrowing Owl 3) Mountain Plover 4) Ferruginous Hawk 5) Swift Fox 6) Plains Leopard Frog 7) Northern Leopard Frog 8) Bald Eagle Winter Range 9) Bald Eagle Winter Concentration or Roost	1) 16 ac 2) 16 ac 3) 1,743 ac 4) 2,093 ac 5) 1,897 ac 6) 108 ac 7) 108 ac 8) 59 ac 9) 15 ac	1) 23 ac (44%) 2) 23 ac (44%) 3) 2,391 ac (37%) 4) 2,426 ac (16%) 5) 2,424 ac (28%) 6) 103 ac (-5%) 7) 103 ac (-5%) 8) 19 ac (-68%) 9) 18 ac (29%)	1) 27 ac (69%) 2) 27 ac (69%) 3) 1,369 ac (-21%) 4) 1,462 ac (-30%) 5) 1,408 ac (-26%) 6) 5 ac (-95%) 7) 5 ac (-95%) 8) 10 ac (-83%) 9) 19 ac (36%)	1) 17 ac (6%) 2) 17 ac (6%) 3) 846 ac (-51%) 4) 1,179 ac (-44%) 5) 1,027 ac (-46%) 6) 14 ac (-87%) 7) 14 ac (-87%) 8) 17 ac (-71%) 9) 1 ac (-93%)	1) 24 ac (50%) 2) 24 ac (50%) 3) 1,878 ac (8%) 4) 2,173 ac (4%) 5) 2,070 ac (9%) 6) 112 ac (4%) 7) 112 ac (4%) 8) 18 ac (-69%) 9) 35 ac (150%)	1) 12 ac (-25%) 2) 12 ac (-25%) 3) 1,790 ac (3%) 4) 2,066 ac (-1%) 5) 1,965 ac (4%) 6) 112 ac (4%) 7) 112 ac (4%) 8) 23 ac (-61%) 9) 6 ac (-57%)	1) 16 ac (0%) 2) 16 ac (0%) 3) 1,742 ac (0%) 4) 2,092 ac (0%) 5) 1,896 ac (0%) 6) 108 ac (0%) 7) 108 ac (0%) 8) 58 ac (-2%) 9) 13 ac (-7%)

Resources, Effect Indicators, and Geographical Areas	No Action Alternative	Effects of Action Alternatives Compared to No Action (Percent Change in Effect Compared to No Action Alternative is Given in Parenthesis)					
		Participants' Proposed Action	**Wetland Alternative**	**Arkansas River Alternative**	**Fountain Creek Alternative**	**Downstream Intake Alternative**	**Highway 115 Alternative**
10) Botta's Pocket Gopher	10) 140 ac	10) 0 ac (-100%)	10) 83 ac (-41%)	10) 83 ac (-41%)	10) 0 ac (-100%)	10) 0 ac (-100%)	10) 140 ac (0%)
Acres of Temporary Effects on Colorado Threatened and Endangered Species and Species of Concern 1) Black-tailed Prairie Dog 2) Western Burrowing Owl 3) Mountain Plover 4) Ferruginous Hawk 5) Swift Fox 6) Plains Leopard Frog 7) Northern Leopard Frog 8) Bald Eagle Winter Range 9) Bald Eagle Winter Concentration or Roost 10) Botta's Pocket Gopher	1) 41 ac 2) 41 ac 3) 1,219 ac 4) 1,444 ac 5) 1,296 ac 6) 5 ac 7) 5 ac 8) 52 ac 9) 31 ac 10) 212 ac	1) 69 ac (68%) 2) 69 ac (68%) 3) 720 ac (-41%) 4) 790 ac (-45%) 5) 784 ac (-40%) 6) 11 ac (120%) 7) 11 ac (120%) 8) 17 ac (-67%) 9) 35 ac (13%) 10) 0 ac (-100%)	1) 90 ac (120%) 2) 90 ac (120%) 3) 945 ac (-22%) 4) 1,183 ac (-18%) 5) 1,041 ac (-20%) 6) 11 ac (-120%) 7) 11 ac (-120%) 8) 18 ac (-65%) 9) 10 ac (-68%) 10) 218 ac (3%)	1) 59 ac (44%) 2) 59 ac (44%) 3) 1,088 ac (-11%) 4) 1,415 ac (-2%) 5) 1,273 ac (-2%) 6) 7 ac (40%) 7) 7 ac (40%) 8) 12 ac (-77%) 9) 4 ac (-87%) 10) 218 ac (3%)	1) 70 ac (71%) 2) 70 ac (71%) 3) 1,084 ac (-11%) 4) 1,309 ac (-9%) 5) 1,300 ac (0%) 6) 11 ac (120%) 7) 11 ac (120%) 8) 16 ac (-69%) 9) 18 ac (-42 %) 10) 0 ac (-100%)	1) 41 ac (-0%) 2) 41 ac (-0%) 3) 883 ac (-28%) 4) 1,036 ac (-28%) 5) 1,032 ac (-20%) 6) 7 ac (40%) 7) 7 ac (40%) 8) 16 ac (-69%) 9) 2 ac (-94%) 10) 0 ac (-100%)	1) 48 ac (17%) 2) 48 ac (17%) 3) 937 ac (-23%) 4) 1,142 ac (-21%) 5) 1,003 ac (-23%) 6) 1 ac (-80%) 7) 1 ac (-80%) 8) 52 ac (0%) 9) 2 ac (-94%) 10) 212 ac (0%)
Permanent Effects on Migratory Bird Nest/Rookeries Disturbed 1) Raptors 2) Herons	1) 7 nests 2) 0 rookeries	1) 4 nests (-43%) 2) 0 rookeries	1) 3 nests (-57%) 2) 0 rookeries	1) 5 nests (-29%) 2) 0 rookeries	1) 5 nests (-29%) 2) 0 rookeries	1) 6 nests (-14%) 2) 0 rookeries	1) 7 nests (0%) 2) 0 rookeries

Resources, Effect Indicators, and Geographical Areas	No Action Alternative	Effects of Action Alternatives Compared to No Action (Percent Change in Effect Compared to No Action Alternative is Given in Parenthesis)					
		Participants' Proposed Action	**Wetland Alternative**	**Arkansas River Alternative**	**Fountain Creek Alternative**	**Downstream Intake Alternative**	**Highway 115 Alternative**
Temporary Effect on Migratory Bird Nest/Rookeries Disturbed: Herons	0 rookeries	1 rookery	1 rookery	0 rookeries	1 rookery	0 rookeries	0 rookeries
Acres of Migratory Bird Habitat Permanently Disturbed	2,329 ac	2,632 ac (13%)	1,535 ac (-34%)	1,279 ac (-45%)	2,424 ac (4%)	2,310 ac (-1%)	2,327 ac (0%)
Acres of Migratory Bird Habitat Temporarily Disturbed	1,635 ac	890 ac (-46%)	1,290 ac (-21%)	1,516 ac (-7%)	1,409 ac (-14%)	1,125 ac (-31%)	1,236 ac (-24%)
Acres of Large Game Overall Ranges Permanently Disturbed 1) Elk 2) Mule Deer 3) White-tailed Deer 4) Pronghorn	1) 190 ac 2) 2,398 ac 3) 90 ac 4) 2,165 ac	1) 20 ac (-89%) 2) 2,534 ac (6%) 3) 19 ac (-79%) 4) 2,565 ac (18%)	1) 102 ac (-46%) 2) 1,506 ac (-37%) 3) 31 ac (-66%) 4) 1,468 ac (-32%)	1) 122 ac (-36%) 2) 1,215 ac (-49%) 3) 62 ac (-31%) 4) 1,128 ac (-48%)	1) 31 ac (-84%) 2) 2,323 ac (-3%) 3) 33 ac (-63%) 4) 2,354 ac (9%)	1) 48 ac (-75%) 2) 2,248 ac (-6%) 3) 56 ac (-38%) 4) 2,224 ac (3%)	1) 190 ac (0%) 2) 2,397 ac (0%) 3) 90 ac (0%) 4) 2,164 ac (-42%)
Acres of Large Game Overall Ranges Temporarily Disturbed 1) Elk 2) Mule Deer 3) White-tailed Deer 4) Pronghorn	1) 379 ac 2) 1,774 ac 3) 173 ac 4) 1,296 ac	1) 27 ac (-93%) 2) 773 ac (-56%) 3) 16 ac (-91%) 4) 866 ac (-33%)	1) 281 ac (-26%) 2) 1,241 ac (-30%) 3) 67 ac (61%) 4) 972 ac (-25%)	1) 307 ac (-19%) 2) 1,468 ac (-17%) 3) 101 ac (41%) 4) 1,054 ac (-19%)	1) 57 ac (-85%) 2) 1,124 ac (-37%) 3) 54 ac (-69%) 4) 1,255 ac (-3%)	1) 52 ac (-86%) 2) 1,018 ac (-43%) 3) 54 ac (-69%) 4) 969 ac (-25%)	1) 349 ac (-8%) 2) 1,325 ac (-25%) 3) 154 ac (-10%) 4) 860 ac (-34%)
Acres of Large Game Severe Winter Ranges Permanently Disturbed 1) Elk 2) Mule Deer	1) 15 ac 2) 154 ac	1) 0 ac (-100%) 2) 0 ac (-100%)	1) 0 ac (-100%) 2) 78 ac (-49%)	1) 0 ac (-100%) 2) 78 ac (-49%)	1) 0 ac (-100%) 2) 0 ac (-100%)	1) 0 ac (-100%) 2) 0 ac (-100%)	1) 15 ac (0%) 2) 154 ac (0%)

Resources, Effect Indicators, and Geographical Areas	No Action Alternative	Effects of Action Alternatives Compared to No Action (Percent Change in Effect Compared to No Action Alternative is Given in Parenthesis)					
		Participants' Proposed Action	Wetland Alternative	Arkansas River Alternative	Fountain Creek Alternative	Downstream Intake Alternative	Highway 115 Alternative
Acres of Large Game Severe Winter Ranges Temporarily Disturbed 1) Elk 2) Mule Deer	1) 23 ac 2) 221 ac	1) 0 ac (-100%) 2) 0 ac (-100%)	1) 0 ac (-100%) 2) 211 ac (-4%)	1) 0 ac (-100%) 2) 208 ac (-6%)	1) 0 ac (-100%) 2) 0 ac (-100%)	1) 0 ac (-100%) 2) 0 ac (-100%)	1) 23 ac (0%) 2) 221 ac (0%)
Acres of Large Game Winter Ranges Permanently Disturbed 1) Elk 2) Mule Deer 3) Pronghorn	1) 160 ac 2) 286 ac 3) 1 ac	1) 9 ac (-94%) 2) 72 ac (-75%) 3) 117 ac (>100%)	1) 87 ac (-46%) 2) 222 ac (-22%) 3) 117 ac (>100 %)	1) 80 ac (-50%) 2) 194 ac (-32%) 3) 26 ac (25%)	1) 6 ac (-96%) 2) 102 ac (-64%) 3) 117 ac (>100%)	1) 2 ac (-99%) 2) 44 ac (-85%) 3) 26 ac (25%)	1) 160 ac (0%) 2) 285 ac (0%) 3) 0 ac (-100%)
Acres of Large Game Winter Ranges Temporarily Disturbed 1) Elk 2) Mule Deer 3) Pronghorn	1) 307 ac 2) 504 ac 3) 0 ac	1) 25 ac (-92%) 2) 130 ac (-74%) 3) 246 ac	1) 208 ac (-32%) 2) 624 ac (24%) 3) 246 ac	1) 197 ac (-36%) 2) 578 ac (15%) 3) 0 ac	1) 18 ac (-94%) 2) 211 ac (58%) 3) 246 ac	1) 7 ac (-98%) 2) 80 ac (-84%) 3) 0 ac	1) 295 ac (-4%) 2) 505 ac (0%) 3) 0 ac
Recreation							
Locations of Effects to Water-based Recreation (Boating and Angling) Access and Opportunities 1) Pueblo area	1) Boating through Pueblo; angling access at Pueblo Dam	1) Angling access at Pueblo Dam; boating through Pueblo (benefits)	1) Angling access at Pueblo Dam; boating through Pueblo (benefits)	1) Boating and angling through Pueblo (benefits)	1)Angling access at Pueblo Dam; boating through Pueblo (benefits)	1) Pueblo Reservoir angling; boating through Pueblo (benefits)	1) Pueblo Reservoir angling; boating and angling through Pueblo

Resources, Effect Indicators, and Geographical Areas	No Action Alternative	Effects of Action Alternatives Compared to No Action (Percent Change in Effect Compared to No Action Alternative is Given in Parenthesis)					
		Participants' Proposed Action	Wetland Alternative	Arkansas River Alternative	Fountain Creek Alternative	Downstream Intake Alternative	Highway 115 Alternative
2) El Paso County area 3) Upper Arkansas River 4) Lower Arkansas River	2) Jimmy Camp Creek Reservoir (benefits) 3) River access at Blue Heron Property; Boating below Florence 4) No effect	2) Upper Williams Creek Reservoir (benefits) 3) Boating below Florence (benefits) 4) Angling at Lake Henry	2) Upper Williams Creek Reservoir (benefits) 3) River access at Blue Heron Property; Boating below Florence (benefits) 4) Lake Meredith; angling at Lake Henry	2) Same as No Action Alternative 3) River access at Blue Heron Property; Boating below Florence (benefits) 4) Lake Meredith; angling at Lake Henry	2) Same as No Action Alternative 3) Boating below Florence (benefits) 4) Angling at Lake Henry	2) Same as No Action Alternative 3) Boating below Florence (benefits) 4) Angling at Lake Henry	2) Same as No Action Alternative 3) River access at Blue Heron Property 4) Same as No Action Alternative
Locations of Effects to Land-based Recreation (Parks and Trails) Access and Opportunities 1) Pueblo area 2) El Paso County area	1) Lake Pueblo State Park trails 2) Pikes Peak Greenway trail; Fountain Creek Regional trail; Clear Spring Ranch Park	1) Same as No Action Alternative 2) Fountain Creek Regional trail; Fountain Creek Regional Park; Clear Spring Ranch Park	1) Same as No Action Alternative 2) Pikes Peak Greenway trail	1) No effect 2) Pikes Peak Greenway trail	1) Same as No Action Alternative 2) Fountain Creek Regional trail; Fountain Creek Regional Park	1) No effect 2) Fountain Creek Regional trail; Fountain Creek Regional Park; Clear Spring Ranch Park	1) No effect 2) Fountain Creek Regional trail; Fountain Creek Regional Park; Clear Spring Ranch Park

Resources, Effect Indicators, and Geographical Areas	No Action Alternative	Effects of Action Alternatives Compared to No Action (Percent Change in Effect Compared to No Action Alternative is Given in Parenthesis)					
		Participants' Proposed Action	Wetland Alternative	Arkansas River Alternative	Fountain Creek Alternative	Downstream Intake Alternative	Highway 115 Alternative
3) Upper Arkansas River 4) Lower Arkansas River	3) No effect 4) No effect	3) Same as No Action Alternative 4) Same as No Action Alternative	3) Same as No Action Alternative 4) Same as No Action Alternative	3) Same as No Action Alternative 4) Same as No Action Alternative	3) Same as No Action Alternative 4) Same as No Action Alternative	3) Same as No Action Alternative 4) Same as No Action Alternative	3) Same as No Action Alternative 4) Same as No Action Alternative
Socioeconomics							
Change in Recreation-related Economy 1) El Paso County 2) Upper Arkansas Valley 3) Pueblo County 4) Lower Arkansas Valley	1) 1 to 5% 2) No effect 3) No effect 4) No effect	1) Same as No Action Alternative 2) Same as No Action Alternative 3) -1 to -5% 4) Same as No Action Alternative	1) Same as No Action Alternative 2) Same as No Action Alternative 3) -1 to -5% 4) Same as No Action Alternative	1 Same as No Action Alternative 2) Same as No Action Alternative 3) Same as No Action Alternative 4) Same as No Action Alternative	1) Same as No Action Alternative 2) Same as No Action Alternative 3) -1 to -5% 4) Same as No Action Alternative	1) Same as No Action Alternative 2) Same as No Action Alternative 3) Same as No Action Alternative 4) Same as No Action Alternative	1) Same as No Action Alternative 2) Same as No Action Alternative 3) Same as No Action Alternative 4) Same as No Action Alternative
Change in Agricultural Production 1) El Paso County 2) Upper Arkansas Valley 3) Pueblo County	1) -1 to -5% 2) No effect 3) No effect	1) 0% 2) Same as No Action Alternative 3) Same as No Action Alternative	1) -1 to -5% 2) Same as No Action Alternative 3) -1 to -5%	1) -1 to -5% 2) Same as No Action Alternative 3) -1 to -5%	1) -1 to -5% 2) Same as No Action Alternative 3) -1 to -5%	1) 1 to 5% 2) Same as No Action Alternative 3) 1 to 5%	1) 0% 2) Same as No Action Alternative 3) Same as No Action Alternative

Resources, Effect Indicators, and Geographical Areas	No Action Alternative	Effects of Action Alternatives Compared to No Action (Percent Change in Effect Compared to No Action Alternative is Given in Parenthesis)					
		Participants' Proposed Action	Wetland Alternative	Arkansas River Alternative	Fountain Creek Alternative	Downstream Intake Alternative	Highway 115 Alternative
4) Lower Arkansas Valley	4) No effect	4) Same as No Action Alternative	4) Same as No Action Alternative	4) Same as No Action Alternative	4) Same as No Action Alternative	4) Same as No Action Alternative	4) Same as No Action Alternative
Change in Property Values 1) El Paso County 2) Upper Arkansas Valley 3) Pueblo County 4) Lower Arkansas Valley	1) Negligible 2) -5 to -10% 3) Negligible 4) Negligible	1) Same as No Action Alternative 2) 5 to 10% 3) -5 to -10% 4) Same as No Action Alternative	1) Same as No Action Alternative 2) Negligible 3) -5 to -10% 4) Same as No Action Alternative	1) Same as No Action Alternative 2) Negligible 3) Same as No Action Alternative 4) Same as No Action Alternative	1) Same as No Action Alternative 2) 5 to 10% 3) -5 to -10% 4) Same as No Action Alternative	1) Same as No Action Alternative 2) 5 to 10% 3) -5 to -10% 4) Same as No Action Alternative	1) Same as No Action Alternative 2) Negligible 3) -5 to -10% 4) Same as No Action Alternative
Change in Construction-related Economy 1) El Paso County 2) Upper Arkansas Valley 3) Pueblo County 4) Lower Arkansas Valley	1) Negligible 2) Negligible 3) Negligible 4) Negligible	Same as No Action Alternative					
Change in Cost of Water or Wastewater Services 1) Colorado Springs 2) Fountain 3) Security 4) Pueblo West	1) >25% 2) Negligible 3) >25% 4) Negligible	Except for Security all Action Alternatives same as No Action Alternative Security >25% than No Action					

Resources, Effect Indicators, and Geographical Areas	No Action Alternative	Effects of Action Alternatives Compared to No Action (Percent Change in Effect Compared to No Action Alternative is Given in Parenthesis)					
		Participants' Proposed Action	Wetland Alternative	Arkansas River Alternative	Fountain Creek Alternative	Downstream Intake Alternative	Highway 115 Alternative
Change in Number of Regional Jobs and Residents 1) El Paso County 2) Upper Arkansas Valley 3) Pueblo County 4) Lower Arkansas Valley	1) 0% 2) 0% 3) 0% 4) 0%	Same as No Action Alternative					
Change in Social Character/Quality of Life 1) El Paso County 2) Upper Arkansas Valley 3) Pueblo County 4) Lower Arkansas Valley	1) No detectable change 2) No detectable change 3) No detectable change 4) No detectable change	Same as No Action Alternative					
Land Use: Total Above-Ground Disturbances	4,172 ac	3,649 ac (-13%)	3,014 ac (-28%)	2,946 ac (-29%)	3,949 ac (-5%)	3,535 ac (-15%)	3,727 ac (-11%)

Resources, Effect Indicators, and Geographical Areas	No Action Alternative	Effects of Action Alternatives Compared to No Action (Percent Change in Effect Compared to No Action Alternative is Given in Parenthesis)					
		Participants' Proposed Action	Wetland Alternative	Arkansas River Alternative	Fountain Creek Alternative	Downstream Intake Alternative	Highway 115 Alternative
Environmental Justice							
Number of High Risk Census Block Groups Affected[14]	1	0 (-100%)	1 (0%)	7 (600%)	4 (300%)	8 (700%)	1 (0%)
Number of Potential Concern Census Block Groups Affected[15]	3	5 (67%)	13 (333%)	15 (400%)	8 (167%)	7 (133%)	6 (100%)
Number of Low Risk Census Block Groups Affected[16]	42	25 (-40%)	34 (-19%)	29 (-31%)	26 (-38%)	29 (-31%)	23 (-45%)
Cultural Resources							
Minimum Number of Historic Properties ("Sites") that May Be Disturbed by SDS Project Construction and Operation 1) Direct Effects 2) Potential Indirect Effects	1) 105 sites 2) 163 sites	1) 43 sites (-59%) 2) 64 sites (-61%)	1) 34 sites (-68%) 2) 79 sites (-52%)	1) 88 sites (-16%) 2) 130 sites (-20%)	1) 103 sites (-2%) 2) 156 sites (-4%)	1) 99 sites (-6%) 2) 151 sites (-7%)	1) 97 sites (-8%) 2) 154 sites (-6%)
Indian Trust Assets							
Number of Indian Trust Assets Affected	No Indian Trust Assets Identified	Same as No Action Alternative					

[14] High risk census block groups have a large number of low-income or minority residents.
[15] Census blocks of potential concern have a moderate number of low-income or minority residents.
[16] Low risk census block groups have a low number of low-income or minority residents.

Resources, Effect Indicators, and Geographical Areas	No Action Alternative	Effects of Action Alternatives Compared to No Action (Percent Change in Effect Compared to No Action Alternative is Given in Parenthesis)					
		Participants' Proposed Action	Wetland Alternative	Arkansas River Alternative	Fountain Creek Alternative	Downstream Intake Alternative	Highway 115 Alternative
Noise							
Increases in Noise Level Above Ambient Levels	Moderate short-term noise effects during construction of pipelines, reservoirs, and other project facilities.	Short-term construction noise would affect fewer people because of shorter pipeline length and a fewer number of pump stations.	Short-term construction noise would affect fewer people because of construction of only one reservoir.	Short-term construction noise would affect fewer people because of construction of only one reservoir	Short-term construction noise would affect fewer people because of a fewer number of pump stations	Short-term construction noise would affect fewer people because of shorter pipeline length and a fewer number of pump stations	Short-term construction noise would affect fewer people because of shorter pipeline length.
Visual Quality							
Number of Facilities Visible from Observation Points within Each Effect Category:							
1) Major Effect (Highly Visible)	1) 3	1) 2 (-33%)	1) 3 (0%)	1) 1 (-67%)	1) 3 (0%)	1) 3 (0%)	1) 3 (0%)
2) Moderate effect	2) 3	2) 0 (-100%)	2) 2 (-33%)	2) 2 (-33%)	2) 1 (-67%)	2) 1 (-67%)	2) 1 (-67%)
3) Minor effect	3) 5	3) 3 (-40%)	3) 0 (-100%)	3) 2 (-60%)	3) 2 (-60%)	3) 5 (0%)	3) 5 (0%)
4) Negligible effect (Nearly Unnoticeable)	4) 8	4) 6 (-25%)	4) 2 (-75%)	4) 4 (-50%)	4) 9 (13%)	4) 7 (-13%)	4) 5 (-38%)
Traffic							
Maximum Percent Change in Traffic Volume (relative to Existing Conditions)							
1) Jimmy Camp Creek Reservoir	1) 4 to 5%	1) No reservoir	1) No reservoir	1) 4 to 5%	1) 4 to 5%	1) 4 to 5%	1) 4 to 5%
2) Upper Williams Creek Reservoir	2) No reservoir	2) 12 to 30%	2) 12 to 30%	2) No reservoir	2) No reservoir	2) No reservoir	2) No reservoir
3) Williams Creek Reservoir	3) 48 to 106%	3) 48 to 106%	3) No reservoir	3) No reservoir	3) 48 to 106%	3) 48 to 106%	3) 48 to 106%

Resources, Effect Indicators, and Geographical Areas	No Action Alternative	Effects of Action Alternatives Compared to No Action (Percent Change in Effect Compared to No Action Alternative is Given in Parenthesis)					
		Participants' Proposed Action	Wetland Alternative	Arkansas River Alternative	Fountain Creek Alternative	Downstream Intake Alternative	Highway 115 Alternative
4) Jimmy Camp Creek Water Treatment Plant 5) Upper Williams Creek Water Treatment Plant	4) 8% 5) No treatment plant	4) No treatment plant 5) 17%	4) No treatment plant 5) 17%	4) 8% 5) No treatment plant	4) 8% 5) No treatment plant	4) 8% 5) No treatment plant	4) 8% 5) No treatment plant
Length of Pipeline to be Installed Under Roadways 1) Major Roadways 2) Minor Roadways	1) 17 miles 2) 4 miles	1) 4 miles (-74%) 2) 0 miles (-100%)	1) 11 miles (-34%) 2) 2 miles (-50%)	1) 15 miles (-11%) 2) 3 miles (-25%)	1) 8 miles (-53%) 2) 1 mile (-75%)	1) 8 miles (-53%) 2) 1 mile (-75%)	1) 11 miles (-35%) 2) 3 miles (-25%)
Number of Roadways Affected by Open Cut Construction 1) Pueblo County 2) El Paso County	1) 0 roads 2) 67 roads	1) 20 roads 2) 22 roads (-67%)	1) 20 roads 2) 70 roads (4%)	1) 8 roads 2) 70 roads (4%)	1) 28 roads 2) 22 roads (-67%)	1) 9 roads 2) 22 roads (-67%)	1) 0 roads 2) 33 roads (-51%)

Resources, Effect Indicators, and Geographical Areas	No Action Alternative	Effects of Action Alternatives Compared to No Action (Percent Change in Effect Compared to No Action Alternative is Given in Parenthesis)					
		Participants' Proposed Action	**Wetland Alternative**	**Arkansas River Alternative**	**Fountain Creek Alternative**	**Downstream Intake Alternative**	**Highway 115 Alternative**
Geology and Paleontology							
Effect on Existing Potential Geologic Resources	No effect	Same as No Action Alternative					
Effect on Paleontological Resources	High potential for paleontological resources at Jimmy Camp Creek Reservoir, Treated Water Pipeline, and Denver Basin Ground Water System.	Low potential for paleontological resources	Low potential for paleontological resources	High potential for paleontological resources at Jimmy Camp Creek Reservoir and Treated Water Pipeline.	High potential for paleontological resources at Jimmy Camp Creek Reservoir and Treated Water Pipeline.	High potential for paleontological resources at Jimmy Camp Creek Reservoir and Treated Water Pipeline.	High potential for paleontological resources at Jimmy Camp Creek Reservoir and Treated Water Pipeline.
Geologic Hazards 1) High Landslide Susceptibility 2) High Corrosivity Soils 3) Shallow Bedrock 4) Expansive Soils and Bedrock	1) 220 ac 2) 641 ac 3) 400 ac 4) 255 ac	1) 0 ac (-100%) 2) 632 ac (-1%) 3) 291 ac (-27%) 4) 301 ac (18%)	1) 218 ac (-1%) 2) 917 ac (43%) 3) 519 ac (30%) 4) 400 ac (57%)	1) 221 ac (<1%) 2) 795 ac (24%) 3) 471 ac (18%) 4) 438 ac (72%)	1) 0 ac (-100%) 2) 811 ac (27%) 3) 349 ac (-13%) 4) 434 ac (70%)	1) 0 ac (-100%) 2) 530 ac (-17%) 3) 249 ac (-38%) 4) 339 ac (33%)	1) 220 ac (0%) 2) 593 ac (-7%) 3) 371 ac (-7%) 4) 254 ac (<-1%)
Soils							
Acres of Important Farmland Affected 1) Prime Farmland 2) Farmland of Statewide Importance	1) 44.9 ac 2) 0.6 ac	1) 13.3 ac (-70%) 2) 0 ac (-100%)	1) 3.1 ac (-93%) 2) 0 ac (-100%)	1) 0 ac (-100%) 2) 0 ac (-100%)	1) 13.3 ac (-70%) 2) 0 ac (-100%)	1) 10.7 ac (-76%) 2) 0 ac (-100%)	1) 35.8 ac (-20%) 2) 0.6 ac (0%)

Resources, Effect Indicators, and Geographical Areas	No Action Alternative	Effects of Action Alternatives Compared to No Action (Percent Change in Effect Compared to No Action Alternative is Given in Parenthesis)					
		Participants' Proposed Action	Wetland Alternative	Arkansas River Alternative	Fountain Creek Alternative	Downstream Intake Alternative	Highway 115 Alternative
Soil Productivity 1) High Susceptibility to Water Erosion 2) High Susceptibility to Wind Erosion 3) Disturbed Area with Good Topsoil Suitability	1) 45 ac 2) 422 ac 3) 722 ac	1) 73 ac (62%) 2) 302 ac (-28%) 3) 1,439 ac (99%)	1) 113 ac (151%) 2) 329 ac (-22%) 3) 1,371 ac (90%)	1) 43 ac (-4%) 2) 267 ac (-37%) 3) 606 ac (-16%)	1) 75 ac (67%) 2) 261 ac (-38%) 3) 699 ac (-3%)	1) 12 ac (-73%) 2) 242 ac (-43%) 3) 618 ac (-14%)	1) 45 ac (0%) 2) 236 ac (-44%) 3) 669 ac (-7%)
Air Quality							
Carbon Dioxide Emissions (tons per year at 2046 water demand)	239,710	243,285 (1%)	354,501 (48%)	380,418 (59%)	248,647 (4%)	511,196 (113%)	246,363 (3%)
Hazardous Materials							
Hazardous Materials Associated with Soil or Ground Water Contamination from Known Sites On or Adjacent to Project Facilities	No hazardous material conditions identified	Four waste disposal areas identified at the Upper Williams Creek Reservoir site	Four waste disposal areas identified at the Upper Williams Creek Reservoir site	Same as No Action Alternative	Same as No Action Alternative	Same as No Action Alternative	Same as No Action Alternative

3.0 Affected Environment and Environmental Consequences

3.1 Terms Used in this Chapter

The following terms are used to describe effects of the project on the various resource categories in this FEIS.

3.1.1 Short-term and Long-term Effects

In the Environmental Consequences section of the FEIS for each resource, effects are described as either short term, long term, temporary, or permanent. Short-term effects primarily would result from temporary construction disturbances that either would be restored, such as pipeline alignments, or would cease, such as construction noise. Short-term effects of the proposed project would last up to 5 years after the completion of final construction for each project component (i.e., pipeline, reservoirs, or distribution lines). For example, construction of the proposed Upper Williams Creek Reservoir is expected to be completed in 2017. Short-term effects associated with the reservoir would last as long as until 2022, 5 years after construction was completed. Construction of the proposed Williams Creek Reservoir is expected to be completed in 2024 (depending on the alternative). Short-term effects associated with the Williams Creek Reservoir would last as long as until 2029, 5 years after construction was completed.

Long-term effects would last more than 5 years after construction; some effects may be in perpetuity (permanent effects). For example, effects on surface water flow would continue as long as the requested contracts are in place. Some temporary construction disturbances could result in long-term effects if recovery of a resource is longer than 5 years (mature riparian forests would take longer than 5 years to re-establish to pre-disturbance quality).

3.1.2 Direct and Indirect Effects

Direct effects are those that would be the direct result of implementing one of the alternatives (40 CFR 1508.08). Most direct effects would occur from construction of pipelines, reservoirs, or other permanent structures. For example, the effects on cultural resources within the footprint of the proposed Upper Williams Creek Reservoir would be a direct effect of reservoir construction. Indirect effects are those that are project-induced, but occur later in time or are farther removed in distance (40 CFR 1508.08). Changes in fish habitat from altered streamflows in area creeks would be an indirect effect.

3.1.3 Cumulative Effects

A cumulative effect is defined as "the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or non-federal) or person undertakes such other actions" (40 CFR 1508.7). For example, the combined effect on streamflow in Fountain Creek from proposed SDS Project reservoir operations and increased development is a cumulative effect.

The time frame considered for the cumulative effects analysis generally extends from the past to 2046, the planning horizon of the SDS Project. Past and present urban development and land and water use projects (Table 25) help define the existing conditions for each resource and are included in the Affected Environment sections. Each of the resource area sections in this FEIS provides a cumulative effects analysis including evaluations of the effects of reasonably foreseeable future actions combined with the SDS alternatives. The reasonably foreseeable future actions occurring from 2008 to 2046 and the rationale for selecting these actions are described in Section 3.1.3.1.

3.1.3.1 Reasonably Foreseeable Actions

Reasonably foreseeable future actions analyzed in this FEIS are those actions and activities independent of the proposed SDS Project that could result in cumulative effects when combined with the effects of the proposed project. These actions are anticipated to occur regardless of which alternative is selected.

Reasonably foreseeable actions that may result in cumulative effects were determined through document reviews and agency contact. An action was deemed reasonably foreseeable when it met the following conditions:

- It is expected to be implemented or to occur between 2008 and 2046 (i.e., the current, expected term of the proposed long-term contracts with Reclamation)
- It is expected to be funded by 2008 (not applied as a stand-alone criterion)
- It is judged to potentially have or contribute to a significant cumulative effect on an area and resource that would be affected by the proposed SDS Project
- It has sufficient information available to define the activity and conduct a meaningful analysis

In addition,

- If required, it is expected to have a permit application submitted to a federal, state, or local agency with jurisdiction over the activity by 2008, or
- If it is a federally authorized water project, it is expected to have completed NEPA compliance by 2008

Reclamation identified three categories of reasonably foreseeable actions: urban development and land use, transportation projects, and miscellaneous actions. Those actions that are reasonably foreseeable are discussed below; cumulative effects are discussed in Chapter 3 under each resource.

Urban Development and Land Use

Urban development and land use activities are expected to result in increased water use and point and non-point water runoff including impermeable surfaces, stormwater runoff, wastewater, and urban/industrial wastewater. Additionally, these activities may affect traffic, air quality, noise, soils, visual quality, and other environmental characteristics.

Table 25. Summary of Past Activities that Affected the Natural and Human Characteristics of the Arkansas River Basin.

Activity	Description
Urban and Suburban Development in El Paso, Fremont, and Pueblo Counties and growth of military installations	Rapid growth and development since the 1950s has resulted in low density suburban development. This has resulted in increased noise levels and hydrologic changes due to increased impervious surfaces. The first military base in Colorado Springs opened in 1946 and today there are five military installations: Fort Carson, Cheyenne Mountain Air Station, Schriever Air Force Base, Peterson Air Force Base, and U.S. Air Force Academy.
Fryingpan-Arkansas Project	This is a transbasin water diversion and delivery project to serve both agricultural and municipal entities was authorized in 1962.
Multiple flood events including 1965, 1993, 1999, and 2005	These flood events caused washed out bridges, trails, and roads, as well as erosion. Homes were flooded, and sewer lines broke in Fountain Creek and along the lower Arkansas River.
Pueblo Dam and Reservoir	Pueblo Reservoir is the largest of the Fryingpan-Arkansas reservoirs with a storage capacity of 349,940 ac-ft that includes a flood control authorization (completed 1975).
California Gulch added to the National Priorities List of Superfund Sites	After designation as a superfund site in 1983, two treatment plants were constructed to remediate acid mine waste drainage into the ground water and, ultimately, into the Arkansas River.
Fountain Valley Conduit	This 45-mile conduit was constructed in 1985 to convey water for municipal use from Pueblo Reservoir to members of the Fountain Valley Authority including Colorado Springs.
Temporary Excess Capacity Contracts	These contracts allow storage of non-Fry-Ark Project water for use at a later date to more efficiently use infrastructure for temporary municipal, industrial, irrigation, fishery, and recreation uses (began in 1986).
Winter Water Storage Program	Initiated in 1990, this program allows direct streamflow agricultural water rights to be stored in Pueblo Reservoir from November to March for use during the peak agricultural demand season to augment Temporary Excess Capacity or Short-Term Excess Capacity contracts.
Upper Arkansas Voluntary Flow Management Program	This program was established in 1990 to manage flows for the protection of the fishery and summer recreational boating.
Colorado Springs' Sanitary Sewer Evaluation and Rehabilitation Program	This is a current project, which began in 2000, to identify and implement improvements to wastewater pipelines.
Pueblo Board of Water Works Long-Term Storage	25-year excess capacity contract allows Pueblo West to store non-Fry-Ark Project water in Pueblo Reservoir (began in 2001)
Colorado Springs Streamside Overlay Ordinance	Ordinance was established in October 2002 to conserve natural features of streams, protect streams, floodplains, slopes, and riparian vegetation.
Pueblo Flow Management Plan	Six-party intergovernmental agreements were signed in 2004 to manage flows form Pueblo Dam to Fountain Creek primarily for recreational purposes.
Recovery of Yield (ROY) Storage Contract	Cooperative multi-party agreement to develop storage in Holbrook Reservoir to recapture un-exchangeable return flows that would have otherwise been lost (developed in principle in 2004, first used in 2005).
City of Colorado Springs Stormwater Enterprise	The 2005 enterprise funds stormwater drainage capital improvement projects, maintenance and operations, and federal permit requirements in the city.

Activity	Description
Fountain Creek Recovery Project	A Colorado Springs project constructed in 2007 to capture sanitary sewer spills to Fountain Creek and keep spills from reaching downstream communities.
Pueblo West Metropolitan District Excess Capacity Conveyance Contract	5-year excess capacity conveyance contract beginning in 2007 to convey non-Fry-Ark Project water to Pueblo West's distribution system.

Urban and Suburban Development in El Paso, Pueblo, and Fremont Counties

Both El Paso and Pueblo counties are expected to grow significantly in the future. El Paso County is expected to grow from 565,000 to an estimated 936,000 county residents by 2035. Likewise, Pueblo County is expected to grow from 151,000 to 243,000 residents by 2035. Fremont County population is projected to grow from 48,000 to 77,000 residents by 2035. County-level data beyond 2035 are not available from the Colorado State Demography Office (CDOLA 2007). Urban and suburban development was assumed to continue after 2035 in these areas. Projected water demands were either provided by the Participants (Section 1.5.1.2), or were extended to 2046 demands using 2040 demands and 2030 to 2040 growth rates from GEI (1998).

A major growth center in El Paso County is expected to be the Banning-Lewis Ranch development. Primarily held by Capital Pacific Holdings, the proposed development project would affect 24,000 acres in eastern Colorado Springs. The eventual development may have up to 75,000 homes and construction may include 2,500 homes per year. SDS Project alternatives, including the No Action Alternative, would provide water for Colorado Springs, including the proposed Banning-Lewis Ranch development.

Within Pueblo County, the City of Pueblo and Pueblo West are expected to continue to be the largest growth centers, while growth in Fremont County is expected to continue throughout the County as well as within the largest community of Cañon City. Growth in both counties may affect water quality and quantity, recreational use, and land use. Development also will occur in other areas of the upper and lower Arkansas River Basin but is not anticipated to be sufficient to have significant cumulative effects on land use. Future water demand due to development throughout the Arkansas River Basin is considered in the analysis of cumulative effects.

Las Vegas Street Wastewater Treatment Facility Improvements – Colorado Springs Utilities

Colorado Springs' existing LVSWWTF will be improved between 2008 and 2010. The improvements are designed to improve the facility's effluent water quality. Additionally, a new lift station and forcemain may be constructed to convey wastewater from the Jimmy Camp Creek Basin to the LVSWWTF between 2008 and 2010. Construction of the lift station and forcemain will occur in the same area and at about the same time as the proposed SDS Project.

Since publication of the DEIS, Colorado Springs Utilities' decided against construction of the proposed 8-mgd Clear Spring Regional Water Reclamation Facility. This facility will not be constructed as described in recent wastewater planning documents and the DEIS. Consequently, this facility has been removed from all effects analyses in this FEIS. Colorado Springs Utilities will instead use the existing LVSWWTF and J.D. Phillps Water Reclamation Facility for wastewater treatment.

750-Megawatt Coal Fired Power Plant in Pueblo – Xcel Energy

Xcel Energy filed a plan with the Colorado Public Utilities Commission in 2004 to add a 750-megawatt coal-fired power plant to Xcel's Comanche Generating Station in Pueblo. The Public Utilities Commission approved the proposed plant, which would increase the station's capacity to 1,410 megawatts. The plant is expected to begin producing electricity by 2009. This facility may affect surface water quantity and quality through withdrawals and discharges.

Stormwater Enterprise – City of Colorado Springs

The City of Colorado Springs is responsible for managing the quantity and quality of stormwater and the condition of drainageways within the city limits. The Colorado Springs Stormwater Enterprise was established in 2005 to fund stormwater drainage capital improvement projects, maintenance and operations, and compliance with Colorado Springs' municipal storm sewer (MS4) discharge permit (Colorado Springs 2008a, 2008b). The Stormwater Enterprise has identified 24 high priority capital projects to be implemented through 2011) These projects include stream channel improvements, storm sewer repair, detention ponds, and other projects designed to protect the public from flood damage (Colorado Springs 2007a). Many of the capital improvement projects were identified in Drainage Basin Planning Studies (DBPSs) in the last 20 years but were not implemented due to lack of funds. Several projects entail construction of stream stability measures including drop structures and stream bank protection, which will reduce erosion and the amount of sediment transported in surface waters. The stream stability measures should protect existing infrastructure in or near the drainageways, such as sanitary sewers, from being damaged by peak flows, reducing the likelihood of sewage spills into the creeks.

To compensate for changes in runoff timing and quantity that occur with development, Colorado Springs has instituted drainage criteria that require detention of stormwater flows and other measures listed in regional DBPSs (Colorado Springs 1994). Detention facilities are required to moderate peak flow rates, by either keeping peak flows at or below the historical rate for up to the 100-year event or by making releases at a rate that protects downstream infrastructure (e.g., bridges or at-risk property) based on the capacity limitations of that infrastructure (Baker 2006). The Stormwater Enterprise is expected to update DBPSs on an ongoing basis, and the drainage criteria and requirements for stormwater detention with development will be modified accordingly.

The City of Colorado Springs' Phase 1 MS4 permit was issued by CDPHE for the control of stormwater quality. The permit requires the City and Colorado Springs Utilities to develop and implement a wide range of stormwater management programs to control and limit pollutants in stormwater runoff including:

- Street maintenance and street sweeping
- A program to address water quality concerns associated with the application of pesticides, herbicides and fertilizers by the City
- A new development site planning program that requires permanent water quality elements for new development and redevelopment
- Review of new flood control structures for inclusion of water quality elements and evaluation of existing facilities for retrofitting opportunities

- Requirement for construction best management practices (BMPs) to ensure that adequate measures are taken to control runoff from construction sites that pose water quality concerns
- A program for the prevention of illicit discharges and illegal disposal
- A stormwater public education and information program targeting youth and adults
- Wet weather monitoring program involving long-term monitoring and assessment of trends in water quality due to stormwater runoff.

To fulfill the requirements of the MS4 permit, Colorado Springs city code was modified and the Drainage Criteria Manual Volume 2 (Colorado Springs 2002) was developed, which focuses on stormwater quality protection and BMPs. The new development site planning program requires developers of more than 1 acre to implement water quality BMPs to treat the runoff generated from small to moderate-sized storms. The runoff must be captured in a basin that drains slowly to allow particulate contaminants to settle out of the stormwater. The program also encourages developers to reduce impervious surfaces, stabilize drainageways, and implement behaviors that protect water quality such as covering materials to keep them from contacting storm water.

Continued implementation of these actions by the Stormwater Enterprise is anticipated to reduce the water quality and quantity effects of historical and future development within the city limits of Colorado Springs on surface waters in the Fountain Creek Basin.

Sanitary Sewer Evaluation and Rehabilitation Program – Colorado Springs Utilities

Colorado Springs is evaluating and improving sanitary sewer pipelines. The program also includes evaluation and improvement of all of Colorado Springs' wastewater pipelines that cross streams. Colorado Springs is also implementing vandalism, spill/release response, and inspection programs for its sanitary sewer system. CDPHE monitors the project. Stabilization of creek crossings may affect geomorphic conditions, although most improvements would likely be upstream of the SDS Project affected environment.

"Pump Back" Project – Pueblo West Metropolitan District

Pueblo West is changing the discharge point for its wastewater effluent to Golf Course Draw, which is tributary to Pueblo Reservoir. Construction is expected to begin in 2009 or 2010. Discharge of treated wastewater may affect water quality in Pueblo Reservoir.

New Wastewater Treatment Facility – Cherokee Metropolitan District

Cherokee Metropolitan District (located adjacent to the eastern side of Colorado Springs) is constructing a new wastewater treatment facility, which will change the discharge point for its wastewater effluent from the Fountain Creek Basin to the Chico Creek Basin, which drains to the lower Arkansas River Basin. Construction is underway and the facility is expected to be operational in late 2009 or early 2010.

Water Supply Project – City of Fountain

Fountain is expanding its Fountain Creek wellfield to meet projected maximum day demand through the year 2046 through the use of 17 new wells in Fountain (Black & Veatch 2007). A new untreated water reservoir and microfiltration water treatment plant will be constructed. This new treatment plant will be located on the west side of Fountain. Treatment brine will be evaporated and waste separated, resulting in no liquid waste discharge. Treated water will be conveyed through new transmission pipelines and pump stations. Small storage facilities for potable water and return flows will be included. The project may have cumulative effects on ground water levels or surface water flow.

Eastern Plains Transmission Project – Western Area Power Administration

The Eastern Plains Transmission Project is a proposed new transmission project that would include about 1,000 miles of new high-voltage transmission lines and related facilities in eastern Colorado and western Kansas, expansions at existing substations and construction of new substations, access roads, and fiber optic communication facilities. The Eastern Plains Transmission Project may affect some resources through land disturbance and construction.

Short-Term Excess Capacity Contracts

Short-term excess capacity contracts are granted by Reclamation to various entities throughout the Arkansas River Basin on an annual basis. These contracts generally allow the contract holder to store non Fry-Ark Project water in Fry-Ark storage space (typically Pueblo Reservoir). The duration of these contracts is generally from 1 to 3 years, but they are renewed annually. Continued issuance of these contracts is reasonably foreseeable. However, with the exception of the Participants, Pueblo Board of Water Works, and Aurora, issuance of short-term contracts historically has been sporadic and inconsistent. Therefore, short-term contracts were not simulated in the hydrologic model for this FEIS (referred to as the Daily Model and described in Section 3.5.3).

Transportation Projects

Five major known transportation projects will occur in the SDS Project area. These projects may result in cumulative transportation effects when combined with the traffic associated with the SDS Project. New roadways associated with new urban development are implicitly included in the action descriptions under Urban and Suburban Development.

Improvements to I-25 through Colorado Springs – CDOT and Federal Highway Administration

This proposed transportation improvement project will add lanes to a 25-mile segment of I-25 from the town of Monument to Academy Boulevard in southern Colorado Springs. The Colorado Department of Transportation (CDOT) released an Environmental Assessment and a Finding of No Significant Impact for the project. Construction may begin in 2009.

Reconstruction of I-25 at Pueblo – CDOT and Federal Highway Administration

Improvement of an 8-mile segment of I-25 near Pueblo, between Eagleridge and Pueblo Boulevard/Lake Avenue, is proposed. Alternatives for the project involve widening the freeway to six lanes either in the existing alignment or a new alignment. The DEIS for the I-25 reconstruction project was scheduled to be published for public review in fall 2008.

Replacement of 4th Street Bridge over the Arkansas River in Pueblo – CDOT

The 4th Street Bridge, which crosses the Arkansas River in Pueblo, has structural deficiencies and will be replaced by CDOT. The new bridge will be located slightly north of the current bridge. Construction is underway.

South Metro Accessibility Project – CDOT and El Paso County

CDOT and El Paso County are developing a project to improve east-west mobility in the southern Colorado Springs area. This project will include extension of a south entrance to the Colorado Springs Airport to Powers Boulevard and extending Mesa Ridge Parkway to Marksheffel Road. Other actions may include improvement and realignment of Drennan Road and connecting Academy Boulevard to Colorado 115.

Improvements to Marksheffel Road – El Paso County

El Paso County Department of Transportation is presently widening and improving Marksheffel Road between U.S. 24 and Constitution Avenue. Marksheffel Road will then be extended north and west to intersect with Black Forest Road. Construction will be completed in late 2008.

Miscellaneous Actions

Climate Change

Global climate change – a warming of our atmosphere – is an ongoing phenomenon well-accepted by most scientists. A layer of gases surrounding the earth that has the ability to trap heat. This phenomenon is the "greenhouse effect." These greenhouse gases (GHG) have accumulated for millions of years and are essential to maintaining temperatures on earth that are suitable for humans and other living organisms. There are many types of GHG, the most common being water vapor, followed by gases such as carbon dioxide (CO_2), methane, tropospheric ozone, halocarbons (manmade compounds) and nitrous oxide. Certain GHG such as CO_2 and methane have both natural and human-induced sources of emissions to the atmosphere. Other gases, such as the refrigerants in most motor vehicle air conditioners, have only human-caused sources. The term "radiative forcing" is used to describe a change in the balance between incoming solar radiation and outgoing infrared radiation. The addition of GHG to the atmosphere traps a higher percentage of the outgoing infrared radiation, with some of the trapped radiation coming back toward the earth's surface and creating the warming effect (California Energy Commission 2003).

The World Meteorological Organization (WMO) reported that since the early 1900s, the global average surface temperature has risen between 0.6 degrees Celsius (ºC) and 0.7 ºC (1.1 to 1.3 degrees Fahrenheit (ºF)). The increase has not been continuous. Since 1976, global average temperature has risen sharply, at 0.18 ºC (0.32 ºF) per decade. In both the northern and southern hemispheres, the warmest decade occurred during the 1990s, with an average increase of 0.38 ºC (0.68 ºF) which is 0.23 ºC (0.41 ºF) above the 30-year average (WMO 2005). The 10 warmest years for the earth's surface temperature have all occurred after 1990 and the two warmest years on record occurred in 1998 and 2005. Recent research suggests that the warming occurring during the last four decades could be attributable to the increasing atmospheric concentrations of GHG due to human activities (Cayan et al. 2006).

Throughout western North America over the past 50 years, there has been a trend toward warmer winter and spring temperatures, a smaller fraction of precipitation falling as snow instead of rain (Knowles et al. 2006), a decrease in the amount of spring snow accumulation in lower and middle elevation mountain zones (Mote et al. 2005), and an advance in snowmelt of five to 30 days earlier in the Spring (Stewart et al. 2005).

Climate variability and change would interact with other environmental stresses and socioeconomic changes. Air and water pollution and management, habitat fragmentation, wetland loss, and changes in fisheries are likely to be compounded by climate-related stresses. An aging populace nationally, and rapidly growing populations in cities and across the West are social factors that interact with and alter sensitivity to climate variability and change (NAST 2000a). Reduced summer runoff, increased winter runoff, and increased demand are likely to compound current stresses on water supplies and flood management in the West (NAST 2000b).

Since 1988, the United Nations Intergovernmental Panel of Climate Change (IPCC), established by the WMO and the United Nations Environment Programme, has continued to prepare comprehensive and up-to-date assessments of policy-relevant scientific, technical, and socioeconomic information relevant for mitigation and adaptation (IPCC 2001). The Fourth IPCC Climate Change Assessment (IPCC 2007) consisted of a large ensemble of simulations from more than 10 state-of-the-science climate models; each was used for simulation of six different projected climate-forcing scenarios. The large number of simulations was also part of the approach to address the embedded uncertainties associated with incomplete or imperfect observations, incomplete conceptual frameworks, and inaccurate prescription of known processes, chaos, and lack of predictability.

While forecasts of specific global temperature and precipitation changes attributed to global warming have a high degree of uncertainty, regional and sub-regional forecasts are even more uncertain. Global weather models do not have the level of detail necessary to predict effects in individual localities, and more detailed local studies are often unavailable. This is a subject of much ongoing research.

Although few studies specific to the Arkansas River Basin are available, studies in the Colorado River Basin have estimated higher temperatures, a shift in the timing of runoff, and changes in future precipitation. Garfin (2005) predicts an increase in winter temperatures of 1.1 to 2.0 ºC (2.0 to 3.6 ºF) by 2050. Upper basin runoff from snowmelt was predicted to peak up to 25 days earlier by 2050 than the historical average. Christensen et al. (2004) predicts temperature increases ranging from 0.5 to 2.4 ºC (0.9 to 4.3 ºF). Estimated decreases in precipitation range from less than 1 percent to 6 percent, and runoff decreases range between -10 percent to -18 percent. However, the magnitude, timing, and location of these events are difficult to predict.

Climate change may have cumulative effects on streamflows, water quality, geomorphology, wildlife habitat, wetlands, vegetation, aquatic life, recreation, cultural resources, and socioeconomics.

Peak to Prairie-Fountain Creek Conservation Project – Colorado Open Lands

Colorado Open Lands, a land trust, intends to knit together a series of already protected lands with working ranches along the Fountain Creek corridor from Cheyenne Mountain, Aiken Canyonlands across Colorado 115 and I-25 to include Fort Carson to the Chico Basin for conservation efforts. Implementation began in 2008 for about 800 acres of the project.

Historic Arkansas Riverwalk of Pueblo Expansion – City of Pueblo
The City of Pueblo will expand the Historic Arkansas Riverwalk of Pueblo (HARP) to connect the existing riverwalk to the Pueblo Convention Center and proposed Exhibition Hall. The existing lake is fed by the outflow of an adjacent power plant and is controlled by a weir structure. The navigable channel level is fed primarily from diversions from the Arkansas River. The expansion will extend the navigable channel and pedestrian walkway toward the convention center and add a boathouse. Construction began in 2008.

Lower Arkansas Valley Super Ditch Company
The Lower Arkansas Valley Super Ditch Company (Super Ditch) was formed in 2008 by shareholders of 6 irrigation districts as an agent to facilitate temporary leases and transfers of irrigation water between the Company and other water users, primarily municipal water users. The Super Ditch would not involve the construction of infrastructure. Rather, lessees would take delivery of the water at their existing diversion points on the river either by direct delivery, if the delivery point is downstream of the source, or by exchange, if the delivery point is upstream of the source. Based on current Company members, the farthest upstream source of the water would be the Rocky Ford High Line Canal.

The development of alternatives in the FEIS pre-dates the formation of the Super Ditch. Furthermore, one of the needs for the SDS Project identified by the Participants' is the development and conveyance of existing water rights. No consideration was given during alternatives development regarding the location of potential future water supplies not included in the purpose and need. Several downstream intake options were evaluated as part of the screening process (Reclamation 2006a). Although specific water rights mechanisms for delivery of Super Ditch water to lessees are unknown at this time, downstream intake options could potentially be more beneficial for diversion of Super Ditch water supplies by shortening the exchange reach from source to point-of-diversion. One of those intake locations, immediately downstream of the Fountain Creek confluence was retained for further evaluation and is included in the Downstream Intake Alternative.

None of the alternatives would be physically precluded from taking deliveries of Super Ditch water supplies. However, additional NEPA analyses outside of this EIS would be required to deliver Super Ditch water, as well as any other source of water not identified and evaluated in the FEIS, through the SDS Project.

3.1.3.2 Actions Not Considered Reasonably Foreseeable

A number of actions that have been proposed were not considered reasonably foreseeable because they did not meet one or more of the criteria necessary to be deemed reasonably foreseeable. Many of these activities lacked funding, government action, or NEPA compliance by 2008 (the time at which NEPA compliance should be largely complete for the proposed SDS Project).

One notable project is the Preferred Storage Options Plan (PSOP), sponsored by the Southeastern Colorado Water Conservancy District and Reclamation. The PSOP calls for reoperation of space in Pueblo Reservoir and other Fry-Ark facilities and enlargement of Pueblo Reservoir. For the project to move forward, however, changes to federal legislation, NEPA compliance, and funding are required.

Another notable project is the Arkansas Valley Conduit (AVC), which is a proposal sponsored by the Lower Arkansas Valley Water Conservancy District and Reclamation. The AVC would include a pipeline with up to 16 mgd of capacity and probably include water treatment facilities to deliver Fry-Ark water and other water supplies to municipalities and other water agencies east of Pueblo. The AVC would deliver high quality water to an area where existing quality is poor and was approved by congress initially as part of the Fry-Ark Project in 1962. However, this project remains speculative due to funding constraints (Black & Veatch and Applegate Group 2006), the need for an independent NEPA analysis (probably an EIS), and the possible need for water rights changes or acquisitions (GEI 2003a; Black & Veatch and Applegate Group 2006). Additionally, despite current local support for the proposed project, the number of participants is undetermined; thus, the size, location, and timing of project facilities are uncertain.

3.1.3.3 Selected Actions Considered Existing

Two actions proposed at the time the DEIS commenced were considered existing because they were expected to be completed by the time the FEIS is issued:

- Arkansas River Fisheries Habitat Restoration (Legacy Project), sponsored by the Corps of Engineers and the City of Pueblo
- Aurora Contract Exchange and Storage Agreement, sponsored by the City of Aurora

Both of these actions are included as part of the affected environment for this FEIS.

3.1.4 Irreversible or Irretrievable Commitment of Resources

NEPA requires a discussion of any irreversible or irretrievable commitment of resources that would result from implementing the alternatives (40 CFR 1502.16). An irreversible commitment of resources means nonrenewable resources are consumed or destroyed. These resources are permanently lost due to project implementation. For the proposed project, fossil fuels used during construction would represent an irreversible commitment of resources because their use is lost for future generations. Loss of historic structures also represents an irreversible commitment of resources because, even with reuse of the material, the historic significance and workmanship of the original structures would be altered.

In contrast to an irreversible commitment of resources, an irretrievable commitment of resources is the loss of resources or resource production, or use of renewable resources, during project construction and during the period of time that structures or reservoirs are in place. Irretrievable commitments are not permanent; they are limited to a specific time frame. For the construction of pipelines, the time frame for irretrievable resource commitments is the period of time that the pipelines are under construction. For example, the pipelines in some alternatives may cross cultivated land. During pipeline construction, land would be taken temporarily out of production. Loss of crop production would be an irretrievable commitment of resources. Any permanent decrease in productivity as a result of pipeline construction would be an irreversible commitment of resources.

3.1.5 Mitigation Measures

Mitigation is intended to do one of the following (40 CFR 1508.20):

- Avoid the impact altogether by not taking a certain action or parts of an action; minimize impacts by limiting the degree or magnitude of the action and its implementation
- Rectify the impact by repairing, rehabilitating, or restoring the affected environment
- Reduce or eliminate the impact over time by preservation and maintenance operations during the life of the action

Mitigation measures are proposed in most of the resource-specific sections of this chapter. The goal of these measures is to mitigate the direct and indirect effects of the SDS Project. Mitigation of cumulative effects is not proposed. Cumulative effects above and beyond the direct and indirect effects of the SDS Project alternatives would be caused by unrelated actions. By implementing these measures, a resource affected by the project would remain in or return to a condition similar to its existing condition. Thus, the description of effects requiring mitigation may differ from the description of direct and indirect effects of the alternatives, which can entail a comparison of an Action Alternative to the No Action Alternative.

3.2 Environmental and Hydrologic Setting

The proposed SDS Project would be located within the Arkansas River Basin of Colorado. The Arkansas River is about 1,450 miles long, and is the fourth longest river in the United States. The Arkansas River Basin in central and southeastern Colorado covers 28,268 square miles or about 27 percent of the surface area of the state, making it the state's largest river basin. One or more SDS Project alternatives include proposed facilities in El Paso, Pueblo, Fremont, and Chaffee counties. Operation of the alternatives may affect the hydrology of streams upstream or downstream of project facilities, including portions of the Western Slope of Colorado. The Western Slope study area includes the headwaters region of the Colorado River Basin in eastern Pitkin County and southeastern Eagle County. General environmental and hydrologic characteristics of the Arkansas River Basin in Colorado [largely excerpted from CWCB (2004) and USGS (1998)] and the headwaters region of the Colorado River Basin are described below. Additional details on the hydrological, physical, land use, and social and economic characteristics of the SDS Project study area are provided in appropriate subsections within this chapter.

3.2.1 Topography

Fenneman (1931) divided the Arkansas River Basin into two physiographic provinces (distinct areas) at about the 105° parallel, which is just east of Cañon City. West of the 105° parallel is the Southern Rocky Mountains Province (upper basin); to the east is the Great Plains Province (lower basin). The upper basin is mostly mountainous with elevations ranging from 5,000 feet to more than 14,000 feet. East of Cañon City, the lower basin ranges in elevation from about 3,500 feet to 7,500 feet. The Western Slope study area has elevations ranging from over 14,000 feet to about 8,000 feet (U.S. Forest Service 2007).

3.2.2 Population Centers

Most of the population in the upper basin is concentrated along the river corridor; the major towns are Leadville (population 2,688), Buena Vista (population 2,174), Salida (population 5,476), and Cañon City (population 16,000). The two largest population centers in the

Arkansas River Basin are Pueblo (population 103,495) and Colorado Springs (population 369,815). Pueblo is downstream of Pueblo Reservoir near the confluence of the Arkansas River and Fountain Creek. Colorado Springs is on Fountain Creek 40 miles upstream from the confluence. Other major towns in the lower basin include La Junta (population 7,260) and Lamar (population 8,414) (U.S. Census Bureau 2006). There are no major population centers in the Western Slope study area.

3.2.3 Climate

Average daily temperatures in the Arkansas River Basin range from 7.8 ºC (46 °F) in the upper river valley to 12.8 ºC (55 °F) in the lower basin (Smith and Hill 2000). Basinwide annual precipitation ranges from less than 10 inches on the valley floor to more than 40 inches at the crest of the mountains (Abbott 1985).

Western Slope summers are mild to warm with regular thunderstorms. In the fall, winter, and spring most precipitation is in the form of snow.

3.2.4 Geology

Geology ranging from Precambrian (over 570 million years old) to Quaternary (recent) age is exposed in the Arkansas River Basin. The upper basin is heavily forested and underlain by igneous and metamorphic rocks. East of Salida, igneous and metamorphic rocks transition to metamorphic and sedimentary rocks. Much of the upper basin is within the Colorado mineral belt and historically has been associated with mineral development. Mining operations continue in the region but on a much smaller scale than in the past. Sedimentary rock and alluvial fill are exposed in the lower basin. Geology in the Western Slope consists of a variety of sedimentary, metamorphic, and igneous rocks.

3.2.5 Land Use

The Arkansas River Basin is about 1 percent developed (CWCB 2004), which includes urban and suburban land use. Land use primarily is agricultural along the river corridor; the remaining areas mostly are rangeland. Grassland and forest are the predominant land use types in the basin, with grasslands covering about 67 percent and forest covering about 13 percent of the basin. The grassland areas are concentrated in the central portion of the basin, whereas the forested lands are located on the western portions of the basin. Most of the Western Slope study area is forested.

3.2.6 Surface Water

3.2.6.1 Arkansas River

The perennial streams composing the headwaters of the Arkansas River are supplied by the snowpack of the mountains surrounding the area of Leadville, Colorado (Abbott 1985). The Arkansas River flows out of the mountains, through the deep canyons near Cañon City, and across the plains until it leaves the state and enters Kansas just east of Holly, Colorado. From the headwaters to Cañon City, the Arkansas River is characterized by steep-gradient, high-velocity flows that are confined to a relatively narrow rock and cobble stream channel. East of Cañon City, the gradient of the river decreases as it flows out of the mountains. Farther downstream, the stream channel changes from a rock and cobble bottom to a shifting sand channel that meanders along the alluvial floodplain.

Along its course to Kansas, several major tributaries enter the river. In terms of streamflow contribution to the Arkansas River, some of the larger tributaries include Fountain Creek, Timpas Creek, and the Purgatoire River.

Upper Arkansas Voluntary Flow Management Program

The UAVFMP is designed to provide water for fisheries and recreation in the upper Arkansas River. The program is primarily aimed at providing target flows for releases of Fry-Ark Project water from Twin Lakes and Turquoise Lake to Pueblo Reservoir. However, many other entities have voluntarily agreed to the program as well, including Colorado Springs, the PBWW, and the City of Aurora. Recommended flows for the program are defined at the Wellsville Gage. Between 1990 and 2007, Colorado Springs 250-cfs year-round flow targets and 700-cfs recreation flow targets were not met 1 percent of the time. Additionally, two-thirds of the days that targets were not met occurred during the drought years 2002 and 2003 (Riley 2008).

The general components of the UAVFMP include:

- Year-Round Flows – Maintenance of a minimum year-round flow of at least 250 cfs to protect the fishery.
- Incubation Flows – Maintenance of streamflow stage no lower than 5 inches below the spawning flow stage (October 15 to November 15) throughout the winter incubation period (mid November through April); and, maintenance of spawning streamflow throughout the incubation period, with an optimum flow range from 250 to 400 cfs. Ranges of incubation flow targets are suggested based on spawning flows.
- Spring Flows – Maintenance of flows between April 1 and May 15 within the range of 250 cfs to 400 cfs in order to provide conditions favorable to egg hatching and fry emergence.
- Annual Volume – Deliveries in excess of 10,000 ac-ft for recreation flows (as described in the following bullet) are subject to review and consideration by Reclamation and the SECWCD.
- Recreation Flows – Augmentation of flows during the July 1 to August 15 period at 700 cfs, for recreational purposes, through releases from the Fry-Ark Project (subject to water and storage availability).
- Daily Changes – Recommendation for Reclamation to limit daily changes in streamflow to 10 to 15 percent.
- Early Fall Flow Reductions –Seek opportunities to reduce flows in the period following Labor Day to October 15, if benefits warrant.

Several other terms and conditions of the arrangement affect how the program is operated. Details can be found in the Water Resources Technical Report (MWH 2007a).

City of Pueblo Flow Management Program and RICD

Several water supply entities within the Arkansas River Basin, including Colorado Springs, PBWW, City of Aurora, and the SECWCD signed intergovernmental agreements (IGAs) for a target flow program on the Arkansas River through the City of Pueblo (March IGA 2004; May IGA 2004). Although Reclamation is not signatory to these agreements, Reclamation recognizes that these are legally binding agreements concerning the signatories' water rights as they relate to operation of Pueblo Reservoir. General components of the program include:

- Year-round Flows – Exchanges (or changes of water rights) will be reduced or curtailed as necessary to attain an average daily flow of 100 cfs at the Above Pueblo Location (the sum of the flow at the Above Pueblo Gage plus the Pueblo fish hatchery flows).

- Likewise, exchanges will be reduced or curtailed to attain an average daily flow of 85 cfs at the combined flow location (downstream of the inflow from Runyon Lake, and above the confluence with Fountain Creek).
- Recreational Flows – During the period of March 16 through November 14 of each year, exchanges (or changes of water rights) will be reduced or curtailed as necessary to maintain the average flows specified in Figure 28.
- Equitable Allocation of Operational Hours – Exchanges are curtailed to the extent necessary to meet flow targets 50 percent of the time (e.g., exchanges curtailed 7:00 a.m. Friday to 7:00 p.m. Monday and not curtailed the remaining 3.5 days of the week).
- Dry-Year Exception – No obligation to reduce or curtail exchanges when the "Most Probable Flow" forecast by the Natural Resource Conservation Service (NRCS) is below 70 percent.
- Cooperative Flow Management Program – Development of a program to manage storage in and release storage from Pueblo Reservoir to meet recreation flow target of 600 cfs to 1,000 cfs for a goal of at least four separate weekend periods during the summer.
- Storage Restoration – The IGAs contain a provision for storage restoration through reduced exchange

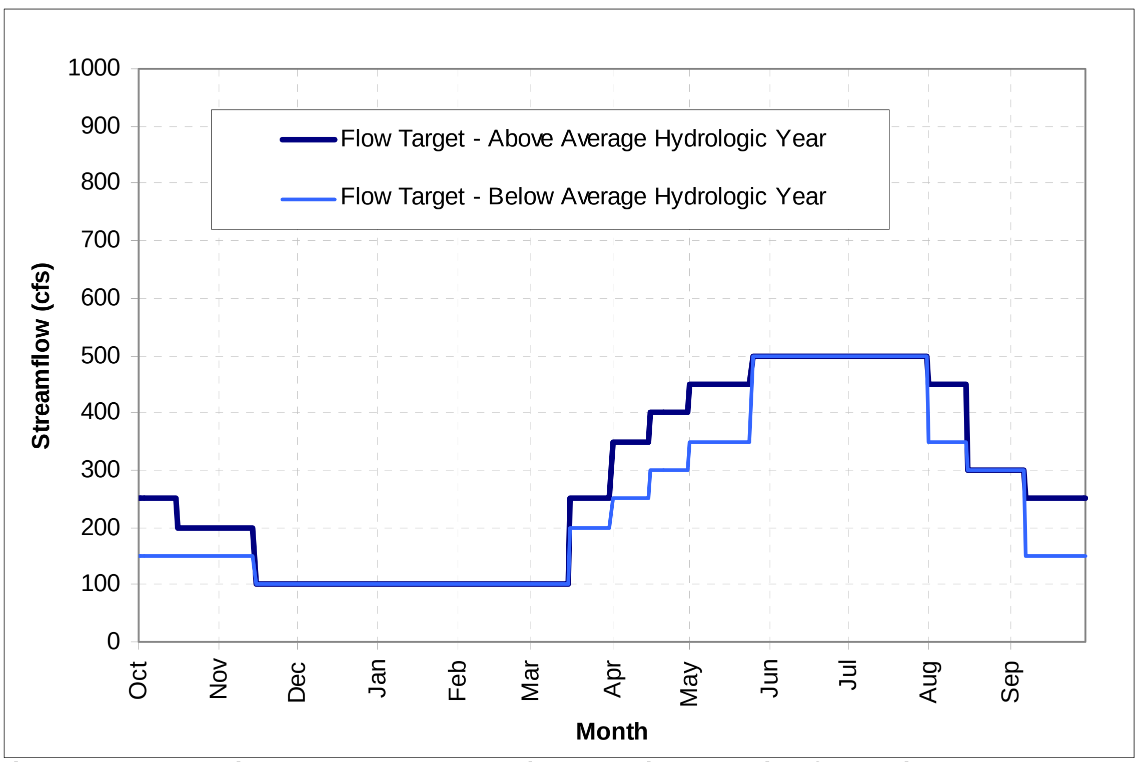


Figure 28. Recreational Flow Targets at Above Pueblo Location for Pueblo Flow Management Program.

curtailment in years following dry years (flows less than 70 percent at Salida).

The IGAs contain several provisions regarding termination of the agreement and other matters, including a stipulation that allows Colorado Springs to terminate the agreements if Colorado Springs "is unable to reasonably construct the SDS from Pueblo Dam due to terms, conditions or requirements contained in any federal, state or local permit, permission, or license including Reclamation's Record of Decision or Pueblo County's 1041 permit" (Section VIII.D, March IGA 2004). The FEIS assumes the PFMP is in place for all alternatives with pipelines out of Pueblo Dam. However, it is not appropriate to attribute the differences among alternatives to the PFMP because there are many other factors that differ among alternatives. Only an analysis of a single alternative comparing effects of that alternative with the PFMP and without the PFMP will show the impact/benefit of the PFMP. This analysis was not performed as part of the FEIS because the underlying effects of alternatives upon the environment are the focus of this analysis; therefore, the FEIS does not offer conclusions about the impact/benefit of the PFMP.

Several other terms and conditions of the IGAs affect how the program is operated. Details can be found in the Water Resources Technical Report (MWH 2007a).

3.2.6.2 Fountain Creek

Fountain Creek is a tributary of the Arkansas River. Fountain Creek headwaters are located on the north and east slope of Pike's Peak and the south slope of the Rampart Range. Fountain Creek flows through the City of Colorado Springs, where it is joined by Monument Creek. The City of Colorado Springs and other Pike's Peak area communities are the major users of water in the Fountain Creek watershed. Much of the tributary inflow to Fountain Creek is diverted for municipal use before entering the main stream. A small amount of irrigated agriculture occurs along the floodplain from Colorado Springs to Pueblo.

Natural streamflow in Fountain Creek upstream of Colorado Springs is primarily the result of snowmelt and rainfall runoff. Downstream of Colorado Springs, streamflow is a result of native streamflow and sewered and non-sewered return flows from cities, towns, and communities in the Fountain Creek watershed, including Colorado Springs. Annual runoff in Monument Creek originates from the Rampart Range. Downstream of Colorado Springs, intermittent runoff occurs from creeks that drain the eastern plains, including Williams Creek and Jimmy Camp Creek.

3.2.6.3 Western Slope

Roaring Fork River

The study area included the Roaring Fork River and tributaries upstream of the Difficult Creek Gage. The Roaring Fork River is located in central Colorado on the west side of the Continental Divide. The watershed includes the Sawatch, Collegiate and Elk Ranges and eight 14,000 foot peaks. Melting snow in these headwaters collects and joins one of three main rivers (Roaring Fork, Fryingpan, and Crystal) and drains to the Colorado River in Glenwood Springs at an elevation of 5,916 feet. The Roaring Fork watershed encompasses an area of about 1,451 square miles. The Twin Lake Project diverts water from the Roaring Fork River to the Arkansas River Basin.

Homestake Creek

The study area included Homestake Creek and tributaries upstream of the Gold Park Gage. Homestake Creek begins around 12,000 feet in the Sawatch Mountains. Homestake Reservoir is located on Homestake Creek. The Homestake Project diverts water from Homestake Creek to the Arkansas River Basin.

Ivanhoe Creek

Ivanhoe Creek is a tributary to the Fryingpan River, located in Pitkin County near the Continental Divide. Ivanhoe Creek begins around 12,000 feet in the Sawatch Mountains. The Busk-Ivanhoe system diverts water from Ivanhoe Creek to the Arkansas River Basin.

3.2.7 Water Storage

Reservoirs on Lake Fork (Turquoise Lake), Lake Creek (Twin Lakes), and Clear Creek (Clear Creek Reservoir) store native streamflow or transmountain diversion water for municipal and irrigation needs. Lake Creek is the largest tributary to the Arkansas River in the upper basin. Just upstream of Pueblo, the river flows into the 349,940 ac-ft Pueblo Reservoir. The reservoir is a multipurpose facility completed in 1975 as part of the Fry-Ark Project. John Martin Reservoir was completed in 1943 by the Corps as a multipurpose project. John Martin Reservoir is located east of Las Animas on the Arkansas River and has a capacity of 615,500 ac-ft.

Reservoir Storage Types

Dead: The volume of a reservoir below the lowest outlet from the dam.
Inactive: The portion of live storage capacity from which water normally will not be withdrawn, in compliance with operating agreements.
Active Conservation: The portion of the live storage capacity in which water normally will be stored or withdrawn for beneficial uses, in compliance with operating agreements or restrictions.
Flood Control: Storage volume allocated to flood control.
Joint Use: Storage space evacuated between April 15 and November 1 for flood control use. Outside of this period, the space can be used for active conservation.

Source: Corps 1998; Reclamation 2004.

3.2.8 Water Quality

Surface water quality in the Arkansas River Basin is generally good. Major water quality issues in the basin are related to acid rock drainage in the headwaters, and urban runoff and salinity in the lower basin. Additionally, return flows from agriculture and municipal water uses concentrate naturally occurring salts, arsenic, and selenium in the basin. Urban stormwater runoff can constitute a majority of flow in parts of the basin during high flow periods; during low flow periods, many of the streams are dominated by historical mining, municipal, and industrial effluent (CDPHE 2002a). Surface water quality in the Western Slope study area is good.

Ground water in the upper Arkansas River Valley is generally suitable for use as potable water supply with a few exceptions associated with acid rock drainage and septic system effluent contamination. Ground water in the lower Arkansas River Basin alluvial aquifer is of fairly good quality (CGS 2003). Similar to the river, however, salinity in ground water increases with distance downstream.

3.2.9 Water Use

Water use within the Arkansas River Basin includes agricultural, municipal, industrial, recreation, fisheries, and augmentation (CWCB 2002). The largest water use in the Arkansas River Basin is agriculture, followed by municipal water use. The CWCB estimates existing (1998) agricultural water use to be 2,033,000 ac-ft and municipal water use to be about 173,000 ac-ft in the Arkansas River Basin. The two largest municipal water users in the basin are Colorado Springs and the PBWW, both of which use surface water as their primary water source. The next largest water use in the Arkansas River Basin is industrial, using about 146,000 ac-ft (CWCB 2002).

3.2.10 Water Supplies

Water supplies for users in the Arkansas River Basin are made up primarily of native Arkansas River surface flows, ground water, and transmountain diversions. Major transmountain projects importing water to the Arkansas River Basin include the Fry-Ark Project; Homestake Project; Twin Lakes Project; Busk-Ivanhoe System; the Columbine, Ewing, and Wurtz ditches; and the Blue River Project. Multiple use diversion projects, including the Colorado Canal System and the Rocky Ford Ditch, have been converted from agricultural use to predominantly municipal and industrial use.

The largest transmountain project is the Fry-Ark Project, which was constructed by Reclamation to supplement municipal and agricultural demands within the Arkansas Valley of Colorado. The Fry-Ark Project consists of five reservoirs and one transmountain diversion tunnel. Fry-Ark reservoirs in the Arkansas River Basin are Turquoise Lake, Twin Lakes, Mount Elbert Forebay, and Pueblo Reservoir. The Boustead Tunnel diverts water from the Fryingpan River and Roaring Fork River Basin on the western slope of the Continental Divide into Turquoise Lake. Water from Turquoise Lake is stored and released through the Mount Elbert Conduit to the Mount Elbert Forebay. Water from the forebay is then used to generate power at the Mount Elbert Pumped-Storage Powerplant. Twin Lakes is the receiving reservoir for water used at the power plant, and water is released from Twin Lakes to the Arkansas River via Lake Creek. Pueblo Reservoir, a direct-streamflow storage reservoir east of Pueblo, stores and delivers water to municipal and agricultural entities in the Lower Arkansas Valley. Table 26 provides a summary of Fry-Ark Project reservoir storage volumes.

The SECWCD was established in the 1950s as the local sponsoring agency for the Fry-Ark Project. The SECWCD is responsible for repayment to the United States and allocation of Fry-Ark water to its constituents. Through its allocation principles, the SECWCD has categorized Fry-Ark Project municipal water users into four groupings: municipal entities west of Pueblo; the PBWW; municipal entities east of Pueblo; and Fountain Valley Authority entities (Fountain, Security, Widefield, Colorado Springs, and Stratmoor Hills). Each entity is allocated a certain percentage of Fry-Ark Project yield and Fry-Ark Project storage. A total of 159,000 ac-ft of Fry-Ark Project storage is set aside for municipal storage and municipal carryover storage of Fry-Ark Project water (Reclamation 1990). A summary of Fry-Ark Project yield and storage allocations for municipal entities is presented in Table 27. Agricultural use makes up the remaining 49 percent of Fry-Ark yield and storage allocation.

In addition to allocated storage space, Reclamation has historically allowed storage of non-Fry-Ark Project water in Fry-Ark Project storage space through programs such as the Winter Water Storage Program (WWSP) and "if and when" (Temporary Excess Capacity or Short-Term Excess Capacity) accounts. These non-Fry-Ark Project accounts are allowed to fill when Fry-Ark Project storage space is not filled with Fry-Ark Project water. The largest municipal users of these contracts have historically been Colorado Springs Utilities and the City of Aurora; amounts have been about 10,000 ac-ft and have typically been stored in Pueblo Reservoir. These contracts are now referred to as "Short-

Term Excess Capacity Contracts" (Short-Term Contracts).

The WWSP was developed to allow direct streamflow agricultural water rights to be stored in Pueblo Reservoir from November 15 to March 15, for use during the peak agricultural water demand season during the spring and summer. The principal entities that divert streamflow under the WWSP include the following agricultural entities: Bessemer, High Line, Oxford, Catlin, Colorado Canal System, Holbrook, Fort Lyon, and Amity. Municipal Fry-Ark Project Reservoir Spill Priorities entities, including Colorado Springs and Aurora, use WWSP storage through shares in the Colorado Canal System.

When storage space is unavailable to accommodate both Fry-Ark Project and non-Fry-Ark Project accounts, non-Fry-Ark Project water is "spilled" from the reservoirs. The spill priorities are contained in Article 13(a) of the contract between Reclamation and the SECWCD (Reclamation 1965) (Table 28). All Participants are requesting "if and when" (i.e., "excess capacity") storage contracts. For purposes of the hydrologic modeling, it was assumed that all entities in the District with excess capacity contracts, including all SDS Participants, would spill under priority 2.

Table 26. Fry-Ark Project Storage Volumes.

Reservoir	Reservoir Storage (ac-ft)					
	Dead	Inactive †	Active Conservation	Joint Use	Flood Control	Total Capacity ‡
Ruedi	63	1,095	101,278	0	0	102,373
Turquoise	2,810	8,920	120,478	0	0	129,398
Pueblo	2,329	28,121	228,828	66,000	26,991	349,940
Twin Lakes	63,324	72,938	67,917	0	0	140,855
Mt. Elbert Forebay	561	3,825	7,318	0	0	11,143

†Inactive includes dead storage.

‡The volume shown for inactive includes the volume shown for dead storage; therefore, Total Capacity equals the sum of Inactive, Active Conservation, Joint Use, and Flood Control.

Source: Reclamation 2004.

Table 27. Summary of Fry-Ark Municipal Yield and Storage Allocations.

Entity	Allocation Percentage	Average Annual Yield Allocation† (ac-ft)	Carryover Storage Space Allocation (ac-ft)
Municipal West of Pueblo	4%	3,216	12,400
Pueblo	10%	8,040	31,200
Municipal East of Pueblo	12%	9,648	37,400
Fountain Valley Pipeline	25%	20,100	78,000
Total	**51%**	**41,004**	**159,000**

† Based on average annual Fry-Ark Project yield of 80,400 ac-ft.

Table 28. Fry-Ark Project Reservoir Spill Priorities.

Spill Order[†]	Storage Account
1	"if and when" storage for water that will be used outside of District (including Aurora)[‡]
2	"if and when" storage for water that will be used inside of District
3	WWSP water in Excess of 70,000 ac-ft
4	In-District Municipal non-Fry-Ark Project water
5	WWSP water less than 70,000 ac-ft
6	Native Arkansas River Basin Fry-Ark Project water

[†] First to spill is the first account in the list.

[‡] Spill priorities do not specify how out-of-district entities are spilled in relation to each other.

Source: Reclamation 1990.

3.3 Study Area Evaluated in the EIS

The area evaluated in this FEIS includes substantial portions of the Arkansas River Basin and the potentially affected environmental resources therein as well as a small portion of the upper Colorado River Basin. Construction and operation of the SDS Project alternatives would affect various environmental resources and geographical areas differently. For example, effects on vegetation may be localized, corresponding to physical disturbances associated with construction of project facilities. Conversely, effects on streamflow may be more widespread due to river and stream diversions and water releases. As shown on Figure 29, the study area was divided into seven sub-areas to facilitate data collection, focus assessment efforts, and ensure that the areas most likely to be potentially affected by the SDS Project were thoroughly evaluated. The seven sub-areas are the Western Slope, Lake Fork Creek and Lake Creek, Upper Arkansas River Basin, Lower Arkansas River Basin, Fountain Creek Basin, Denver Basin aquifers, and Alternative Components. Boundaries for these areas were based on major hydrologic boundaries and physical locations of proposed SDS Project facilities ("alternative components"). The following subsections describe the sub-areas that compose the EIS study area and identify general categories of environmental resources evaluated within each sub-area.

The development of study areas for the SDS EIS was guided by information received during initial public scoping and through results of initial effects analyses. The downstream limit of the study area was defined as immediately upstream of John Martin Reservoir. Because no substantial adverse effects were shown in the lower Arkansas River immediately upstream of John Martin Reservoir, it was concluded that there would be no substantial adverse effects downstream of John Martin Reservoir. Reclamation determined that limiting the downstream study area to upstream of John Martin Reservoir was adequate to describe effects of the SDS Project.

3.3.1 Western Slope

The Western Slope study area was defined using results of the hydrologic model results, which contain a summary of expected diversions through each of the transmountain diversion projects simulated in the model. It includes the headwaters region of the Colorado River Basin in eastern Pitkin County and southeastern Eagle County. A summary of simulated transmountain diversions from the hydrologic model is presented in Appendix D.

The hydrologic model results show that diversions in the Homestake Project, Twin Lakes Project, and the Busk-Ivanhoe System would differ from Existing Conditions and between alternatives. Therefore, these systems and the water bodies that the systems divert from are included in the study area. The analysis shows that diversions by the Fry-Ark Project through the Boustead Tunnel would be the same for Existing Conditions and all alternatives. Therefore, the Fry-Ark Project Western Slope diversion system and water bodies are not included in the study area. Resources examined in the Western Slope include surface water hydrology and water–dependent resources.

3.3.2 Lake Fork and Lake Creek

Lake Fork and Lake Creek between Twin Lakes and Turquoise Lake and the Arkansas River are the farthest upstream parts of the EIS study area. This sub-area was evaluated for effects on water resources, wetland and riparian resources, and aquatic life. Effects on other resources are not anticipated based on the hydrologic and water quality effects reported in Sections 3.5 and 3.7, respectively.

3.3.3 Upper Arkansas River Basin

The Upper Arkansas River Basin sub-area is the river and adjacent communities between Leadville and Pueblo Reservoir. This sub-area was evaluated for effects on water resources, wetland and riparian resources, aquatic life, recreation, and socioeconomics. Effects on other resources are not anticipated based on the hydrologic and water quality effects reported in Sections 3.5 and 3.7, respectively.

3.3.4 Lower Arkansas River Basin

The Lower Arkansas River Basin sub-area is the river and adjacent communities between Pueblo Dam and Las Animas near the inlet to John Martin Reservoir, and the confluence with Fountain Creek. The upper reach of this segment between Pueblo Dam and the confluence with Fountain Creek is also referred to as the Middle Arkansas River. This entire sub-area was evaluated for effects on water resources, wetland and riparian resources, aquatic life, recreation, and socioeconomics. Effects on other resources are not anticipated based on the hydrologic and water quality effects reported in Sections 3.5 and 3.7, respectively.

3.3.5 Fountain Creek Basin

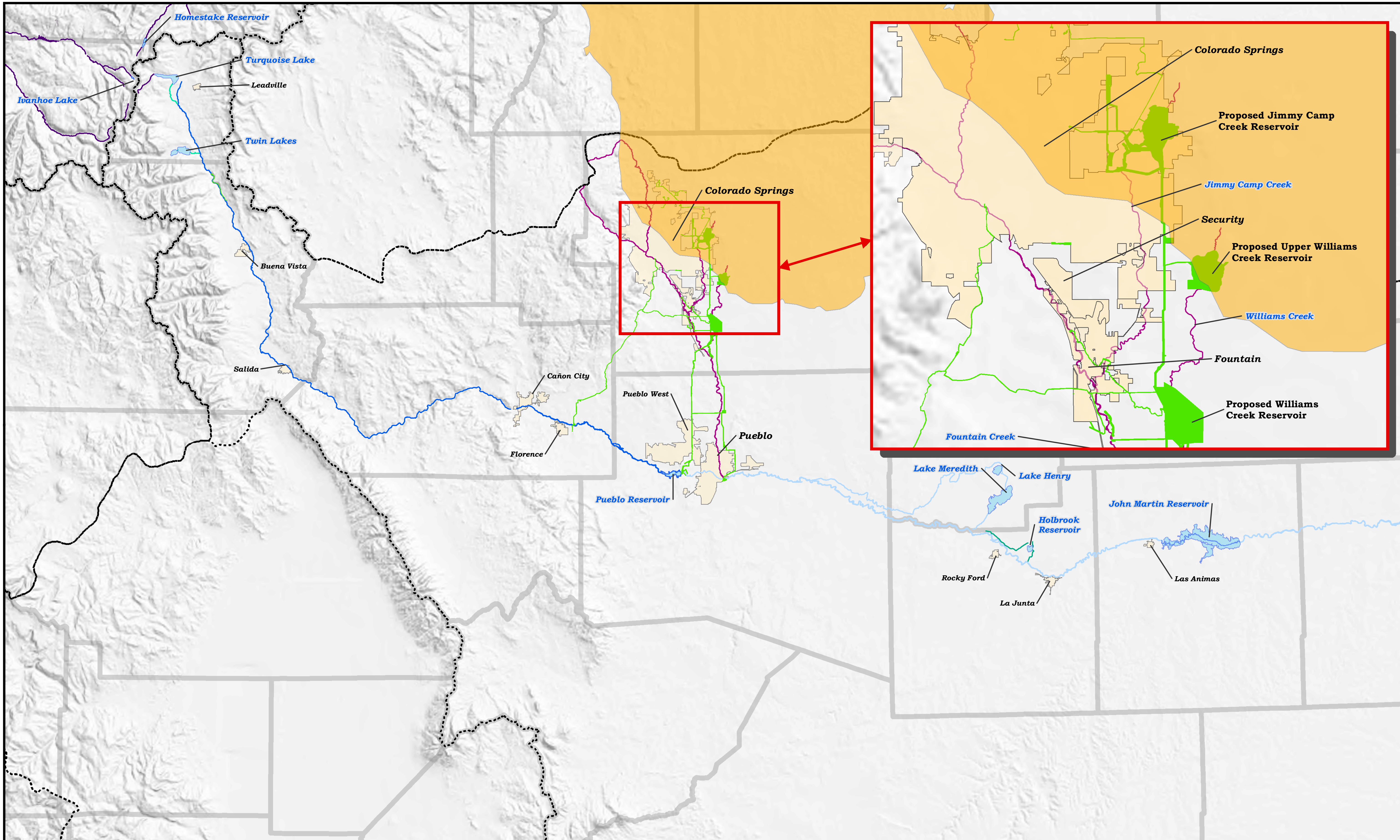
The Fountain Creek Basin sub-area includes Monument Creek from Garden of the Gods Road in Colorado Springs (the most upstream point where SDS Project return flows may be discharged) to Fountain Creek, Fountain Creek from Monument Creek to the Arkansas River, Jimmy Camp Creek from the proposed reservoir site to Fountain Creek, and Williams Creek from the Upper Williams Creek Reservoir site to Fountain Creek. This sub-area was evaluated for effects on water resources, water-dependent biological resources, recreation, and socioeconomics.

3.3.6 Denver Basin Aquifers

The Denver Basin aquifers would be affected only by ground water withdrawals under the No Action Alternative. This sub-area was evaluated for effects on ground water hydrology.

3.3.7 Alternative Components

Physical facilities associated with the SDS Project alternatives (e.g., intakes, pipelines, dams, and treatment plants) would have both



Project: Southern Delivery System
Source: MWH
Date: December 8, 2008

Alternative Component
Denver Basin Aquifer
Upper Arkansas River
Fountain Creek and Tributaries
Lower Arkansas River
Western Slope
Canals
Lake Fork and Lake Creek
Watershed Boundary
County
City

0 10 20 40 Miles

N

Figure 29.
General Study Area for this FEIS.

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construction- and operations-related effects. The environment affected due to the physical footprint of the facilities included all construction corridors, all land and water quality management buffers, and room for siting uncertainty. This area is referred to as the "study area." The study area was used to provide an overall view of existing conditions at all areas of disturbance and surrounding areas. A smaller sub-area representing only the potential physical disturbance area (including inundation areas) for each alternative based on the current level of design was evaluated for effects on an array of physical, biological, cultural, socioeconomic, and human resources. This area is referred to as the "analysis area." The analysis area was used to provide the best estimate of effects due to physical disturbances of each alternative.

3.4 Organization and Analysis Approach

Chapter 3 describes potential environmental consequences associated with construction and operation of the SDS Project alternatives described in Chapter 2. The effects analysis is presented by environmental resource (e.g., wetlands) and represents environmental resources in the area likely to be affected by some aspect of an alternative. More emphasis is placed on resources associated with significant issues identified during scoping (Section 2.1.1). Because many of the effects are related to changes in surface or ground water quantity or quality, these resources are discussed first, followed by other resources. Most resource sections are organized using the same general outline. The typical outline and the information provided for each resource is described below.

3.4.1 Resource

This subsection provides a general introduction to the resource being analyzed, why it is being analyzed, and the indicators used to identify effects. Key terms or concepts are described. Any technical reports that were prepared to support the analysis also are identified.

3.4.2 Summary of Effects

This subsection concisely summarizes, typically through a table or brief narrative, the direct and indirect effects of the alternatives on the subject resource.

3.4.3 Regulatory Framework

This subsection summarizes regulations that apply to the subject resource.

3.4.4 Analysis Area and Methods

This subsection summarizes the geographical area of analysis for the subject resource, describes the methods that were used to analyze effects, and identifies any major uncertainties or incomplete or unavailable data. Where appropriate, representative locations and representative hydrologic conditions are used to characterize effects. Detailed technical information and information on additional locations and hydrologic conditions are incorporated by references to SDS Project technical reports (discussed below). Methods used in these analyses of resources for this FEIS are adequate to support Reclamation's decision-making by disclosing the comparative effects and merits of the alternatives.

3.4.5 Affected Environment

This subsection summarizes the present condition of each resource (also referred to as the "existing condition"). Additional information about the affected environment is presented in and is incorporated by references to SDS Project technical reports (discussed below). The Affected Environment section is a synthesis of available data supplemented with data collected specifically for this FEIS. Effects of past and present actions are reflected by the existing condition and, thus, are included in the affected environment.

3.4.6 Environmental Consequences

3.4.6.1 Direct and Indirect Effects

This subsection summarizes direct and indirect effects (as defined in Section 3.1.2) of the project alternatives. Two primary types of comparisons are made:

- No Action Alternative versus Existing Condition
- Each Action Alternative versus No Action Alternative

In the first comparison, the condition of the resource under the No Action Alternative is evaluated against Existing Conditions. This first comparison is used to show effects that can be expected in the absence of an approved Action Alternative. In the second comparison, the condition of the resource under each Action Alternative is evaluated against the No Action Alternative. This second comparison is used to determine the "net effect" of each Action Alternative (Reclamation 2000). Some comparisons of Action Alternatives against Existing Conditions are included where they are relevant to quantifying or characterizing the magnitude of effects.

Permanent effects are typically described for 2046, the final year of the requested long-term contracts and when effects of SDS Project operations would be greatest. Temporary effects on resources associated with SDS Project construction are evaluated for periods involving construction. In most cases, the effects on resources are described using averages of conditions that would occur over a number of years. More details on the range and variability of effects can be found in the technical reports (discussed below). Section 3.27.1 provides an evaluation of whether extending the term of requested contracts from 2046 to 2050 would have substantial changes in the results of the effects analyses. Section 3.27.2 describes processes that would be required at the end of the contract period.

The Direct and Indirect Effects subsection is usually organized either by project alternative or by geographical area. Organization by alternative (e.g., No Action Alternative or Participants' Proposed Action) is used for resources that would be affected mostly by project construction (i.e., effects would occur on a smaller spatial scale). Effects of a single alternative are described over the entire EIS analysis area (e.g., effect of the No Action Alternative on wetland acreage).

Organization by geographical area is used for resources that would be affected mostly by project operation (i.e., effects would occur on a larger spatial scale). Effects of all alternatives on a specific geographical area are described together (e.g., effects of each alternative on streamflow in the Arkansas River from Avondale to Las Animas), after which effects on other geographical areas are described.

3.4.6.2 Cumulative Effects

This subsection summarizes cumulative effects of the SDS Project alternatives in conjunction with reasonably foreseeable actions (identified in Section 3.1.3). The comparisons and organizational approach used for the preceding Direct and Indirect Effects subsection are followed for cumulative effects, with addition of the reasonably foreseeable actions.

3.4.6.3 Resource Commitments

This subsection describes any irreversible or irretrievable uses of the resource (as defined in Section 3.1.4). These commitments may be the result of one or more of the SDS Project alternatives.

3.4.6.4 Mitigation

This subsection describes mitigation measures that could be taken to avoid, minimize, or compensate for direct or indirect effects on the resource. In general, these measures apply to all alternatives. Differing details for specific alternatives are described as necessary. Reclamation will identify the specific mitigation measures to be implemented by the Project Participants in a compilation of environmental commitments that will be included in the ROD. Detailed mitigation plans will be prepared for the Preferred Alternative prior to construction.

Monitoring programs are described separately for several resource areas and may contain overlapping elements or overlap with the Participants' existing monitoring programs, monitoring by others, or existing permit or regulatory requirements. Final environmental commitments included in the ROD will combine any overlapping mitigation requirements and leverage existing programs in an efficient and effective way that eliminates unnecessary overlap.

The specific mitigation requirements in the ROD will consider factors specific to the Preferred Alterative. These factors include, among others:

- Use of existing systems and information for ongoing monitoring efforts by Project Participants and others
- Balancing the specific mitigation requirements against the projected environmental impacts of the alternative, so that required mitigation is appropriate and proportional
- Consistency of mitigation with existing water rights and the Colorado water rights system; consideration of drought and other unusual stress conditions
- Maintenance of project yield

3.4.7 Technical Reports

Detailed technical reports were prepared to describe the affected environment or environmental consequences for many resources. Those reports are incorporated into the FEIS through references in the appropriate resource section(s) and are available for inspection at:

Bureau of Reclamation
Eastern Colorado Area Office
11056 W. County Road 18E
Loveland, CO 80537-9711
Attn: Jaci Gould, Special Projects Manager
Telephone: 970.962.4338
Facsimile: 970.663.3212

Some information in the technical reports may differ from that presented in this FEIS where the proposed project information, design, or analysis have been updated. Information that has been updated is documented in the administrative record and can be obtained from Reclamation at the contact information above. The following is a list of the technical reports:

- Alluvial Ground Water Hydrology Effects Analysis (MWH 2007b)
- Alluvial Ground Water Administrative Record Documentation (MWH 2008a)
- Aquatic Resources Effects Analysis (GEI 2008a)
- Aquatic Resources Technical Report (GEI 2006)
- Aquatic Resources Administrative Record Documentation (GEI 2008b)
- Bird/Wildlife Aircraft Strike Hazard Assessment Report (ERO 2007a)
- Bird/Wildlife Aircraft Strike Hazard Assessment Report Administrative Record Documentation (ERO 2008a)
- Comparisons of Simulated Hydrodynamics and Water Quality for Projected Conditions in 2046, Pueblo Reservoir, Southeastern Colorado (Ortiz et al. 2008)
- Comparisons of Simulated Hydrodynamics and Water Quality for Projected Conditions in 2046, Pueblo

Reservoir, Southeastern Colorado (Update) (Ortiz et al. in press)

- Southern Delivery System Project: 115 Acre Class III Cultural Resource Inventory of a Proposed Water Treatment Plant in El Paso County, Colorado (Chambellan 2008a) [Cultural resource reports are on file at the Colorado Office of Archaeology and Historic Preservation. The National Historic Preservation Act prohibits public access to these reports.]
- Addendum to A Class I and Class III Cultural Resource Inventory of the Southern Delivery System Project, Chaffee, El Paso, Fremont, and Pueblo Counties, Colorado (Chambellan 2008b).
- Hazardous Materials Assessment Report (ERO 2007b)
- Hazardous Materials Assessment Administrative Record Documentation (ERO 2008b)
- Hydrologic Model Documentation Report (MWH 2007c)
- Hydrologic Model Documentation Report Administrative Record Documentation (MWH 2008b)
- Recreation Resources Technical Report (ERO 2007c)
- Riparian Vegetation Effects Analysis (ERO 2007d)
- Simulation of Hydrodynamics and Water Quality in Pueblo Reservoir, Southeastern Colorado, for 1985 to 1987 and 1999 to 2002. (Galloway et al. 2008)
- Socioeconomic Effects Analysis (BBC 2008a)
- Socioeconomic Resources Technical Report (BBC 2007)
- Socioeconomic Resources Administrative Record Documentation (BBC 2008b)
- Southern Delivery System Phase 2 EIS No Action Alternative – Denver Basin Ground Water Modeling (HRS 2007)
- Supplemental Hydrology Administrative Record Documentation (MWH 2008c)
- Surface Water Hydrology Effects Analysis (MWH 2007d)
- Surface Water Hydrology Effects Administrative Record Documentation (MWH 2008d)
- Vegetation Resources Technical Report (ERO 2007e)
- Vegetation and Wildlife Resources Administrative Record Documentation (ERO 2008c)
- Water Quality Effects Analysis Approach Technical Memorandum (MWH 2008e)
- Water Quality Effects Analysis (MWH 2008f)
- Water Quality Technical Report (MWH 2008g)
- Water Quality Administrative Record Documentation (MWH 2008h)
- Water Resources Effects Analysis (MWH 2008i)
- Water Resources Technical Report (MWH 2007a)
- Water Resources Administrative Record Documentation (MWH 2008j)
- Wetland and Riparian Resources Technical Report (ERO 2007f)

- Wetland and Riparian Resources Administrative Record Documentation (ERO 2008d)
- Wildlife Resources Technical Report (ERO 2007g)

3.5 Surface Water Hydrology

This section describes the existing surface water conditions in the analysis area and the effects of the alternatives on streamflow quantity, streamflow depths, timing of streamflow, reservoir storage, and reservoir water surface elevation and depth. The affected environment is described for several streamflow and reservoir locations throughout the study area. Hydrologic conditions and effects associated with flood events are described in a separate section (Section 3.8).

Changes in surface water hydrology were not, by themselves, considered potentially significant effects. Consequently, impact classification criteria were not developed and applied. The importance of each potential change in surface water hydrology was determined based on the response(s) of water-dependent resources (e.g., fish) to that change. Those effects are described in other sections of this FEIS.

3.5.1 Summary of Effects

The hydrologic effects of each alternative would vary primarily based on the location of the untreated water intake, and whether the alternative includes return flow storage or a return flow pipeline. A summary of the direct effects analysis is presented in Figure 30. The figure shows markers that depict effects that have a greater than 10 percent reduction in average annual streamflow (less than -10 percent), a 1 to 10 percent reduction in average annual streamflow (-10 to -1 percent), 1 to 10 percent increase in average annual streamflow, greater than 10 percent increase in average annual streamflow, and no effect (-1 to 1 percent). The percentages were calculated as the percent difference in streamflow at the selected gage or the percent difference in reservoir storage at the selected reservoir. Based upon the modeling results, the following summarizes general surface water hydrology changes. Except as noted, comparisons in this section are made using average annual streamflow or reservoir contents as a measure. There can be differences between average monthly streamflows and reservoir contents, or between wet and dry year streamflows and reservoir contents, that are not reflected in average annual streamflow. More detailed comparisons are provided in Section 3.5.5 and Appendix E.

Some tables and figures in this section use the following numbers to identify the alternatives:

- Alternative 1 (No Action Alternative)
- Alternative 2 (Participants' Proposed Action)
- Alternative 3 (Wetland Alternative)
- Alternative 4 (Arkansas River Alternative)
- Alternative 5 (Fountain Creek Alternative)
- Alternative 6 (Downstream Intake Alternative)
- Alternative 7 (Highway 115 Alternative)

None of the alternatives would substantially change water diverted from the Western Slope to the Arkansas River Basin; thus, none of the alternatives would substantially change streamflow or reservoir contents in Western Slope streams and reservoirs. Total Western Slope diversions for the Action Alternatives would be slightly less than Western Slope diversions for the No Action Alternative. There would be some differences among alternatives in the timing of Western Slope diversions, resulting in effects on average monthly streamflow. In Homestake Creek, the Action Alternatives except the Highway 115 Alternative generally would result in slightly less streamflow, while the Highway 115

Alternative would result in slightly higher streamflow than the No Action Alternative. In the Roaring Fork River, the Action Alternatives except the Highway 115 Alternative generally would result in slightly higher streamflow than the No Action Alternative, while the Highway 115 Alternative would result in about the same streamflow as the No Action Alternative. In Ivanhoe Creek, the Action Alternatives generally would result in about the same to slightly higher streamflow as the No Action Alternative.

None of the alternatives would cause a substantial change in streamflow on the Arkansas River upstream of the confluence of Lake Creek compared to Existing Conditions. The Arkansas River between the confluence of Lake Creek and the Arkansas River, and where the Ark-Otero Intake diverts near the Arkansas River at Granite Gage would have greater streamflow for the No Action Alternative compared to Existing Conditions. The Action Alternatives, except the Highway 115 Alternative, would have less streamflow compared to the No Action Alternative because operations would be similar to Existing Conditions for these alternatives. The Highway 115 Alternative would have slightly greater streamflows than the No Action Alternative. This would be due to the releases from Twin Lakes that are required in the No Action Alternative and the Highway 115 Alternative to fill the untreated water intake.

For the Arkansas River between the Ark-Otero Intake and the Highway 115 Intake near Florence, there would be little difference in streamflow between the No Action Alternative and Existing Conditions because the increased exchanges through this reach would be offset by the increased releases from the upper basin. All Action Alternatives would slightly decrease streamflow relative to the No Action Alternative due to fewer releases from reservoirs in the upper basin storage.

Effects on the UAVFMP also were evaluated. Neither the No Action Alternative nor the Participants' Proposed Action includes participation in the program by the Participants. Overall, all of the alternatives, including the Participants' Proposed Action, would meet the target flows slightly more frequently than the No Action Alternative. The exception is that the Participants' Proposed Action would meet the recreational target flow (700 cfs) about 3 percent less of the time than the No Action Alternative and the other Action Alternatives.

Streamflow in the Arkansas River from the Highway 115 Intake to Pueblo Reservoir in the No Action Alternative would be lower than Existing Conditions due to the increased exchanges to the upper basin. All of the Action Alternatives, except the Highway 115 Alternative, would increase streamflow relative to the No Action Alternative due to fewer exchanges to the upper basin. Larger increases in streamflow would occur for alternatives that would include the Highway 115 Return Flow Pipeline with a downstream intake (Wetland and Arkansas River alternatives). The Highway 115 Alternative would have slightly more exchanges to the upper basin than the No Action Alternative resulting in decreased streamflow.

In the reach from the Arkansas River at Pueblo Reservoir to Fountain Creek, the No Action Alternative, streamflow would be lower than for Existing Conditions due to increased exchanges through the reach to the upper basin. Streamflow effects for the Action Alternatives would range from decreases in streamflow for alternatives that include return flow releases to Fountain Creek and upstream intakes (Participants' Proposed Action

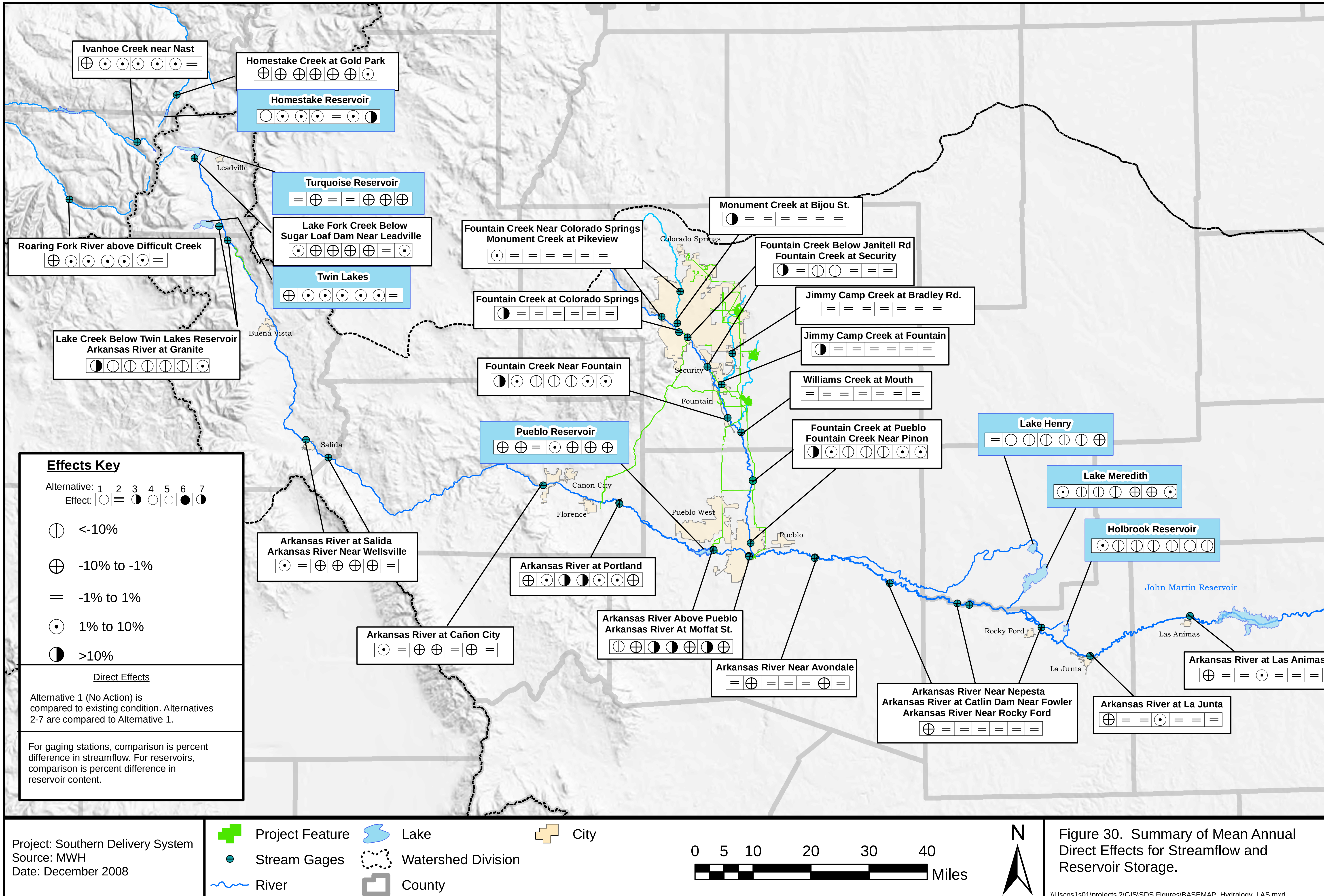

Figure 30. Summary of Mean Annual Direct Effects for Streamflow and Reservoir Storage.

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Fountain Creek Alternative and Highway 115 Alternative), to increases in streamflow for the alternatives that include the Highway 115 Return Flow Pipeline (Wetland and Arkansas River alternatives) or an untreated water intake downstream of the confluence (Downstream Intake Alternative). The alternatives with return flow releases to Fountain Creek and upstream intakes rely on exchanges, which result in decreased streamflow within the exchange reach, to take delivery of reusable return flows through the SDS intake or into regulating storage.

For the Arkansas River downstream of the Fountain Creek confluence to the Colorado Canal outlet, the No Action Alternative would slightly decrease streamflow compared to Existing Conditions due to increased exchanges through this reach. The Action Alternatives would have greater exchanges, thus slightly lower streamflow, when compared to the No Action Alternative.

Streamflow in the Arkansas River downstream of the Colorado Canal outlet in the No Action Alternative would be slightly less than Existing Conditions. Streamflow effects for Action Alternatives compared with the No Action Alternative would range from slight increases in streamflow for the alternatives that include a Highway 115 Return Flow Pipeline (Wetland and Arkansas River alternatives) to nearly the same or slight decreases in streamflow for the other alternatives.

In Fountain Creek downstream of the LVSWWTF, the No Action Alternative would increase streamflow due to increased simulated demands and effluent from the LVSWWTF in 2046 compared to 2006 Existing Conditions demand. For alternatives with a return flow pipeline to the Arkansas River at Colorado 115 (Wetland and Arkansas River alternatives), streamflow downstream of the LVSWWTF would be less than the streamflow in the No Action Alternative. For the Fountain Creek Alternative, which includes a return flow pipeline from return flow storage to the mouth of Fountain Creek, streamflow would be similar to No Action Alternative upstream of the Chilcotte Ditch diversion, and lower downstream of the Chilcotte Ditch diversion. For alternatives with the Williams Creek Return Flow Conveyance Pipeline (Participants' Proposed Action, Downstream Intake, and Highway 115 alternatives), average annual streamflow in Fountain Creek would be nearly the same as the No Action Alternative. For the Participants' Proposed Action and Highway 115 alternatives, average monthly streamflow would be higher than the No Action Alternative during months when return flow storage releases would be made to Fountain Creek and lower during months when reusable return flows are stored in return flow storage.

Compared to Existing Conditions, streamflow in Jimmy Camp Creek would be greater for the No Action Alternative due to increased non-sewered return flows from development serviced by the proposed SDS water treatment plant. All Action Alternatives would have identical simulated streamflow as the No Action Alternative, and no effect when compared with the No Action Alternative.

Because none of the alternatives would include operational releases of stored water to Williams Creek, there would be no effect on average annual or monthly streamflow in Williams Creek downstream of Upper Williams Creek Reservoir or Williams Creek Reservoir. Seepage likely would occur from both reservoirs. Seepage from the reservoirs would be relatively low, and seepage data were not included in the Daily Model. Additionally, there may be some effects due to incidental flood attenuation during peak flow events. Flood attenuation also is not included in the

Daily Model. Changes in streamflow during peak flow events are discussed in Section 3.8.

3.5.1.1 Reservoirs

On the Western Slope, the No Action Alternative would reduce average reservoir contents in Homestake Reservoir. The Action Alternatives would have the same to slightly higher average reservoir contents than the No Action Alternative.

In the upper Arkansas Basin, the No Action Alternative would have lower average contents than Existing Conditions due to increased deliveries for higher municipal demands. All Action Alternatives would have slightly lower contents in Turquoise Lake than the No Action Alternative. The Action Alternatives except the Highway 115 Alternative would have higher contents in Twin Lakes than the No Action Alternative. The Highway 115 Alternative would have only slightly higher contents in Twin Lakes than the No Action Alternative.

The No Action Alternative would have less storage in Pueblo Reservoir when compared with Existing Conditions. Except for the Arkansas River Alternative, the Action Alternatives would have slightly lower average reservoir contents in Pueblo Reservoir than the No Action Alternative. This is because the WWSP would be able to store more water in Pueblo Reservoir under the No Action Alternative, and because demands from storage would be slightly less for the No Action Alternative due to increased availability of reusable return flows that could not be stored by the Participants. These changes offset the increased storage in Excess Capacity accounts by the Participants for all Action Alternatives.

Colorado Canal Reservoirs would have slightly higher average monthly storage volumes under the No Action Alternative compared to Existing Conditions. Slightly more of Colorado Springs' reusable return flows would be stored in the Colorado Canal Reservoirs due to lack of long-term excess capacity storage in the No Action Alternative. Average monthly storage volumes would be lower than the No Action Alternative for all Action Alternatives except the Highway 115 Alternative due to decreased storage of reusable return flows. The Highway 115 Alternative would have slightly higher average Colorado Canal storage contents due to differences in the timing of exchanges.

The No Action Alternative would have slightly higher average annual storage volumes in Holbrook Reservoir compared to Existing Conditions. The Action Alternatives would have lower simulated storage volumes than No Action Alternative. As with the other reservoirs, the return flows that could not be stored in Williams Creek Reservoir or exchanged to the upper basin in the No Action Alternative would result in increased storage in Holbrook Reservoir due to Colorado Springs' operations of its ROY storage account compared with the Action Alternatives. There would only be minor differences in storage volumes among Action Alternatives.

3.5.2 Regulatory Framework

The Colorado Constitution mandates the use of the prior appropriation system for the regulation of surface water and tributary ground water in the state. This water can be diverted by water users from natural streams or ground water pumping. The senior water right holders have the earliest water rights and have the priority of use during short supply over those with later water rights (or junior water rights). This is often referred to as "first in time, first in right." The water users must have a plan to divert, store, or otherwise capture, possess, and control the water for beneficial use. Types of beneficial use include but are not limited to irrigation, stock watering, domestic, municipal, industrial, commercial, power generation, instream flows, and recreation. More information on the Colorado Water Rights system can be found in Appendix A. Detailed water rights within the Arkansas River Basin were obtained from Hydrobase (CDWR 2005) and were incorporated into the Daily Model (see Surface Water Methods section below). These water rights identify all water rights for each structure within the model, including conditional, storage, and exchange water rights.

All alternatives were developed using the Participants' existing water rights. The Participants' water rights used for SDS are listed in Table 4. These rights are primarily exchange rights and change in use rights that have priority dates in the 1980s, 1990s and 2000s. These rights are junior rights, which by law, cannot injure the operation of senior water rights within the Arkansas River Basin. Injury occurs when a particular water operation (e.g., diversion, storage or exchange) results in loss of water by a senior decreed water right in amount, timing or location that they would have been entitled to had the operation not occurred. All analyses completed for this FEIS assumed that water rights within the study area would be operated by the Division Engineer according to Colorado Water Law. Because the hydrologic model developed for the analysis (see Section 3.5.3) operates based on water rights priorities and Colorado Water Law, the hydrologic model cannot, by definition, show injury to senior water rights.

3.5.3 Analysis Area and Methods

To assess the extent of hydrologic changes, the analysis area included the following surface waters (Section 3.3):

- Homestake Creek and tributaries upstream of the Gold Park Gage
- Roaring Fork River and tributaries upstream of the Difficult Creek Gage
- Ivanhoe Creek
- Arkansas River from the Lake Fork confluence to the Las Animas Gage
- Lake Fork Creek from Turquoise Lake to the mouth at the Arkansas River
- Lake Creek from Twin Lakes to the mouth at the Arkansas River
- Fountain Creek from upstream of Colorado Springs to the mouth at the Arkansas River
- Monument Creek from upstream of Colorado Springs to the mouth at Fountain Creek
- Jimmy Camp Creek from the Jimmy Camp Creek Reservoir site to the mouth at Fountain Creek
- Williams Creek from the Upper Williams Creek Reservoir site to the mouth at Fountain Creek

Reservoir storage was simulated for Homestake Reservoir, Turquoise Lake, Twin Lakes, and Pueblo Reservoir (all Fry-Ark Project facilities), Lake Henry and Lake Meredith (Colorado Canal facilities), and Holbrook Reservoir (ROY storage).

3.5.3.1 Arkansas Basin

The effects on streamflow and reservoir storage in the Arkansas River Basin were determined using the Arkansas River Daily Model (or "Daily Model"). The Daily Model was prepared using the MODSIM software package developed by Colorado State University and Reclamation (Labadie et al. 2000) specifically for simulating river and reservoir operations. Development and application of this model are detailed in the Hydrologic Model Documentation Report (MWH 2007c), Hydrologic Model Documentation Report Administrative Record (MWH 2008b), Surface Water Hydrology Effects Analysis Report (MWH 2007d), and Surface Water Hydrology Effects Administrative Record Documentation (MWH 2008d). Briefly, the Daily Model is a daily time-step river, reservoir operations, and water rights model of the Arkansas River Basin upstream of the Las Animas streamflow gage, including the Fountain Creek Basin.

Throughout this FEIS, unless noted otherwise, **averages** were calculated using an **arithmetic mean**.

All simulated years are **water years**, which run from October 1 of the previous year to September 30 of the stated year.

To provide a concise description of the hydrologic analysis results, the information presented in this FEIS is a condensed summary of the Daily Model results. The selected locations represent major streamflow gaging stations and reservoirs in the Arkansas River and Fountain Creek basins, as well as a location within the Williams Creek Basin that is not currently measured. In addition to simulated streamflow and storage data, which are a direct output of the Daily Model, simulated reservoir surface water elevation and depth also were estimated for each of the reservoirs. Changes in streamflow and reservoir storage were evaluated for overall average years, wet years, and dry years. Only effects for overall average years are presented in this section; results for wet, dry, and average years at selected locations are provided in Appendix E. Full results can be found in the Surface Water Hydrology Effects Administrative Record Documentation (MWH 2008d).

Simulated streamflow and reservoir storage for the No Action Alternative were compared to those for the Existing Conditions simulation to describe how simulated future conditions for the No Action Alternative would vary from Existing Conditions. For purposes of comparing effects of the alternatives, simulated streamflow, streamflow depth, and reservoir storage for the Action Alternatives were compared to simulated streamflow, streamflow depth, and reservoir storage for the No Action Alternative.

Two sets of simulations were performed as part of the effects analysis: Direct Effects and Cumulative Effects. Direct Effects are intended to isolate the future effects (direct and indirect) of the alternatives, while Cumulative Effects evaluate the effects of the alternatives in conjunction with all reasonably foreseeable future activities in the study area. The primary difference between the two sets of simulations is that the Direct Effects scenario includes existing levels of demand by non-SDS Project participants, while the Cumulative Effects scenario includes projected 2046 demands by non-SDS Project participants. Both simulations include projected 2046 demands by SDS Project Participants. The analyses also include potential increases in streamflow that may occur in the future within the Fountain Creek Basin based on a trend analysis of historical flows. The model is constructed so that the direct effects analysis assumes a proportion of potential increases in streamflow consistent with the Participants' proportion of growth in the Fountain Creek Basin at 2046, while the cumulative effects analysis assumes full levels of potential increases in streamflow.

Summaries of the Daily Model variable settings used for the direct and cumulative effects model runs are presented in the Surface Watery Hydrology Effects Administrative Record Documentation (MWH 2008d).

Growth is not a direct or indirect effect of the SDS Project (Section 3.1.3.1). However, because the source of water to fill the SDS Project mostly comprises reusable return flows, the hydrologic modeling assumed that additional water users were present within the SDS Project delivery area to both consume and generate return flows from those deliveries. Therefore, the direct and indirect effects hydrologic analysis shows effects of additional return flows even though they are generated by growth that is only considered under the cumulative effects analysis.

Existing Conditions generally represent operations and water demands as they were in 2006. Therefore, the Existing Conditions scenario assumed planning-level 2006 demands (unconstrained by drought-related conservation programs that may be in effect), current (2006) levels of excess storage capacity contracts (If/When contracts) in Pueblo Reservoir, existing facilities, and decreed water rights as of the beginning of the year. A summary of the variable settings and other details for the Existing Conditions model runs can be found in the Hydrologic Model Documentation Report (MWH 2007c), Surface Water Hydrology Effects Analysis (MWH 2007d), and Hydrologic Model Documentation Report Administrative Record (MWH 2008b).

Model simulations for the alternatives assumed operations and municipal water demands as they are anticipated to be in 2046. The simulated operations include planning-level 2046 demands, future levels of long-term (If/When) excess storage capacity contracts, the SDS Project alternatives, and for the cumulative effects scenario, reasonably foreseeable actions. Unadjudicated water rights were not included in the model simulations.

Both average and median statistics at simulated 2046 demands are presented in this document. Median value is a non-parametric statistic that is the value in which there are the same number of data points greater than the value as there are less than the value. Unlike average values, median values are unaffected by extremely low or high values in the data set.

Boxplots were prepared to display the simulated daily data. The standard quartile boxplot method was used. The box represents the first (25th percentile, Q1) and third (75th percentile, Q3) quartiles of the data, split by a line that shows the median (50th percentile). The median value is displayed next to the box. Half of all the data are less than or equal to the median. Twenty-five percent of all the data points are less than or equal to the first quartile mark. Seventy-five percent of all the data points are less than or equal to the third quartile mark. Lines extend from the box by an amount equal to 1.5 times the difference between the first and third quartiles and are called "whiskers." Values outside of the whiskers are marked individually with an "*". Whiskers are truncated if the available data are less than the calculated value (Helsel and Hirsch 2001). With a boxplot graph, all data points within the study time period are represented. Because there are so many days within the time period simulated for this FEIS, many of the "*" markers overlap and resemble a solid black column. Figure 31 presents a summary of the type of data shown in a boxplot.

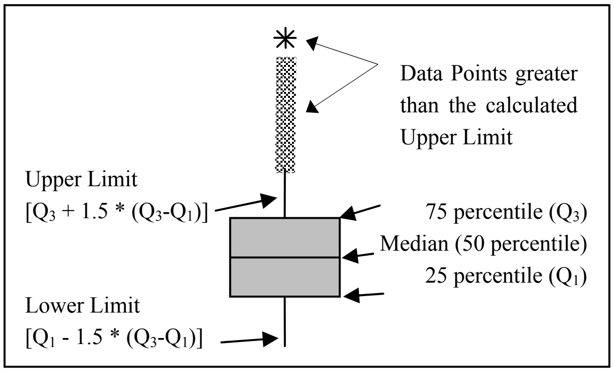


Figure 31. Statistics of a Boxplot.

All historical and simulated hydrologic data are presented in terms of "water year," which runs from October 1 to September 30.

The No Action Alternative and the Participants' Proposed Action were simulated assuming that the Colorado Springs operations would not participate in the UAVFMP (see Section 3.2.6). The five other Action Alternatives were simulated assuming participation in the UAVFMP, which would result in restrictions on exchanges to the upper Arkansas River Basin reservoirs during times that Reclamation would be making releases for purposes of the UAVFMP.

For SDS Project Participants, it was assumed that the Participants' Proposed Action, the Wetland Alternative, and the Fountain Creek Alternative would include participation in the PFMP because SDS Project diversions would be made directly from Pueblo Dam. This is consistent with the terms of the PFMP as described in Section 3.2.6. The remaining alternatives assume no participation in the PFMP.

The 1982 through 2004 study period adequately characterizes typical years as well as extreme low and high flow years. Annual flows as compared with the average flows for the Arkansas River at Cañon City Gage are shown in Figure 32. Several significant events have affected the annual flows shown in the

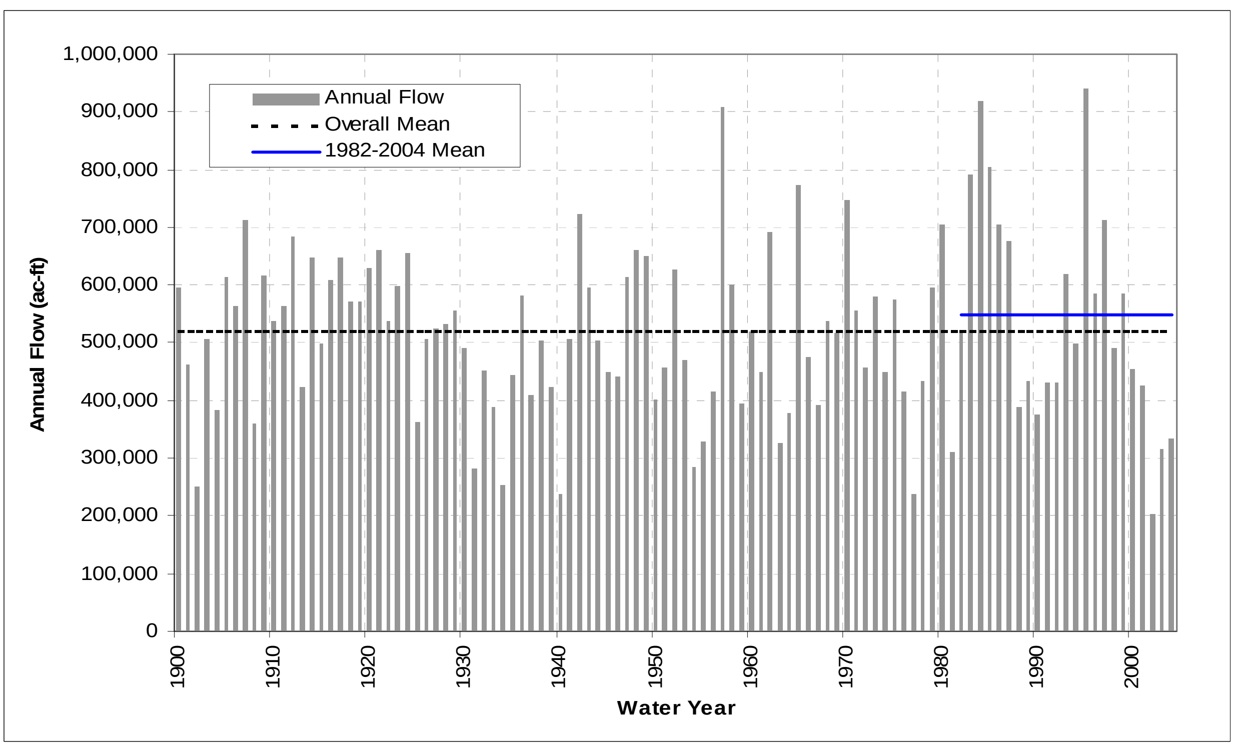


Figure 32. Average Annual Flow Volume, Arkansas River at Cañon City Gage.

Cañon City Gage hydrograph, such as diversions through Boustead Tunnel, storage in Pueblo Reservoir and Turquoise Lake, Reclamation control of Twin Lakes Dam and Colorado Canal transfers from agriculture to municipal uses. The average of the study period is about 9 percent higher than the overall statistics; however, the median is only 1 percent higher. This difference is primarily due to Boustead Tunnel imports into the Arkansas Basin, which did not start until 1970, which average about 50,000 ac-ft (MW 2000).

The computational accuracy of the Daily Model was verified and the model was calibrated to 1996 through 2004 historical data. Although the calibration comparisons with historical conditions showed some differences in streamflow and reservoir storage volumes, these differences do not have a significant effect on the ability of the model to simulate existing and future conditions and make comparisons between alternatives. Based on results of both the calibration runs and simulations of Existing Conditions (described below), the Daily Model was determined by Reclamation to be adequate for investigating the effects of alternatives. Specific details on the model calibration and verification can be found in the Hydrologic Model Documentation Report (MWH 2007c) and Hydrologic Model Documentation Report Administrative Record (MWH 2008b).

Changes in streamflow may decrease stream stage to a level at which intake structures within the study area are physically unable to divert water. The administration of Colorado water law by the Division Engineer would ensure that effects of the SDS Project would not injure senior water rights (i.e., streamflow would be adequate to provide the volume of water in the stream to meet senior water rights). However, reductions in stream stage may reduce the physical capacity of the diversion structure at a given streamflow, resulting in the diversion structure being unable to divert its full entitlement even though there is adequate streamflow in the river. An analysis of the hydraulic characteristics and capacity of individual diversion structures within the study area was not performed as part of the EIS.

3.5.3.2 Western Slope

Streamflow for the Western Slope rivers and tributary streams in the study area was not directly simulated in the Daily Model. Therefore, net simulated transmountain diversions from the Western Slope to the Arkansas River Basin were used to estimate streamflow and streamflow effects for the alternatives. Streamflows were estimated for Existing Conditions and each of the alternatives at the closest downstream USGS gaging station to the transmountain projects. These estimated streamflows were then distributed to each of the diversion points within the transmountain diversion projects based on tributary inflow areas.

The first step in estimating Western Slope streamflow for each alternative was to estimate historical undepleted streamflow at each gage. This was done by adding historical diversions for each system back into the historical gaged streamflow. Then, the simulated trans-mountain diversions were subtracted from the historical estimated undepleted streamflow. Because the Daily Model was not configured or calibrated to simulate daily streamflow on the Western Slope, all calculations were performed on an average monthly basis, and subsequently, all results were presented as average monthly streamflow.

Potential changes in tributary streamflow upstream of the gages were evaluated by estimating the affected streamflow in the tributaries. The area of the subwatershed containing each tributary with a diversion was measured using a Geographical Information System and 7.5 minute quadrangle maps. The streamflow at the mouth of each ungaged tributary was calculated by multiplying the percentage of the contributing subwatershed by the calculated streamflow at the USGS gage for each alternative. As with the calculated streamflow at the gages, all calculations were performed, and results presented, as average monthly streamflow.

Because the Daily Model explicitly simulated storage of Homestake Project net diversions (i.e., diversions by the collection system that are not used to meet instream flow requirements) in Homestake Reservoir, it was evaluated in the same manner as the other reservoirs evaluated in the FEIS. Simulated total reservoir storage contents and stage were compared among alternatives.

Effects tables for each location provide simulated monthly streamflow (cfs), effects on streamflow (cfs), and percent change effects on streamflow (%). The streamflow measurement techniques used at USGS gaging stations and approximate methods used to calculate streamflow and subsequent hydrologic effects on the Western Slope would result in streamflow estimates that are no more accurate than 1 cfs. Therefore, streamflow and effects values are rounded to 1 cfs to reflect accuracy of streamflow measurement and estimation methods. Effects percentages were calculated based on unrounded values to show relative differences between simulated values. Therefore, effects percentages may show effects when absolute values show no effects. Effects on water-dependent resources within the Western Slope study are were evaluated qualitatively using the hydrologic information.

3.5.4 Affected Environment

3.5.4.1 Streamflow

The USGS and the Colorado Department of Natural Resources (CDNR) maintain streamflow gaging stations throughout the Arkansas River Basin and the Western Slope. Table 29, Table 30, and Table 31 present summaries of average annual streamflow and estimated tributary inflows within the study area for the Western Slope, Arkansas River, and Fountain Creek. Historical daily streamflow records for the 1982 to 2004 study period for representative gages within the study area are discussed below. For simplicity, only the most pertinent gages within the study area are discussed.

Table 29. Average Annual Streamflow for Western Slope Rivers and Tributary Inflows 1982 – 2004.

Location	Main Stem Streamflow (ac-ft)	Tributary Inflow (ac-ft)
Homestake Basin		
East Fork at Confluence with Homestake Creek†		4,100
Missouri Ck above Confluence with Sopris Creek†		1,600
Sopris Ck at Confluence with Missouri Creek†		2,000
Missouri Ck above Confluence with Fancy Creek†		4,100
Fancy Ck at Confluence with Missouri Creek†		1,700
Missouri Ck at Confluence with Homestake Creek†		6,000
French Ck at Confluence with Homestake Creek†		2,800
Homestake Creek at Gold Park (09064000)	21,300	
Roaring Fork Basin		
Roaring Fork above Confluence with Lost Man Creek†	6,400	
Lost Man Ck at Confluence with Roaring Fork†		7,200
Roaring Fork above Confluence with Lincoln Creek†	14,100	
Lincoln Ck below Grizzly Reservoir†		10,800
Lincoln Ck above Confluence with New York Creek†		14,200
Tabor Ck at Confluence with Lincoln Creek†		2,200
Brooklyn Ck at Confluence with New York Creek†		2,200
New York Ck above Confluence with Brooklyn Creek†		2,300
New York Ck at Confluence with Lincoln Creek†		5,100
Lincoln Ck at Confluence with Roaring Fork†		23,800
Roaring Fork River above Difficult Creek near Aspen (09073300)	54,100	
Ivanhoe Creek Basin		
Ivanhoe Creek near Nast (09077610)	2,200	
Ivanhoe Ck at Confluence with Fryingpan River†	7,200	

† Unmeasured location. Streamflow estimated based on methods described in this section.

Source: MWH 2008c.

Table 30. Average Annual Streamflow for the Arkansas River and Tributary Inflows 1982 – 2004.

Location	Main Stem Streamflow (ac-ft)	Tributary Inflow (ac-ft)
Arkansas River Near Leadville (07081200)	56,414	
Lake Fork Creek Below Sugar Loaf Dam Near Leadville (07082500)		15,475
Halfmoon Creek Near Malta (07083000)		23,033
Lake Creek Below Twin Lakes (LAKBTLCO)		164,884
Arkansas River At Granite (07086000)	314,122	
Clear Creek Below Clear Creek Reservoir (CCBCCRCO)		49,686
Chalk Creek At Nathrop (07091000)		35,643
Cottonwood Creek Below Hot Springs, Near Buena Vista (07089000)		45,190
Arkansas River At Salida (07091500)	481,790	
Arkansas River Near Wellsville (07093700)	544,853	
Arkansas River At Cañon City (07096000)	570,699	
Fourmile Creek Near Cañon City (07096500)		28,074
Arkansas River At Portland (07097000)	611,484	
Beaver Creek Near Portland (07099100)		30,045
Pueblo Reservoir		
Arkansas River Above Pueblo (07099400)	553,939	
Fountain Creek At Pueblo (07106500)		121,499
Saint Charles River At Vineland (07108900)		31,036
Arkansas River Near Avondale (07109500)	754,522	
Huerfano River Near Boone (07116500)		27,418
Arkansas River Near Nepesta (07117000)	601,534	
Apishapa River Near Fowler (07119500)		13,324
Arkansas River At Catlin Dam Near Fowler (07119700)	541,574	
Timpas Creek At Mouth Near Swink (07121500)		47,477
Arkansas River At La Junta (07123000)	218,324	
Arkansas River At Las Animas (07124000)	227,391	

Source: MWH 2007a.

Table 31. Average Annual Streamflow for Fountain Creek and Tributary Inflows 1982 – 2004.

Location	Main Stem Streamflow (ac-ft)	Tributary Inflow (ac-ft)
Fountain Creek Near Colorado Springs (07103700)	14,683	
Monument Creek At Pikeview (07104000)		27,608
Fountain Creek At Colorado Springs (07105500)	57,143	
Fountain Creek Below Janitell Rd Below Colorado Springs (07105530)	101,294	
Fountain Creek At Security (07105800)	109,314	
Jimmy Camp Creek At Fountain (07105900)		1,809
Fountain Creek Near Fountain (07106000)	122,891	
Fountain Creek Near Piñon (07106300)	112,960	
Fountain Creek At Pueblo (07106500)	121,499	

Source: MWH 2007a.

Homestake Creek

To evaluate potential effects resulting from increased diversions through the existing Homestake Tunnel, the study area for Homestake Creek extends from Homestake Dam to the Homestake Creek at Gold Park Gage (gage number 09064000). A summary of daily average historical streamflow at the Gold Park Gage is presented in Figure 33. Tributaries to Homestake Creek within this reach that have diversions to the Homestake Collection System (French, Fancy, Sopris, and Missouri creeks) are included in the analysis from the point-of-diversion into the Homestake Collection System to its confluence with Homestake Creek. Streamflow in these tributaries is not gaged. Historical streamflow was estimated using the methods described in Section 3.5.3.2.

Roaring Fork River

For potential hydrologic effects due to increased diversions from Twin Lakes Tunnel, the study area includes the Roaring Fork River and tributaries from the Twin Lakes Tunnel to USGS Roaring Fork above Difficult Creek Gage (09073300). A summary of daily average historical streamflow at this gage is presented in Figure 34. Existing diversion structures for the Independence Pass Tunnel Diversion System (i.e., Western Slope portion of the Twin Lakes Project) collect water from the Roaring Fork River and its tributaries, Lost Man Creek, Lincoln Creek, Brooklyn Creek, Tabor Creek, New York Creek, and Grizzly Creek. These tributaries are included in the analysis from the point-of-diversion to its confluence with the Roaring Fork River. Streamflow in these tributaries is not gaged. Historical streamflow was estimated using the methods described in Section 3.5.3.2.

Ivanhoe Creek

Potential effects due to diversions from the Busk-Ivanhoe system were evaluated on Ivanhoe Creek from the Ivanhoe Tunnel to its confluence with the Fryingpan River. The Ivanhoe Creek near Nast Gage (09077610) represents streamflow in Ivanhoe Creek downstream of the Busk-Ivanhoe Tunnel diversion. A summary of daily average historical streamflow is presented in Figure 35. The collection system does not divert from tributaries; thus no tributaries to Ivanhoe Creek are included in the study area.

Wellsville Gage

Average streamflow for the Arkansas River near Wellsville Gage from 1982 to 2004 is about 400 cfs from late September to early May. Streamflow generally peaks at 2,500 cfs in June. The range of historical daily streamflow, and the year-round and recreational target streamflow associated with the UAVFMP is shown in Figure 36.

The average historical streamflow shows that the flow program targets were generally met. However, as shown by the ranges of flows, there were years in the study period when the 700-cfs streamflow target was not met. This primarily occurred during drought conditions in 2002 and during years in the study period prior to the UAVFMP, which began in 1990.

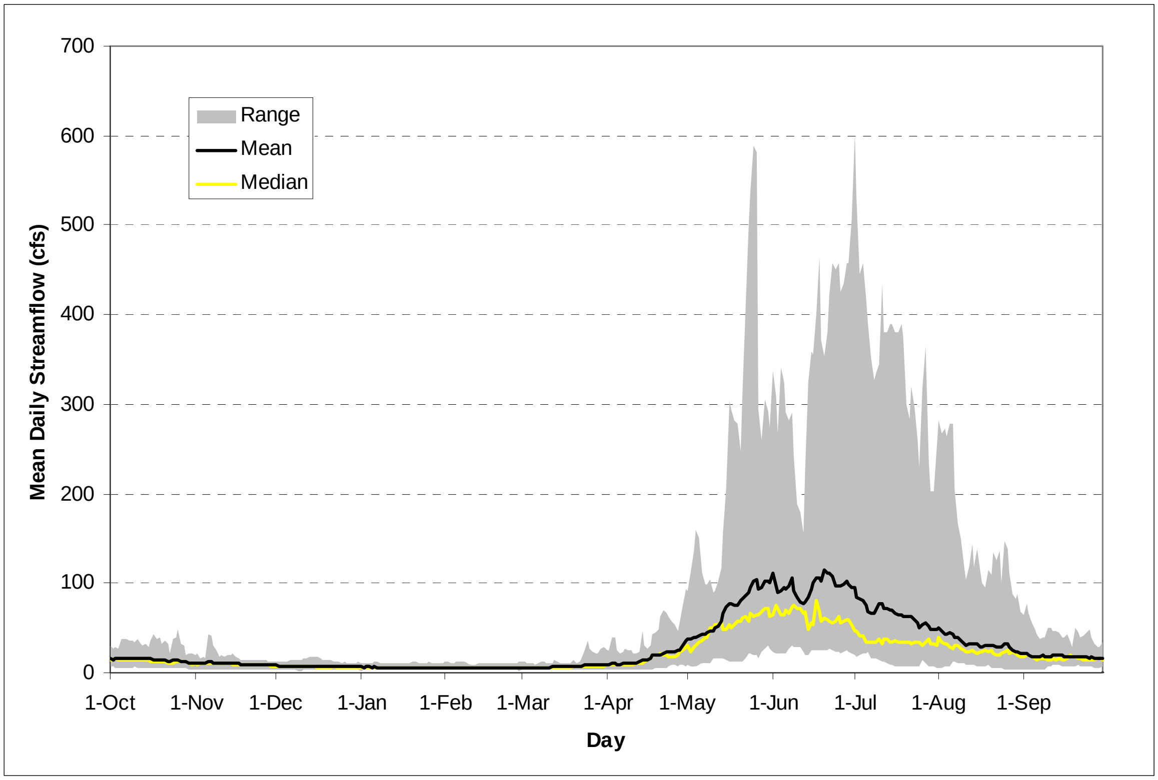


Figure 33. Homestake Creek at Gold Park Gage Daily Average Historical Streamflow Summary.

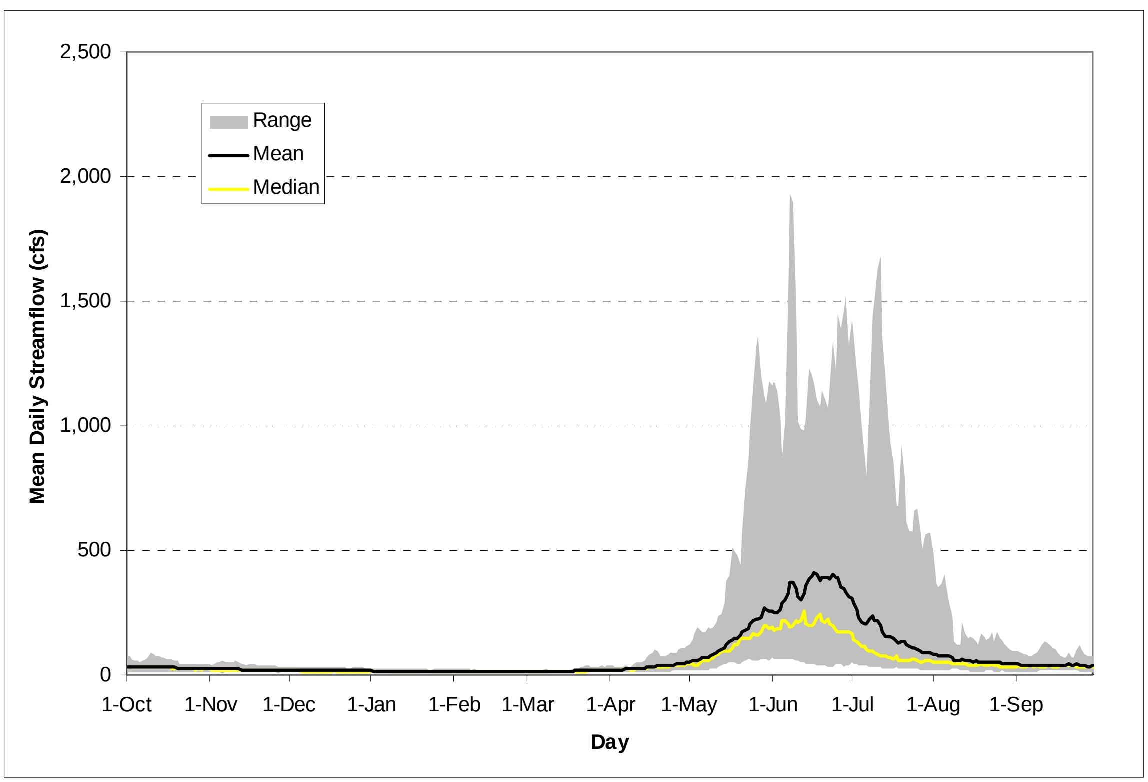


Figure 34. Roaring Fork above Difficult Creek Gage Daily Average Historical Streamflow Summary.

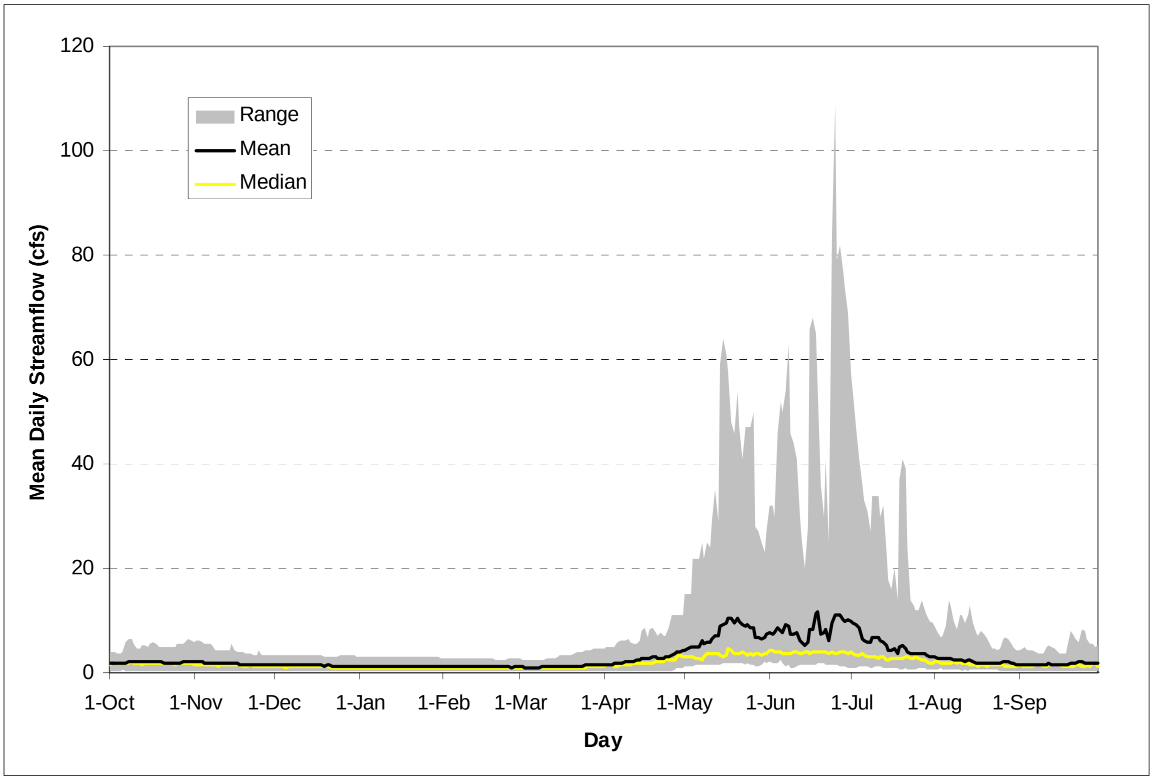


Figure 35. Ivanhoe Creek near Nast Gage Daily Average Historical Streamflow Summary.

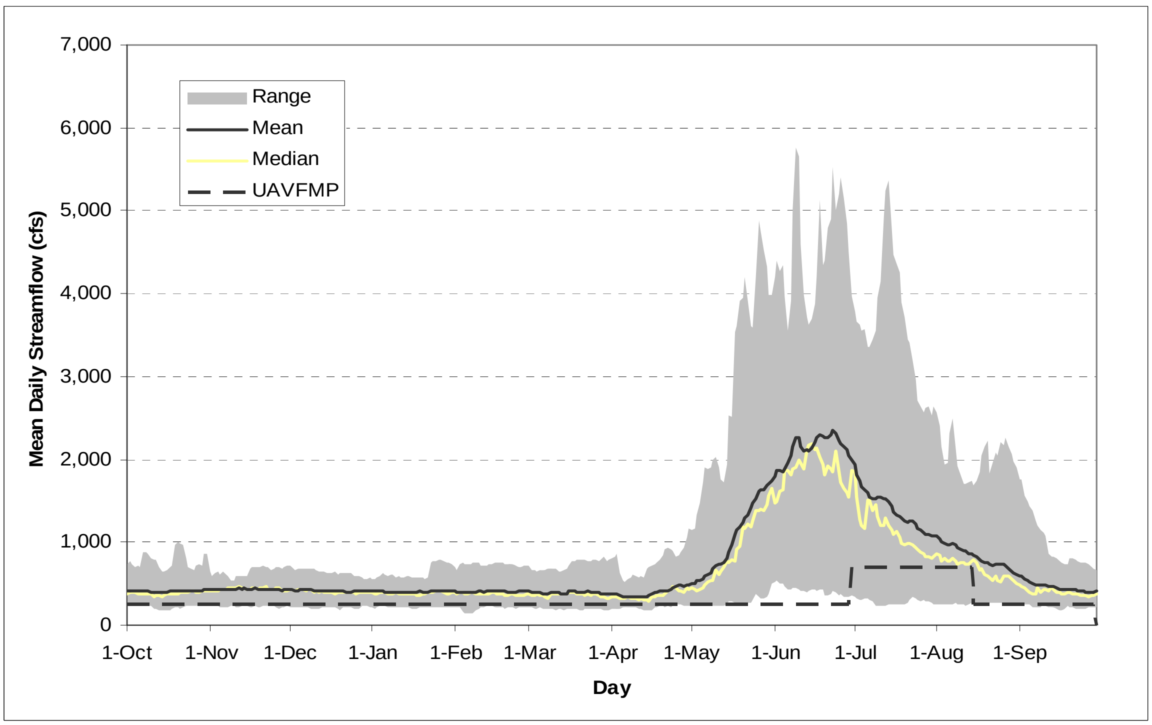


Figure 36. Wellsville Gage Daily Average Historical Streamflow Summary.

Above Pueblo Gage
Streamflow at the Above Pueblo Gage is controlled by releases from Pueblo Reservoir. High average streamflow in late summer is a result of Pueblo Reservoir releases made for irrigation. The average streamflow at the Arkansas River above Pueblo also peaks in the month of June at around 2,500 cfs, as shown in Figure 37. The flow program streamflow line shown in Figure 37 represents the "above average" target flows for the PFMP. Streamflow shown in Figure 37 is recorded streamflow at the physical gage location; however, the target flows are administered as a combination of the Above Pueblo Gage streamflow and releases through the Pueblo Fish Hatchery. The fish hatchery releases water to the Arkansas River immediately downstream of the gage, and these releases have historically averaged 15 to 30 cfs. Releases from storage are not made to meet PFMP target flows. The target flows only curtail exchanges by entities that are party to the PFMP. Additionally, target flows only apply during certain days of the week.

Avondale Gage
The daily historical streamflow summary for the Avondale Gage is shown in Figure 38. As with the Above Pueblo Gage, streamflow at the Avondale Gage is heavily influenced by releases from Pueblo Reservoir for irrigation purposes that can total several thousand cfs. The other streamflow event clearly evident in the Avondale Gage streamflow summary is the extremely large rainfall event that lasted from April 30 to May 1 in 1999, resulting in a daily streamflow of 12,300 cfs.

Las Animas Gage
The daily historical streamflow summary for the Arkansas River at Las Animas Gage is presented Figure 39. Flows at the Las Animas Gage are lower than flows at the Avondale Gage. This is due to diversions for irrigation that take place in the intervening reach. Winter-time flows are less due to the WWSP (Section 3.2.10), off-channel diversions to the Colorado Canal System reservoirs and the Great Plains System reservoirs through the Fort Lyon Storage Canal. As with the Avondale Gage, the April 30 to May 1, 1999 peak flow event of 22,600 cfs is clearly evident in the graph.

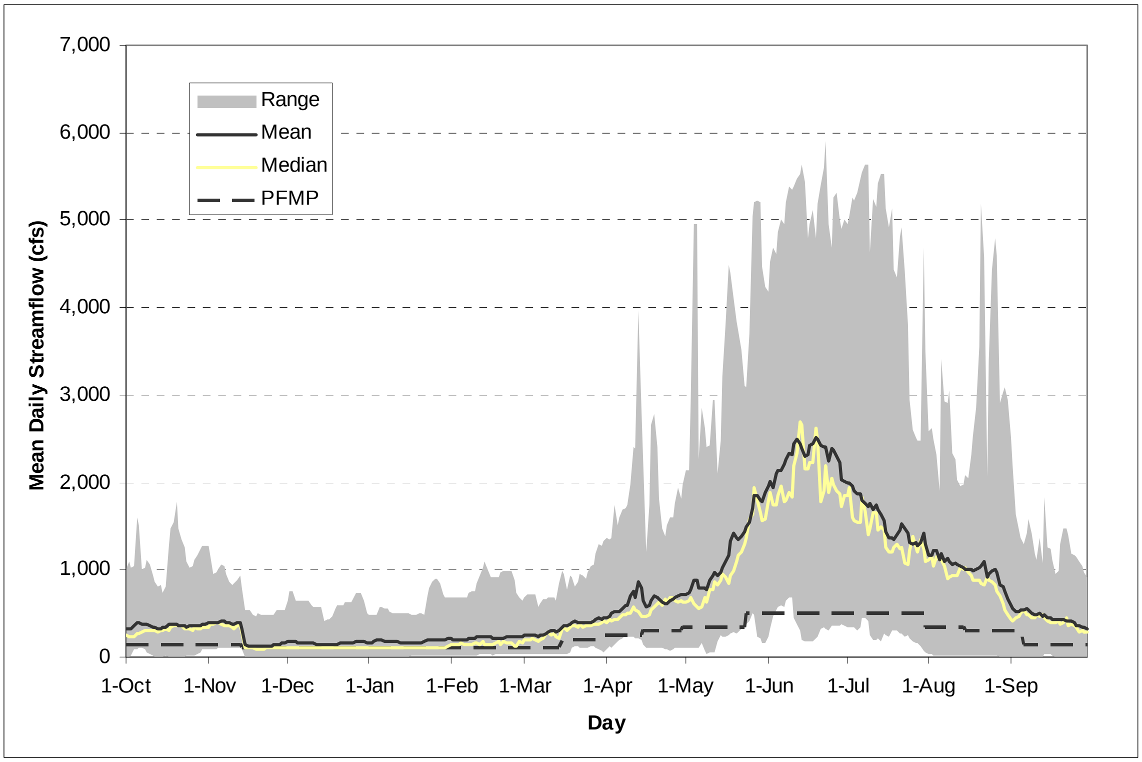


Figure 37. Above Pueblo Gage Daily Average Historical Streamflow Summary.

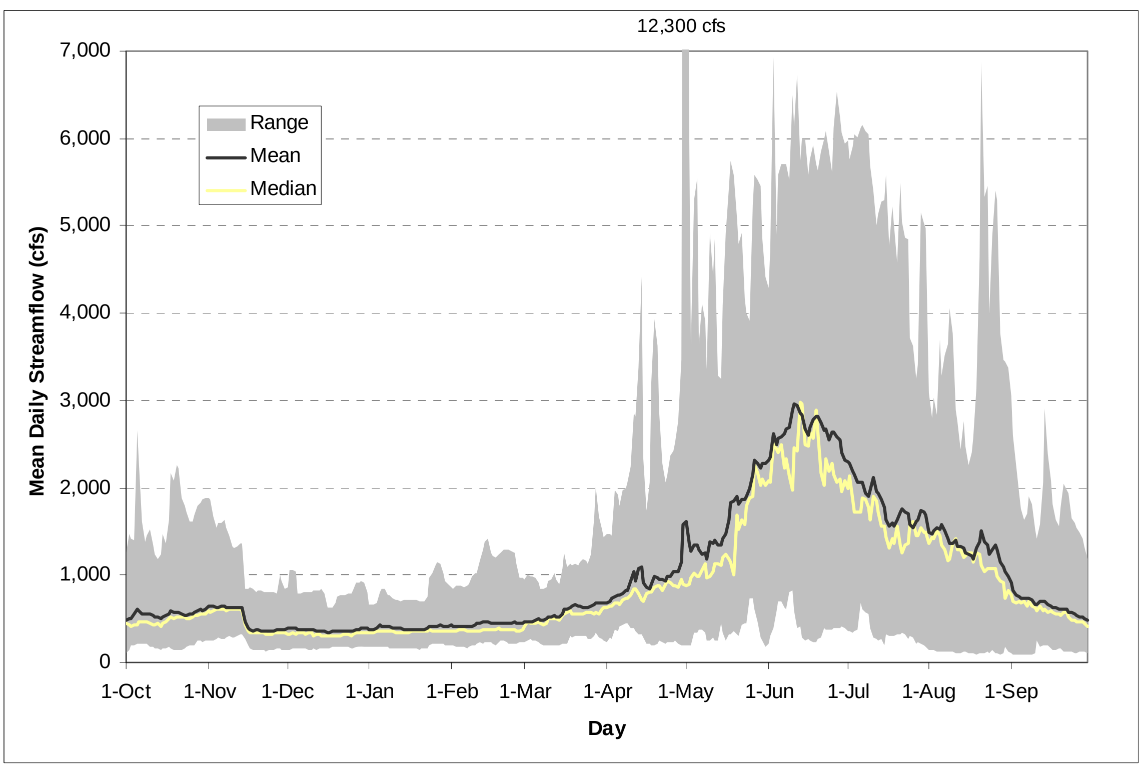


Figure 38. Avondale Gage Daily Average Historical Streamflow Summary.

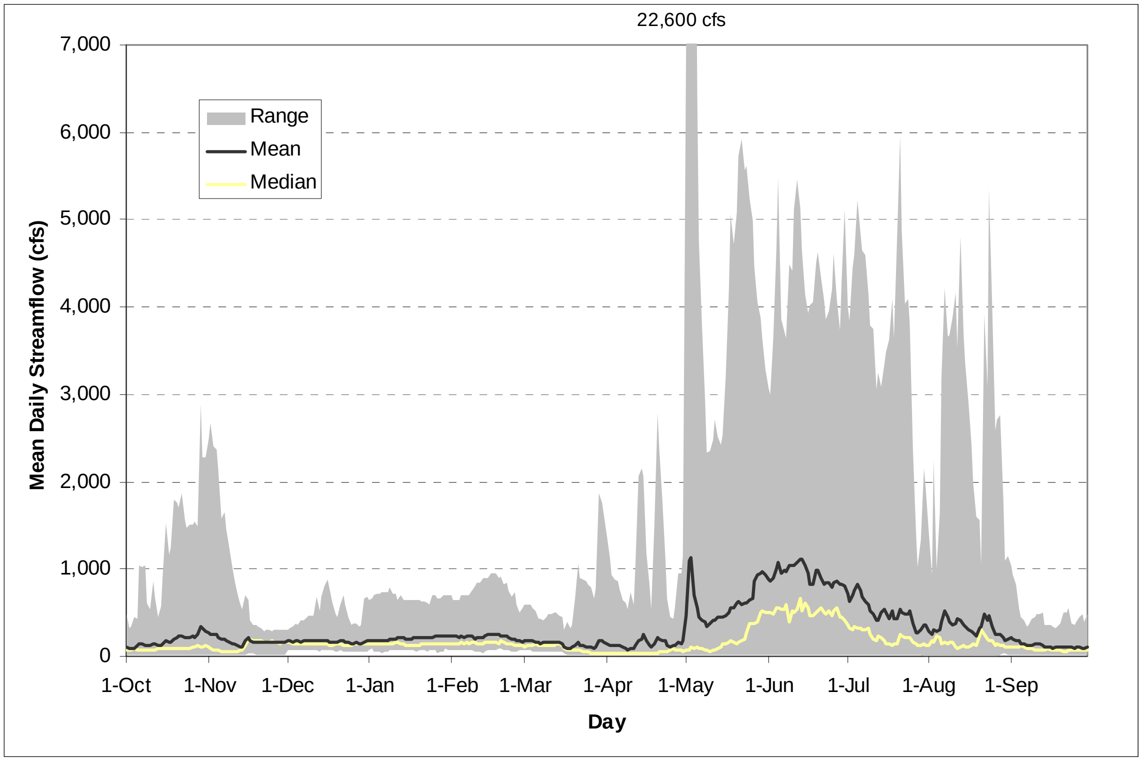


Figure 39. Las Animas Gage Daily Average Historical Streamflow Summary.

Fountain Creek near Fountain Gage

A summary of daily historical streamflow at the Fountain Creek near Fountain Gage is shown in Figure 40. Flows on Fountain Creek are usually much lower than flows in the Arkansas River. Return flows from Colorado Springs and other smaller municipalities north of Pueblo contribute to flows in Fountain Creek.

As shown, the median flows remain fairly constant between 80 and 150 cfs. However, the gage also shows the influences of summer rainfall events, where both the median and average values show significantly more fluctuation. These individual events produce runoff that is significantly higher than the normal median and average daily streamflow values.

Again, the April 30 to May 1, 1999 peak flow event is evident in the gage flows. This flow event was more than twice the next highest peak flow event in the study area

Fountain Creek at Pueblo Gage

Historical streamflow for the Fountain Creek at Pueblo Gage is shown in Figure 41. Hydrology at this gage is very similar to that at the Fountain Creek near Fountain Gage. Streamflow is lower at the Fountain Creek at Pueblo Gage than it is at the Fountain Creek near Fountain Gage due to several agricultural diversions in the intervening reach.

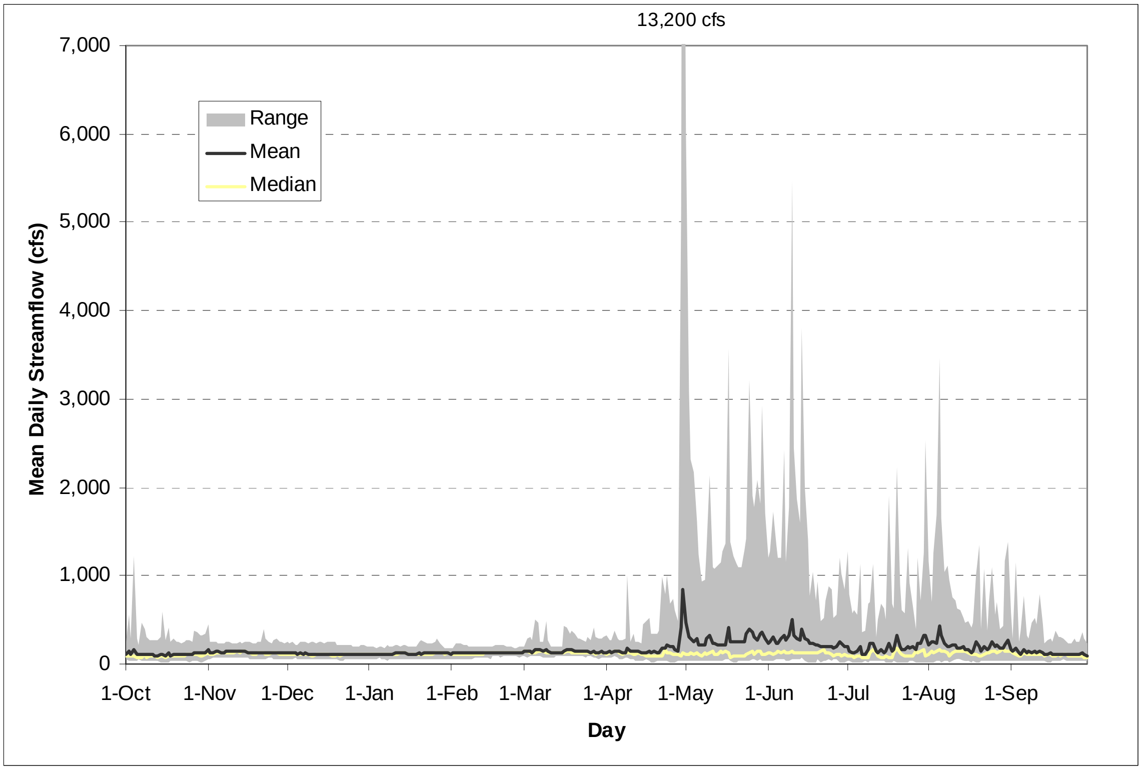


Figure 40. Fountain Creek near Fountain Gage Daily Average Historical Streamflow Summary.

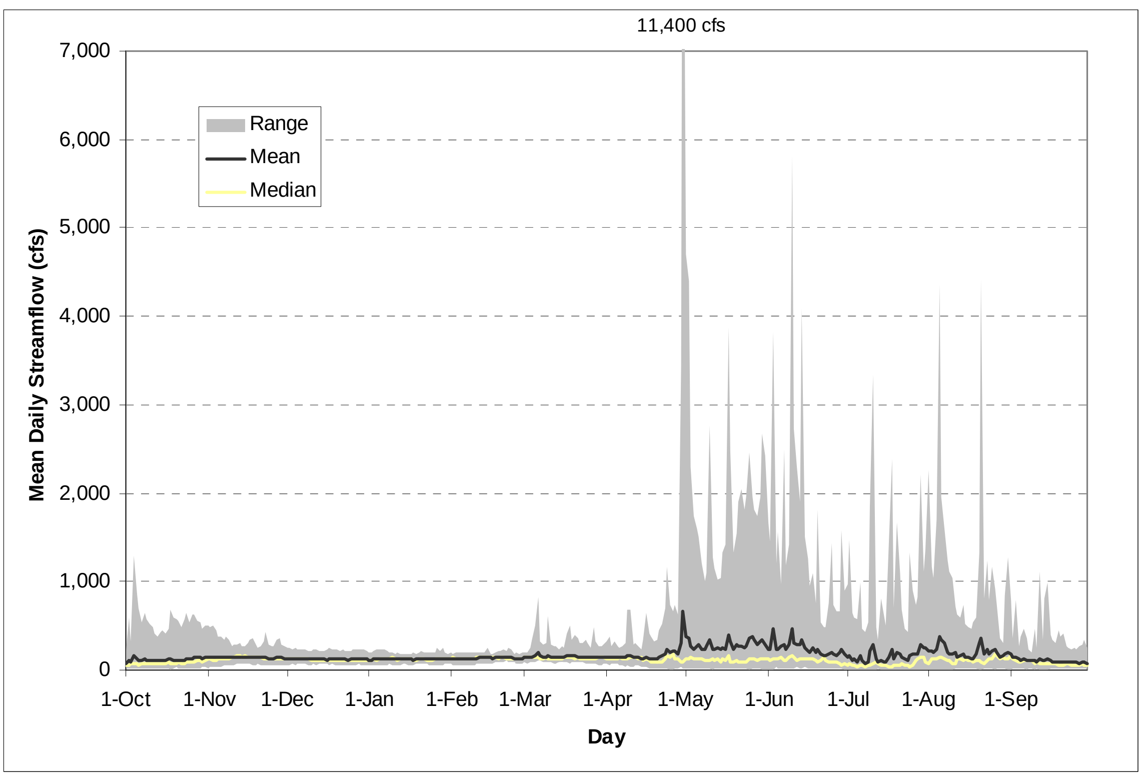


Figure 41. Fountain Creek at Pueblo Gage Daily Average Historical Streamflow Summary.

3.5.4.2 Reservoirs

Table 26 shows the storage capacities for the Fry-Ark Project Reservoirs (Twin Lakes, Turquoise Lake, and Pueblo Reservoir). Total storage capacities for the Colorado Canal reservoirs are 10,000 ac-ft for Lake Henry and 41,000 ac-ft for Lake Meredith. Historical daily storage records for the study period are summarized below. For simplicity, only the most pertinent reservoirs within the study area are discussed.

Homestake Reservoir

The Western Slope study area includes Homestake Reservoir. Homestake Reservoir is located on Homestake Creek above the Gold Park Gage and has a capacity of about 43,000 ac-ft. Homestake Reservoir stores water that is captured in the collection system prior to its diversion to Turquoise Reservoir through the Homestake Tunnel. A summary of daily average historical storage contents for Homestake Reservoir is presented in Figure 42.

Turquoise Lake

Average and median daily historical reservoir storage for Turquoise Lake is shown in Figure 43. Storage water in Turquoise Lake is generally drawn down through the winter months to meet streamflow requirements at the Wellsville Gage and to make room for the following summer's transmountain diversions through the Boustead Tunnel. In addition, water from non-Fry-Ark Project space, including Homestake space and CF&I space, is released for delivery through the Otero Pump Station and Homestake pipeline. This is evident in Figure 43, as storage space in Turquoise Lake is drawn down by about 40,000 ac-ft during the winter. In the past, releases of 3 to 4 cfs to Lake Fork have been made from Fry-Ark Project storage during the winter for fish habitat purposes. Native inflows during the WWSP season are stored in Turquoise and Twin Lakes reservoirs for the benefit of WWSP participants.

Twin Lakes

Average and median daily historical reservoir storage for Twin Lakes is shown in Figure 44. Although commonly reported together, the Twin Lakes storage volumes shown do not include the Mt. Elbert Forebay storage volume. Average daily storage at Twin Lakes is less variable than at Turquoise Lake; however, Twin Lakes is the tailwater reservoir for the Mt. Elbert Pumped-Storage Project. Therefore, from day-to-day, there can be changes in reservoir storage of several thousand ac-ft. Historically, releases of 15 cfs to Lake Creek have been made from Fry-Ark Project storage for fish habitat purposes during the winter months.

Pueblo Reservoir

Average and median daily historical reservoir storage for Pueblo Reservoir is shown in Figure 45. Pueblo Reservoir was constructed as part of the Fry-Ark Project and has had no additional non-project space added to the Fry-Ark Project volume. Therefore, Fry-Ark Project space is considered the only "firm" accounts in Pueblo Reservoir. Remaining accounts are "excess capacity" accounts that can only be used when space is available.

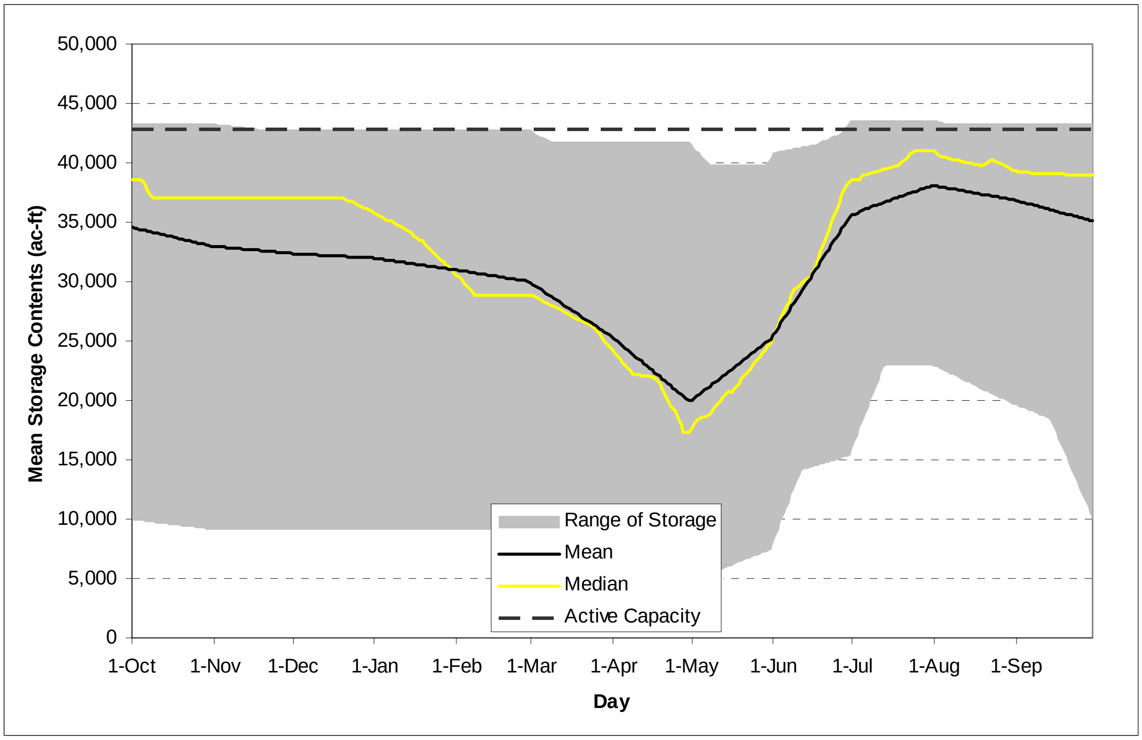


Figure 42. Homestake Reservoir Daily Average Historical Storage Summary.

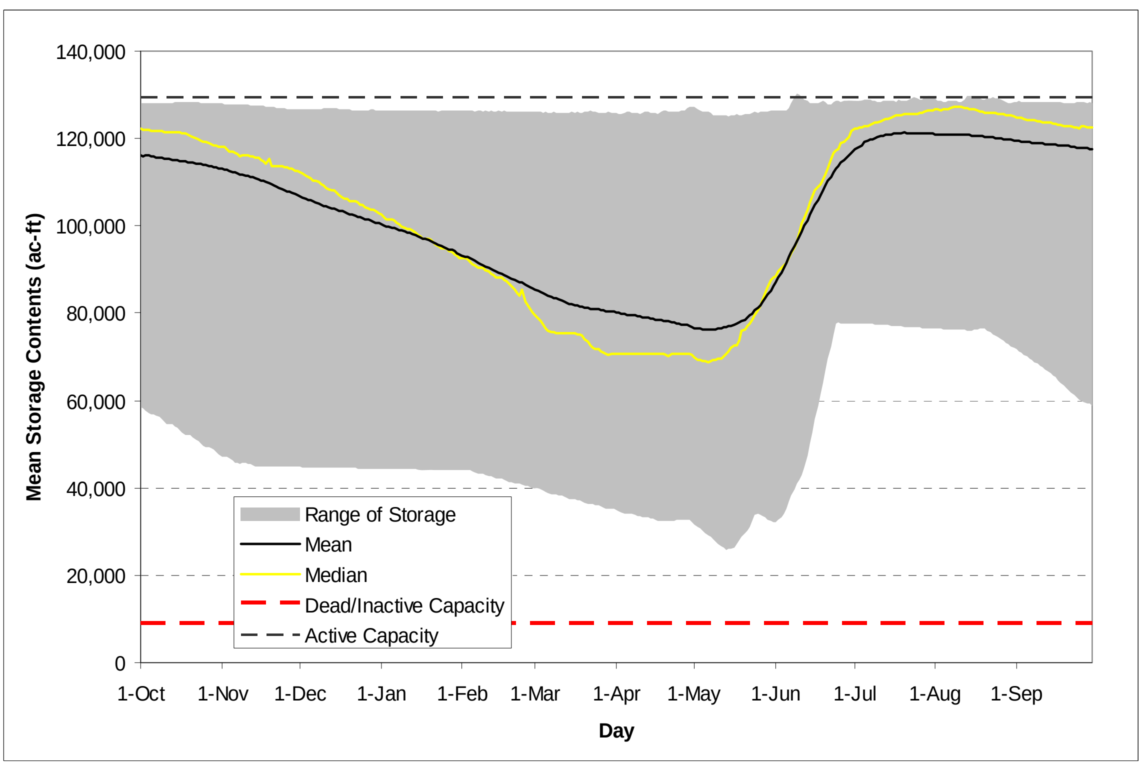


Figure 43. Turquoise Lake Daily Historical Storage Summary.

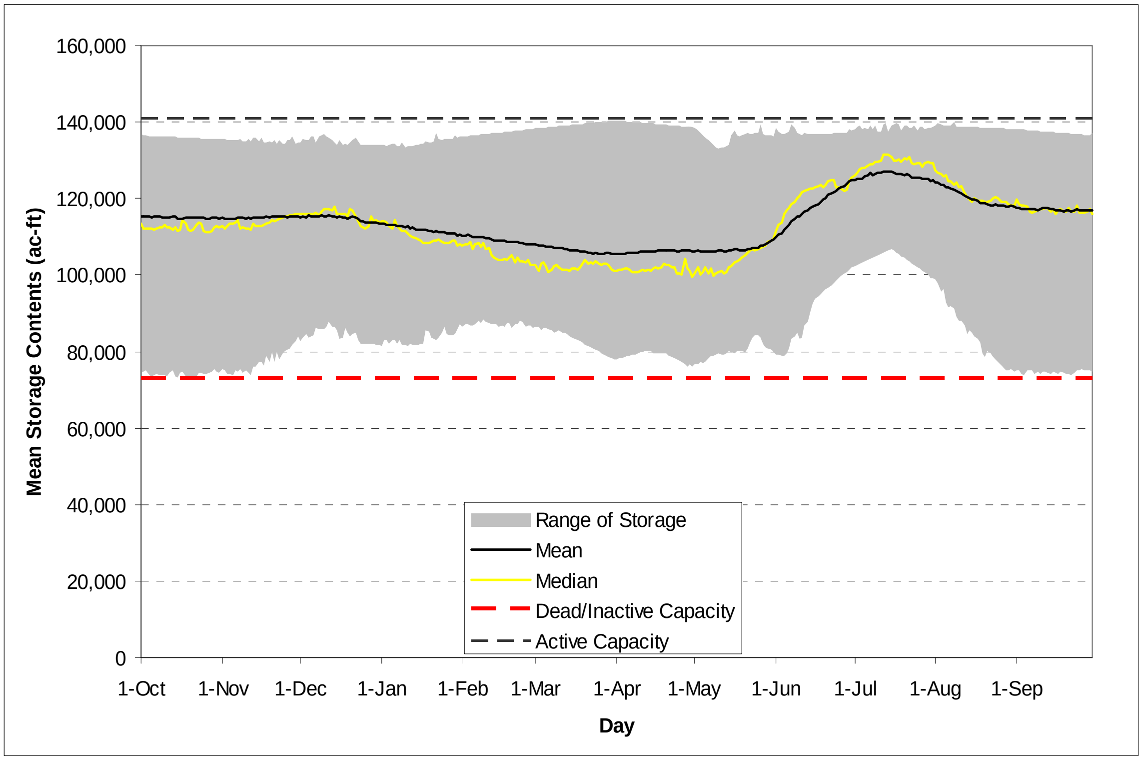


Figure 44. Twin Lakes Daily Historical Storage Summary.

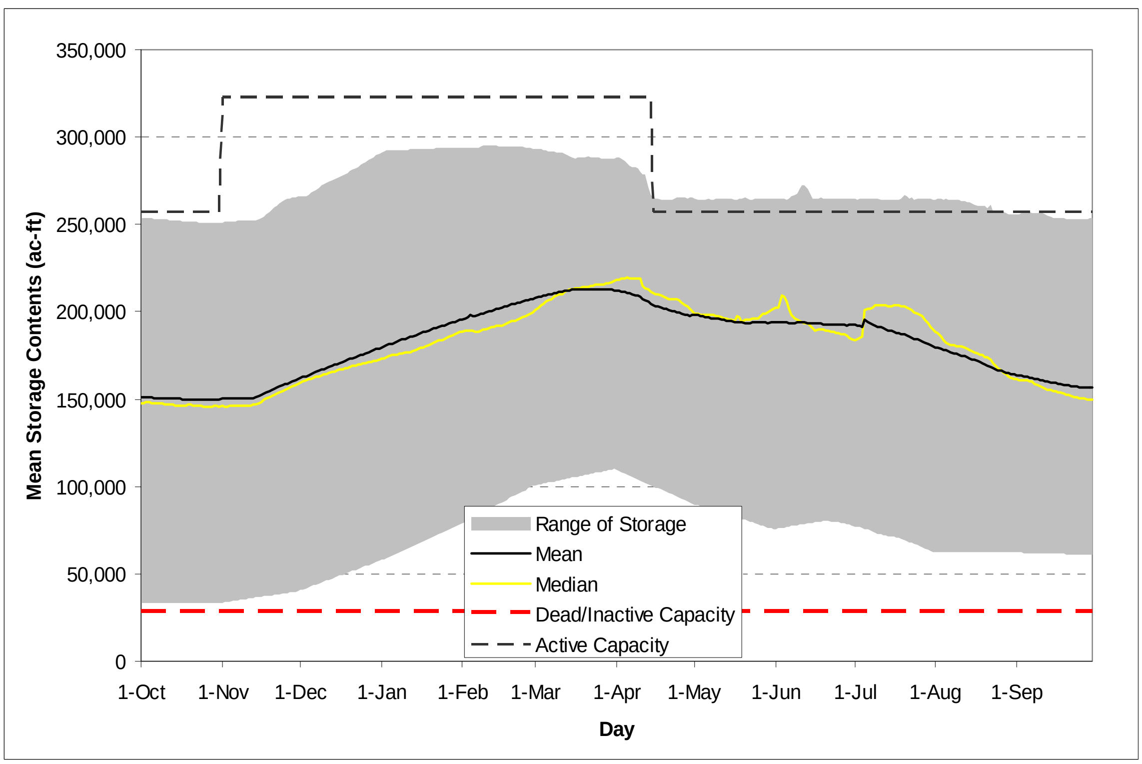


Figure 45. Pueblo Reservoir Daily Historical Storage Summary.

The capacity of Pueblo Reservoir (top of conservation pool) is 256,949 ac-ft not including the dead pool (Figure 45). The joint use pool contains an additional 66,000 ac-ft of storage capacity, which is available for storage from November 1 to April 15. The flood control pool is 26,991 ac-ft, and the Joint Use pool must be evacuated between April 15 and November 1 for flood control use.

Pueblo Reservoir stores water during the winter months as part of the WWSP. Typically, Pueblo Reservoir stores between 30,000 and 50,000 ac-ft/yr of WWSP water, with a few years outside of this range (GEI 1998). A decline in reservoir storage through the summer months reflects the delivery of both Fry-Ark Project water and WWSP water from the reservoir to meet late season agricultural and municipal demands.

3.5.5 Environmental Consequences

The effects on streamflow and reservoir storage for each alternative were determined using the Daily Model and the estimation techniques described for the Western Slope. The following subsections describe general results by stream reaches within the study area, which are most clearly described by using averages and average year values.

3.5.5.1 Direct and Indirect Effects

Streamflow

Table 32 presents summaries of average annual simulated streamflow for the direct effects analysis on the Western Slope while Table 33 presents summaries in the Arkansas River Basin. Boxplots of the individual gages are displayed with median daily streamflow values within each subsection. Comparisons with both average annual, average monthly, and daily median streamflow are made within each subsection. Median values are sometimes preferred to average values because average

Table 32. Average Annual Simulated Streamflow Direct Effects – Western Slope.

Location	Existing Conditions	Alt 1	Alt 2	Alt 3	Alt 4	Alt 5	Alt 6	Alt 7
Simulated Streamflow (cfs)								
Homestake Creek at Gold Park (09064000)	20	20	19	19	19	19	19	20
Roaring Fork River above Difficult Creek near Aspen (09073300)	75	69	73	73	73	72	73	70
Ivanhoe Creek near Nast (09077610)	6	5	5	5	5	5	6	5
Difference in Streamflow (cfs) (Alternative - Alternative 1)								
Homestake Creek at Gold Park	---	---	-1	0	0	-1	-1	1
Roaring Fork River above Difficult Creek near Aspen	---	---	4	4	4	3	4	1
Ivanhoe Creek near Nast	---	---	0	0	0	0	0	0
Difference in Streamflow (%) [(Alternative-Alternative 1) / Alternative 1]								
Homestake Creek at Gold Park	---	---	-3%	-2%	-2%	-3%	-3%	4%
Roaring Fork River above Difficult Creek near Aspen	---	---	5%	6%	6%	5%	6%	1%
Ivanhoe Creek near Nast	---	---	3%	5%	5%	4%	8%	1%

Western Slope streamflow and differences in cfs are rounded values to reflect accuracy of measurements and calculations. Percent differences are based on unrounded values to reflect relative differences between alternatives.

Table 33. Average Annual Simulated Streamflow Direct Effects – Arkansas River Basin.

Location	Existing Conditions	Alt 1	Alt 2	Alt 3	Alt 4	Alt 5	Alt 6	Alt 7
Simulated Streamflow (cfs)								
Lake Creek Below Twin Lakes Reservoir (LAKBTLCO)	172	235	172	169	169	172	171	241
Arkansas River At Granite (07086000)	352	417	354	349	349	354	353	424
Arkansas River Near Wellsville (07093700)	677	685	678	674	674	678	677	682
Arkansas River At Portland (07097000)	766	703	769	858	858	768	767	692
Arkansas River Above Pueblo (07099400)	631	562	547	635	717	547	627	552
Arkansas River Near Avondale (07109500)	971	961	951	953	953	956	949	955
Arkansas River At Las Animas (07124000)	321	310	310	313	314	312	309	309
Fountain Creek At Security (07105800)	170	234	235	141	141	235	236	235
Fountain Creek At Pueblo (07106500)	188	249	253	168	168	171	256	254
Jimmy Camp Creek At Fountain (07105900)	2	8	8	8	8	8	8	8
Williams Creek at Mouth (ungaged)	0	0	0	0	0	0	0	0
Difference in Streamflow (cfs) (Alternative - Alternative 1)								
Lake Creek Below Twin Lakes Reservoir	---	---	-63	-67	-67	-63	-64	5
Arkansas River At Granite	---	---	-63	-68	-68	-63	-64	7
Arkansas River Near Wellsville	---	---	-7	-11	-11	-7	-8	-3
Arkansas River At Portland	---	---	66	155	155	65	64	-11
Arkansas River Above Pueblo	---	---	-15	72	154	-15	65	-11
Arkansas River Near Avondale	---	---	-11	-9	-8	-6	-12	-6
Arkansas River At Las Animas	---	---	0	3	4	2	-1	-1
Fountain Creek At Security	---	---	0	-93	-93	0	1	1
Fountain Creek At Pueblo	---	---	4	-81	-81	-78	7	5
Jimmy Camp Creek At Fountain	---	---	0	0	0	0	0	0
Williams Creek at Mouth (ungaged)	---	---	0	0	0	0	0	0
Difference in Streamflow (%) [(Alternative-Alternative 1) / Alternative 1]								
Lake Creek Below Twin Lakes Reservoir	---	---	-27%	-28%	-28%	-27%	-27%	2%
Arkansas River At Granite	---	---	-15%	-16%	-16%	-15%	-15%	2%
Arkansas River Near Wellsville	---	---	-1%	-2%	-2%	-1%	-1%	0%
Arkansas River At Portland	---	---	9%	22%	22%	9%	9%	-2%
Arkansas River Above Pueblo	---	---	-3%	13%	27%	-3%	11%	-2%
Arkansas River Near Avondale	---	---	-1%	-1%	-1%	-1%	-1%	-1%
Arkansas River At Las Animas	---	---	0%	1%	1%	1%	0%	0%
Fountain Creek At Security	---	---	0%	-40%	-40%	0%	1%	0%
Fountain Creek At Pueblo	---	---	2%	-33%	-33%	-31%	3%	2%
Jimmy Camp Creek At Fountain	---	---	0%	0%	0%	0%	0%	0%
Williams Creek at Mouth (ungaged)	---	---	0%	0%	0%	0%	0%	0%

values can occasionally be skewed upward when there are a few very high flow days reported. The median value "smoothes" out the skewed values and represents the most common flow rate. Because the Western Slope analysis was not conducted on a daily basis, median values are not presented at the Western Slope locations. Average monthly streamflow and streamflow depth for overall average, dry,- and wet-year conditions, are presented in Appendix E. Unless otherwise noted, streamflow depth is reported as the depth of water at the lowest point in the cross-section of the channel.

Western Slope Streams

A summary of average annual streamflow and direct effects within the Homestake Basin is presented in Table 34. Average annual streamflow for the No Action Alternative would be similar to streamflow under Existing Conditions. Average annual streamflow for all Action Alternatives except the Highway 115 Alternative would generally be up to 1 cfs lower than that for the No Action Alternative, as a result of slightly higher Western Slope diversions for these alternatives. Average Annual streamflow for the Highway 115 Alternative is about the same as that for the No Action Alternative. Homestake Project transmountain diversions would be slightly higher for the Action Alternatives than the No Action Alternative because of increased availability of Turquoise Lake storage space to store Homestake diversions in the Action Alternatives.

Average monthly direct effects for the Homestake Creek at Gold Park Gage are presented in Table 35. Monthly average streamflow for the No Action Alternative would be similar to streamflow for Existing Conditions, with slightly lower monthly streamflow for July and August relative to Existing Conditions. Most of the effects on monthly streamflow for Action Alternatives would occur from May to July, because peak diversions from Homestake Creek would occur during summer months when water availability and differences in storage availability are

Table 34. Average Annual Simulated Streamflow Direct Effects – Homestake Creek and Tributaries.

Streamflow Location	Existing Conditions	Alt 1	Alt 2	Alt 3	Alt 4	Alt 5	Alt 6	Alt 7
Simulated Streamflow (cfs)								
Homestake Creek at Gold Park	20	20	19	19	19	19	19	20
French Creek at Confluence with Homestake Creek	3	3	3	3	3	3	3	3
Missouri Creek above Confluence with Sopris Creek	2	1	1	1	1	1	1	2
Sopris Creek at Confluence with Missouri Creek	2	2	2	2	2	2	2	2
Missouri Creek above Confluence with Fancy Creek	4	4	4	4	4	4	4	4
Fancy Creek at Confluence with Missouri Creek	2	2	1	2	2	1	1	2
Missouri Creek at Confluence with Homestake Creek	6	6	5	5	5	5	5	6
East Fork at Confluence with Homestake Creek	4	4	4	4	4	4	4	4

Table 35. Average Monthly Simulated Streamflow Direct Effects – Homestake Creek at Gold Park.

Month	Overall Average Conditions							
	Existing Conditions	Alt 1	Alt 2	Alt 3	Alt 4	Alt 5	Alt 6	Alt 7
Simulated Streamflow (cfs)								
Oct	16	16	16	16	16	16	16	16
Nov	12	12	12	12	12	12	12	12
Dec	8	8	8	8	8	8	8	8
Jan	6	6	6	6	6	6	6	6
Feb	6	6	6	6	6	6	6	6
Mar	8	8	8	8	8	8	8	8
Apr	25	25	25	25	25	25	25	25
May	38	38	34	36	36	35	34	37
Jun	33	34	32	32	32	33	30	40
Jul	44	42	40	39	39	39	39	45
Aug	26	21	23	24	24	23	24	24
Sep	20	20	20	20	20	20	20	20
Mean	20	20	19	19	19	19	19	20
Effects (Alternative - Alternative 1)								
Oct	---	---	0	0	0	0	0	0
Nov	---	---	0	0	0	0	0	0
Dec	---	---	0	0	0	0	0	0
Jan	---	---	0	0	0	0	0	0
Feb	---	---	0	0	0	0	0	0
Mar	---	---	0	0	0	0	0	0
Apr	---	---	0	0	0	0	0	0
May	---	---	-4	-2	-2	-4	-4	-2
Jun	---	---	-2	-2	-2	-1	-3	6
Jul	---	---	-2	-3	-2	-2	-3	3
Aug	---	---	1	3	3	1	3	2
Sep	---	---	0	0	0	0	0	0
Mean	---	---	-1	0	0	-1	-1	1
Effects % (Alternative - Alternative 1 / Alternative 1)								
Oct	---	---	-2%	-2%	-2%	-2%	-2%	-1%
Nov	---	---	0%	0%	0%	0%	0%	0%
Dec	---	---	0%	0%	0%	0%	0%	0%
Jan	---	---	0%	0%	0%	0%	0%	0%
Feb	---	---	0%	0%	0%	0%	0%	0%
Mar	---	---	0%	0%	0%	0%	0%	0%
Apr	---	---	0%	0%	0%	0%	0%	0%
May	---	---	-11%	-6%	-6%	-10%	-11%	-4%
Jun	---	---	-6%	-6%	-6%	-4%	-10%	17%
Jul	---	---	-4%	-6%	-6%	-6%	-7%	7%
Aug	---	---	6%	13%	13%	6%	14%	11%
Sep	---	---	0%	0%	0%	0%	0%	0%
Mean	---	---	-3%	-2%	-2%	-3%	-3%	4%

Western Slope streamflow and differences in cfs are rounded values to reflect accuracy of measurements and calculations. Percent differences are based on unrounded values to reflect relative differences between alternatives.

highest. Average monthly streamflow would be between 4 and 11 percent less for all Action Alternatives, except the Highway 115 Alternative, relative to the No Action Alternative during these months. The Highway 115 Alternative would have lower streamflow in May, but higher streamflow in June and July than the No Action Alternative. All Action Alternatives would have between 6 and 14 percent higher streamflow in August. Summaries of average monthly streamflow for tributaries and average monthly streamflow depth at the streamflow gaging stations are presented in Appendix E.

A summary of average annual streamflow and direct effects within the Roaring Fork Basin is presented in Table 36. Average annual streamflow for the No Action Alternative would be slightly lower than Existing Conditions due to slight increases in transmountain diversions resulting from higher future demand by Twin Lakes Project shareholders. Average annual streamflow for all Action Alternatives would generally be slightly higher than that for the No Action Alternative as a result of slightly lower Western Slope diversions than the No Action Alternative. Effects would be greatest for the Participants' Proposed Action, Wetland, Arkansas River, and Downstream Intake alternatives, with up to 4 cfs higher streamflows relative to the No Action Alternative. Effects would be the lowest for the Highway 115 Alternative, with up to a 1 cfs increase in average annual streamflow. Twin Lakes Project diversions would be slightly lower for the Action Alternatives than the No Action Alternatives because the Action Alternatives would be able to more fully divert

Table 36. Average Annual Simulated Streamflow Direct Effects – Roaring Fork River and Tributaries.

Streamflow Location	Existing Conditions	Alt 1	Alt 2	Alt 3	Alt 4	Alt 5	Alt 6	Alt 7
Simulated Streamflow (cfs)								
Roaring Fork River above Difficult Creek near Aspen	75	69	73	73	73	72	73	70
Roaring Fork above Confluence with Lost Man Ck	9	8	9	9	9	9	9	8
Lost Man Ck at Confluence with Roaring Fork	10	9	10	10	10	10	10	9
Roaring Fork above Confluence with Lincoln Ck	19	18	19	19	19	19	19	18
Lincoln Ck below Grizzly Reservoir	15	14	15	15	15	14	15	14
Lincoln Ck above Confluence with New York Ck	20	18	19	19	19	19	19	18
Tabor Ck at Confluence with Lincoln Ck	3	3	3	3	3	3	3	3
Brooklyn Ck at Confluence with New York Ck	3	3	3	3	3	3	3	3
New York Ck above Confluence with Brooklyn Ck	3	3	3	3	3	3	3	3
New York Ck at Confluence with Lincoln Ck	7	6	7	7	7	7	7	7
Lincoln Ck at Confluence with Roaring Fork	33	30	32	32	32	32	32	31

and use reusable return flows to extinction, resulting in slightly less demand for Twin Lakes Project water.

Average monthly streamflow direct effects for the Roaring Fork River above Difficult Creek are provided in Table 37. Monthly average streamflow for the No Action Alternative would be similar to streamflow for Existing Conditions, with slightly lower monthly streamflow from May through July relative to Existing Conditions. Most of the effects on monthly streamflow for the Action Alternatives would be greater streamflow, and would occur from May to July when water availability is highest. Average monthly streamflow would be between 4 and 11 percent higher for all Action Alternatives except the Highway 115 Alternative relative to the No Action Alternative for these months. The Highway 115 Alternative would result in streamflows that are similar to the No Action Alternative during all months.

A summary of average annual streamflow direct effects within the Ivanhoe Creek Basin is presented in Table 38. Average annual streamflow for the No Action Alternative would be slightly lower than streamflow under Existing Conditions, indicative of increased Western Slope diversions under the alternative. Average annual streamflow for the Action Alternatives would be about the same or slightly higher than that for the No Action Alternative as a result of slightly lower Western Slope diversions for the Action Alternatives. Effects would be lowest for the Participants' Proposed Action and the Highway 115 alternatives. Streamflow for the remaining Action Alternatives would be up to 1 cfs higher streamflow relative to the No Action Alternative. None of the Project Participants own or use water from the Busk-Ivanhoe system. Effects on the Busk-Ivanhoe system would be due to modified operations by the owners of the Busk-Ivanhoe system resulting from the operations of SDS components.

Monthly average streamflow for the No Action Alternative would be similar to streamflow for Existing Conditions, with 1 to 6 cfs lower monthly streamflow from May through August relative to Existing Conditions. Average monthly streamflow would generally be 1 to 5 cfs higher for the Action Alternatives relative to the No Action Alternative from May through August. Average monthly streamflow and streamflow depth are presented in Appendix E.

Arkansas River Upstream of Colorado 115

The No Action Alternative would have up to 65 cfs greater average annual streamflow than Existing Conditions between Twin Lakes and the Ark-Otero Intake (Lake Creek Gage and Granite Gage, Table 33). This would be due to releases from upper Arkansas River Basin reservoirs to the untreated water intake simulated in the No Action Alternative. Below the Ark-Otero Intake, the combination of increased exchanges to the Ark-Otero Intake and the releases to the Highway 115 Intake would result in an 8-cfs annual average streamflow increase for the No Action Alternative compared to Existing Conditions.

The Action Alternatives would result in decreases in streamflow relative to the No Action Alternative. At the Lake Fork below Turquoise Lake Gage, effects would be minimal. However, between Twin Lakes and the Ark-Otero Intake (Lake Creek Gage and Granite Gage), average annual streamflow would be up to 68 cfs lower than the No Action Alternative for all Action Alternatives except the Highway 115 Alternative. The Highway 115 Alternative would be operated very similarly to the No Action Alternative.

Table 37. Average Monthly Direct Effects Streamflow – Roaring Fork above Difficult Creek.

Month	Overall Average Conditions							
	Existing Conditions	Alt 1	Alt 2	Alt 3	Alt 4	Alt 5	Alt 6	Alt 7
Simulated Streamflow (cfs)								
Oct	31	31	31	31	31	31	31	31
Nov	22	22	22	22	22	22	22	22
Dec	18	18	18	18	18	18	18	18
Jan	15	15	15	15	15	15	15	15
Feb	15	15	15	15	15	15	15	15
Mar	17	17	17	17	17	17	17	16
Apr	32	32	32	32	32	32	32	32
May	143	129	139	139	138	139	140	129
Jun	346	299	325	333	330	320	330	303
Jul	158	151	158	161	161	158	159	155
Aug	58	58	58	58	58	58	58	58
Sep	40	40	40	40	40	40	40	40
Mean	75	69	73	73	73	72	73	70
Effects (Alternative - Alternative 1)								
Oct	---	---	0	0	0	0	0	0
Nov	---	---	0	0	0	0	0	0
Dec	---	---	0	0	0	0	0	0
Jan	---	---	0	0	0	0	0	0
Feb	---	---	0	0	0	0	0	0
Mar	---	---	0	0	0	0	0	0
Apr	---	---	0	0	0	0	0	0
May	---	---	10	10	9	10	11	1
Jun	---	---	25	34	31	20	31	3
Jul	---	---	7	10	10	7	9	4
Aug	---	---	0	0	0	0	0	-1
Sep	---	---	0	0	0	0	0	0
Mean	---	---	4	4	4	3	4	1
Effects % [(Alternative - Alternative 1) / Alternative 1]								
Oct	---	---	-1%	-1%	-1%	-1%	-1%	0%
Nov	---	---	1%	0%	0%	0%	0%	0%
Dec	---	---	0%	0%	0%	0%	0%	0%
Jan	---	---	0%	0%	0%	0%	0%	0%
Feb	---	---	1%	1%	1%	1%	1%	-1%
Mar	---	---	1%	1%	1%	1%	1%	0%
Apr	---	---	0%	0%	0%	0%	0%	0%
May	---	---	8%	7%	7%	8%	9%	0%
Jun	---	---	8%	11%	10%	7%	10%	1%
Jul	---	---	5%	7%	7%	4%	6%	3%
Aug	---	---	0%	0%	0%	0%	0%	-1%
Sep	---	---	0%	0%	0%	0%	0%	0%
Mean	---	---	5%	6%	6%	5%	6%	1%

Western Slope streamflow and differences in cfs are rounded values to reflect accuracy of measurements and calculations. Percent differences are based on unrounded values to reflect relative differences between alternatives.

Table 38. Average Annual Simulated Streamflow Direct Effects – Ivanhoe Creek.

Streamflow Location	Existing Conditions	Alt 1	Alt 2	Alt 3	Alt 4	Alt 5	Alt 6	Alt 7
Simulated Streamflow (cfs)								
Ivanhoe Creek near Nast	6	5	5	5	5	5	6	5
Ivanhoe Creek at Confluence with Fryingpan River	19	17	17	18	18	18	18	17

The Highway 115 Alternative would have slightly greater releases from upper Arkansas River Basin storage than the No Action Alternative, resulting in greater average annual streamflow at the Lake Creek Gage and the Granite Gage. Average monthly streamflow and streamflow depth for overall average, dry-year, and wet-year conditions at the Lake Creek and Granite gages is presented in Appendix E.

Average annual streamflow between the Ark-Otero Intake and the Highway 115 Intake sites (represented by the Wellsville Gage) would be between 3 and 11 cfs lower than the No Action Alternative for all Action Alternatives (Table 33). Slight differences between alternatives would be attributed to differences in the exchanges of reusable return flows to the upper Arkansas River Basin. Overall average monthly streamflow at the Wellsville Gage is presented in Table 39, while a boxplot depicting daily streamflow and median values is presented in Figure 46. Average monthly dry- and wet-year streamflow and streamflow depth at the Wellsville Gage are presented in Appendix E.

All Action Alternatives would have slightly lower streamflow than the No Action Alternative. Median flows for all Action Alternatives would be up to 29 cfs lower than the No Action Alternative and overall average annual streamflow would be up to 11 cfs (2 percent) lower than the No Action Alternative. The Participants' Proposed Action, Fountain Creek, and Downstream Intake alternatives would have lower streamflow than the No Action Alternative because of increased releases from Colorado Springs' upper Arkansas River Basin storage accounts to supplement diversions by the SDS Project. The Wetland Alternative and Arkansas River Alternative, would have the lowest streamflow because return flows from Colorado Springs would accrue to (i.e., be added to) the Arkansas River and Pueblo Reservoir upstream of the SDS Project intake via a return flow pipeline, thus requiring fewer releases from Colorado Springs' upper Arkansas River Basin storage accounts to supplement SDS Project diversions. The Highway 115 Alternative would have the highest streamflow of the Action Alternatives because of continuous releases from upper basin storage to meet SDS diversion supply needs. The Highway 115 Alternative would result in lower streamflow than the No Action Alternative because more exchanges would be made to the Ark-Otero Intake due to excess capacity storage in Pueblo Reservoir.

Table 39. Average Monthly Streamflow Direct Effects – Wellsville Gage.

Month	Existing Conditions	Alt 1	Alt 2	Alt 3	Alt 4	Alt 5	Alt 6	Alt 7
Simulated Streamflow (cfs)								
Oct	386	448	403	385	385	397	386	447
Nov	424	461	435	429	428	435	429	446
Dec	412	426	422	412	412	423	412	376
Jan	394	395	390	393	391	393	391	365
Feb	358	335	347	351	351	348	350	330
Mar	339	328	344	335	339	343	348	361
Apr	350	338	348	342	343	346	346	359
May	879	883	873	872	868	882	869	859
Jun	1,996	1,923	1,961	1,988	1,983	1,949	1,993	1,926
Jul	1,350	1,342	1,352	1,345	1,349	1,355	1,357	1,379
Aug	791	823	802	790	791	806	794	824
Sep	431	501	450	430	430	449	436	500
Average	677	685	678	674	674	678	677	682
Difference in Streamflow (cfs) (Alternative - Alternative 1)								
Oct	---	---	-45	-62	-63	-51	-61	0
Nov	---	---	-27	-32	-33	-26	-33	-15
Dec	---	---	-5	-14	-14	-4	-14	-50
Jan	---	---	-5	-2	-4	-2	-5	-31
Feb	---	---	12	16	16	13	15	-5
Mar	---	---	16	6	10	14	20	32
Apr	---	---	10	4	5	8	9	21
May	---	---	-10	-12	-16	-1	-14	-24
Jun	---	---	38	65	60	26	70	3
Jul	---	---	10	3	7	13	15	36
Aug	---	---	-21	-33	-32	-17	-29	1
Sep	---	---	-51	-71	-71	-53	-66	-1
Average	---	---	-7	-11	-11	-7	-8	-3
Difference in Streamflow (%) [(Alternative-Alternative 1) / Alternative 1]								
Oct	---	---	-10%	-14%	-14%	-11%	-14%	0%
Nov	---	---	-6%	-7%	-7%	-6%	-7%	-3%
Dec	---	---	-1%	-3%	-3%	-1%	-3%	-12%
Jan	---	---	-1%	-1%	-1%	-1%	-1%	-8%
Feb	---	---	4%	5%	5%	4%	5%	-2%
Mar	---	---	5%	2%	3%	4%	6%	10%
Apr	---	---	3%	1%	2%	2%	3%	6%
May	---	---	-1%	-1%	-2%	0%	-2%	-3%
Jun	---	---	2%	3%	3%	1%	4%	0%
Jul	---	---	1%	0%	0%	1%	1%	3%
Aug	---	---	-3%	-4%	-4%	-2%	-3%	0%
Sep	---	---	-10%	-14%	-14%	-10%	-13%	0%
Average	---	---	-1%	-2%	-2%	-1%	-1%	0%

A summary of the percent of time that the UAVFMP minimum aquatic habitat and recreational flows would be met for each of the alternatives is presented in Table 40, while a summary of annual releases from upper basin storage reservoirs is presented in Table 41. As discussed in Section 3.2.6.1, the UAVFMP comprises several different flow targets that vary throughout the year. The Daily Model directly simulates the year-round and recreational flow targets. The Daily Model simulates releases during the incubation flow period, but the target releases are calculated based on historical release patterns, which generally result in steady releases that are close to those targeted by the UAVFMP. The spring flow maximum target of 400 cfs is not directly simulated in the model. The range of flow targets during the spring period would be met during slightly more than half of the days for Existing Conditions and all alternatives.

Overall, the effect of the No Action Alternative would be a reduction of about 2 percent in the amount of time that the year-round and recreational flow targets are met, and a 4 percent reduction in the amount of time that overall flow target flows are met relative to Existing Conditions. The effects of the Action Alternatives would be increases in the amount of time that the year-round target flows would be met when compared with the No Action Alternative. For recreational flows, all of the Action Alternatives that include participation in the UAVFMP (all Action Alternatives except the Participants' Proposed Action) would result in nearly the same number of days or slightly more days that the recreational flow targets are met. The Participants' Proposed Action would meet the recreational flow

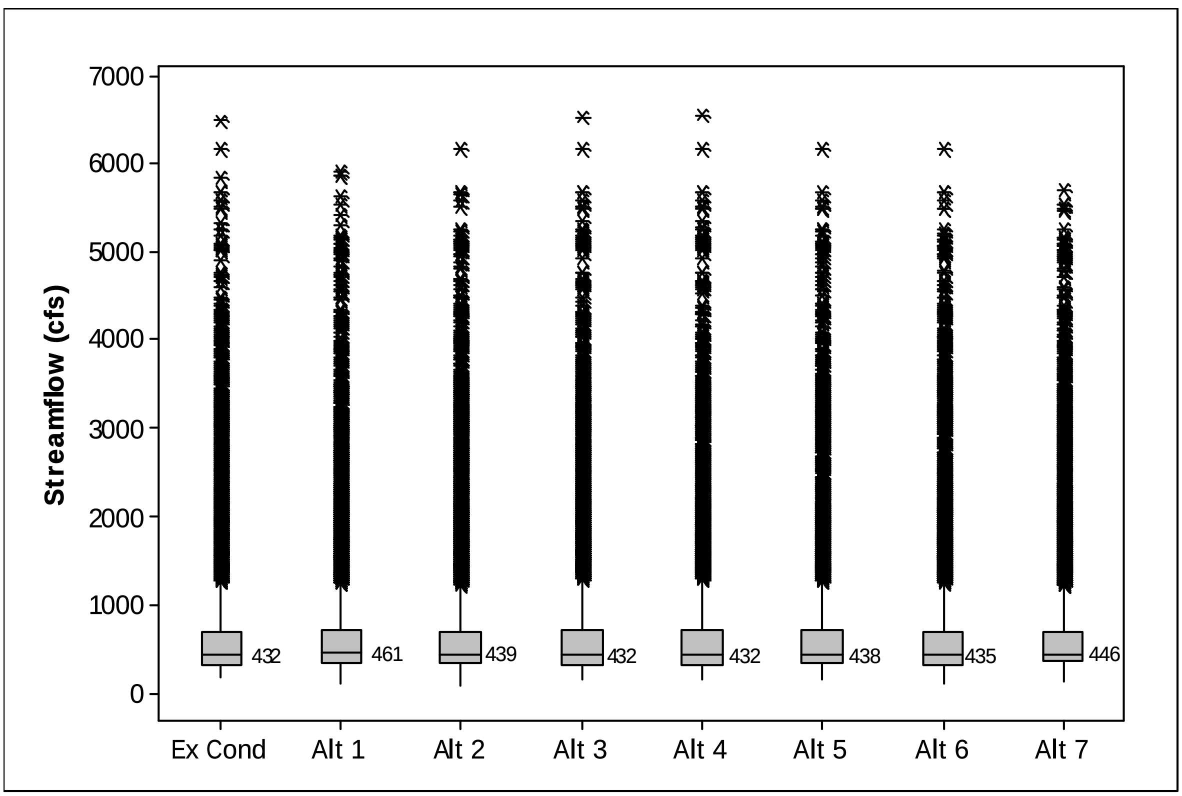


Figure 46. Boxplot of Daily Direct Effects Analysis Streamflow – Arkansas River near Wellsville Gage.

Table 40. Percent of Time UAVFMP Target Flows Met under Direct Effects – Arkansas River near Wellsville.

Target	Existing Conditions†	Alt 1	Alt 2	Alt 3†	Alt 4†	Alt 5†	Alt 6†	Alt 7†
Year-round flow (250 cfs) ‡	95%	93%	95%	95%	95%	95%	95%	96%
Winter incubation flows §								
Minimum flow depth	89%	74%	88%	89%	89%	89%	89%	75%
Minimum flow	91%	84%	91%	91%	91%	92%	91%	88%
Spring flows (250 cfs - 400 cfs)								
Overall	53%	50%	51%	56%	56%	53%	57%	55%
Greater than minimum flow ‡	90%	86%	87%	89%	90%	89%	91%	94%
Less than maximum flow	63%	65%	64%	67%	67%	64%	66%	61%
Recreation flow (700 cfs) ‡	91%	91%	88%	91%	91%	90%	91%	92%
Flow fluctuations (<15%)	87%	85%	84%	87%	87%	85%	87%	85%
Overall *	79%	75%	76%	79%	79%	77%	79%	76%
Overall (250 cfs/700 cfs) Φ	94%	92%	94%	94%	94%	94%	95%	95%

† UAVFMP is in effect.

‡ Directly simulated as a flow target in Daily Model.

§ Daily Model configured to simulate approximate patterns of historical releases during incubation period as determined through calibration process.

* Includes all target flow components.

Φ Includes only those flows directly simulated in the Daily Model (year-round and recreation flows).

Table 41. Annual Summary of Direct Effects Reservoir Releases and Storage Volumes.

Fry-Ark Release Component	Existing Conditions†	Alt 1	Alt 2	Alt 3†	Alt 4†	Alt 5†	Alt 6†	Alt 7†
Average Annual Volume Released								
Total UAVFMP (ac-ft)	8,900	8,600	9,200	8,400	8,400	7,700	8,500	4,900
Recreation Flows (ac-ft)	7,200	5,900	7,500	6,600	6,700	6,200	6,900	3,300
Percent of years > 10,000 ac-ft ‡	30%	26%	30%	26%	26%	26%	26%	9%
July 1 Fry-Ark Contents in Upper Basin Reservoirs								
Average (ac-ft)	65,000	71,500	67,100	66,000	66,100	67,700	66,400	66,500
Minimum (ac-ft)	30,800	51,500	32,400	33,400	33,200	36,000	33,400	43,400

† UAVFMP is in effect.

‡ Includes releases during recreation period only.

targets about 2 percent less time than the No Action Alternative. This corresponds to an average of about 1 day per year. Typically, the days in which flow targets would not be met for all alternatives would be during dry years, such as during drought conditions in 2002 and 2003. All Action Alternatives would meet the incubation flow targets more often than the No Action Alternative, with all Action Alternatives except the Highway 115 Alternative, which would meet the incubation flow targets up to 7 percent more often than the No Action Alternative.

The contract exchanges proposed as part of all Action Alternatives would have no effect on Reclamation's ability to make releases to meet the UAVFMP targets. Average annual releases to meet the target flows would vary between alternatives because of operations of other systems and the corresponding effects on flows upstream of Pueblo Reservoir, not because of Fry-Ark water availability in upper basin storage. The minimum amount of Fry-Ark storage in upper basin reservoirs available on July 1 to meet recreational targets would be greater than 30,000 ac-ft in all alternatives, which is greater than the 10,000 ac-ft that Reclamation has committed to the recreational flow targets plus the amount needed to meet the other flow targets during the remainder of the year. July 1 Fry-Ark storage contents in upper basin reservoirs for the No Action Alternative would be higher than Existing Conditions. All Action Alternatives would have lower July 1 Fry-Ark storage contents in upper basin reservoirs than the No Action Alternative, but slightly higher contents than Existing Conditions. See subsequent subsections for further discussion of storage contents.

While the effects displayed in this section for the Participants' Proposed Action were simulated without the UAVFMP, the potential hydrologic effects of the Participants' Proposed Action also were evaluated with the UAVFMP to better understand the impacts of the program on exchange potential between Pueblo Reservoir and the upper Arkansas River Basin facilities (MWH 2008d). The primary effect of participation in the UAVFMP would be an increase of about 2 percent (average of 1 day per year) in the amount of time the recreational flow targets would be met when compared with the Participants' Proposed Action without the UAVFMP. The Participants' Proposed Action with the UAVFMP would be nearly identical to Existing Conditions in terms of the frequency of meeting the remaining flow targets. Although not analyzed using the Daily Model, if participation in the UAVFMP were not simulated for the Wetland, Arkansas River, Fountain Creek, Downstream Intake, or Highway 115 alternatives, reductions in the amount of time that flow targets would be met would be of a magnitude similar to that described for the Participants' Proposed Action.

Average annual streamflow depths at Lake Creek and Granite would increase by up to 0.3 feet for the No Action Alternative relative to Existing Conditions, and be reduced by up to 0.3 feet relative to the No Action Alternative for all Action Alternatives except the Highway 115 Alternative. The Highway 115 Alternative would not affect average annual streamflow depths at Lake Creek or Granite compared to the No Action Alternative. Streamflow depths would not substantially change between the Ark-Otero Intake and the Highway 115 Intake for any alternative relative to the No Action Alternative.

During dry years, effects at the Wellsville Gage would be about the same as the overall average effects for the Fountain Creek Alternative, slightly less effect than the overall average for the Highway 115 alternatives, and slightly more effect than the overall average for the remaining Action Alternatives. During wet years, there would be no effects for the Fountain Creek and Highway 115 alternatives, slight increases (2 to 3 cfs) for the Participants' Proposed Action and Downstream Intake alternatives, and slight decreases (-5 to -6 cfs) for the Wetland and Arkansas River alternatives. Differences in streamflow among alternatives for dry and wet years would be primarily due to slight differences in timing of exchanges to upper basin storage.

Arkansas River from Colorado 115 to Pueblo Reservoir

Streamflow in the Arkansas River between the potential SDS Project Highway 115 Intake and Pueblo Reservoir would be affected by changes in river operations, releases of SDS Project return flows through the return flow pipeline Wetland and Arkansas River alternatives), and diversions at the potential Highway 115 Intake (No Action and Highway 115 alternatives). Median daily streamflow at the Portland Gage is presented in Figure 47. Average monthly streamflow and streamflow depth for overall average, dry-year and wet-year conditions at the Portland Gage are presented in Appendix E.

For the No Action Alternative, average annual streamflow at the Portland Gage would be 63 cfs lower than Existing Conditions. Average annual streamflow at the Portland Gage would be up to 155 cfs greater than the No Action Alternative for the Action Alternatives except for the Highway 115 Alternative (Table 33). The lowest flows would occur under the No Action Alternative and the Highway 115 Alternative due to increased exchanges to facilities in the upper Arkansas River Basin and the diversion upstream of the gage to the

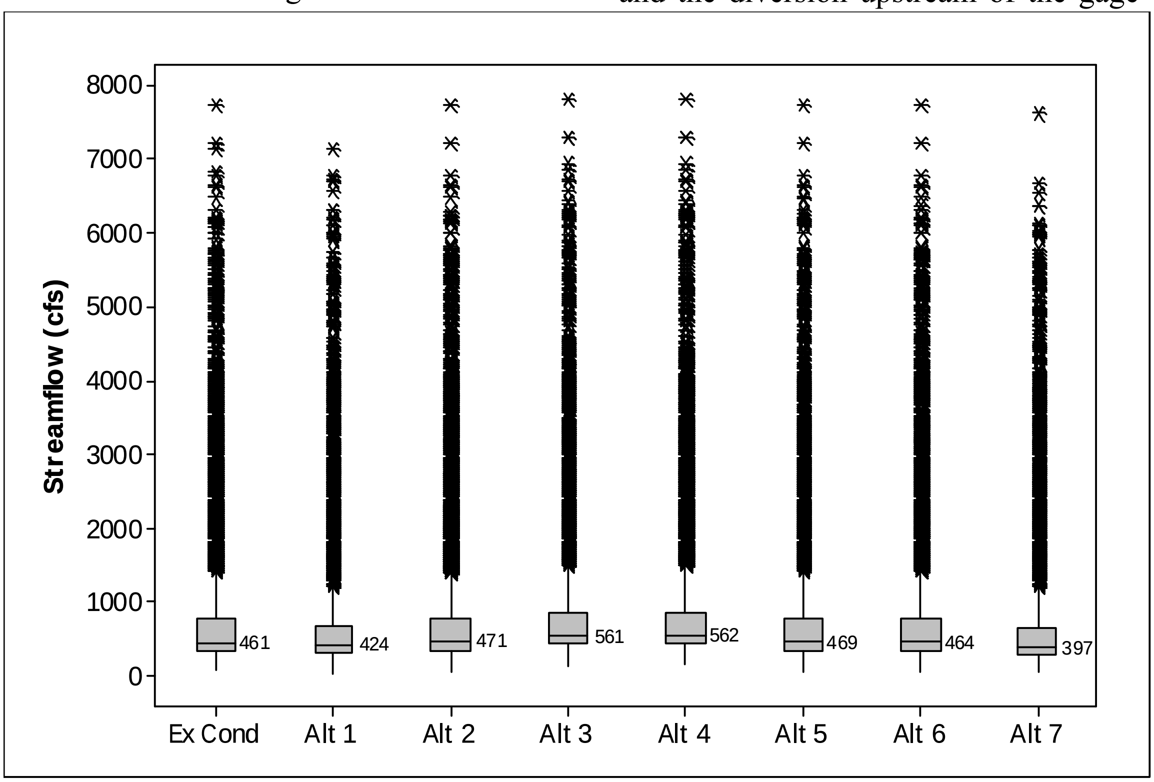


Figure 47. Boxplot of Daily Direct Effects Analysis Streamflow – Arkansas River at Portland.

Highway 115 Intake.

Median daily streamflow for the Wetland Alternative and the Arkansas River Alternative would be about 137 cfs higher than the No Action Alternative. Both of these alternatives incorporate a return flow pipeline that would release reusable return flows from Fountain Creek to the Arkansas River at Colorado 115 near Florence above the Portland Gage. The reusable return flows would flow through this stream reach to the untreated water intake at Pueblo Dam (Wetland Alternative) or immediately upstream of the confluence with Fountain Creek (Arkansas River Alternative). Therefore, all water diverted for these alternatives would flow through this stream reach.

The Participants' Proposed Action, Fountain Creek, and Downstream Intake alternatives would have median daily streamflow that would be between 40 and 47 cfs greater than the No Action Alternative. This increase would be due to differences in the amount of water that would be exchanged from the Pueblo Reservoir to upper Arkansas River Basin storage among the alternatives. For the No Action Alternative, all reusable return flows must be exchanged to the Ark-Otero Intake or the upper Arkansas River Basin storage facilities before they could be brought into the Participants' untreated water systems.

Median daily streamflow for the Highway 115 Alternative would about 27 cfs lower than the No Action Alternative. The Highway 115 Alternative would exchange more reusable return flows to upper Arkansas River Basin facilities than the No Action Alternative. Both alternatives are configured similarly, except that the Highway 115 Alternative would have storage in Pueblo Reservoir and would comply with the UAVFMP target flows. Storage in Pueblo Reservoir would facilitate exchanges to the Ark-Otero Intake or into upper Arkansas River Basin storage, allowing the Highway 115 Alternative to exchange more than the No Action Alternative, despite the UAVFMP. Due to the increased exchanges, the Highway 115 Alternative would result in the lowest median streamflow of all the alternatives.

Exchange decrees held by Colorado Springs and Aurora contain stipulations that prohibit exchanges when the exchanges would cause flows at the Fremont County Rainbow Park WWTF to drop below 190 cfs or would cause flows at the Salida WWTF to drop below a range of 180 cfs to 239 cfs, depending on the time of year. These stipulations are included in the Daily Model for Colorado Springs' and Aurora's exchanges. Existing Conditions and the Action Alternatives would result in flows at the Portland Gage (closest downstream gage to the Rainbow Park WWTF) equal to or greater than 190 cfs more than 98 percent of the time, while the No Action Alternative would result in flows of 190 cfs 97 percent of the time. The No Action Alternative would be slightly lower due to decreased releases of Fry-Ark water to meet Wellsville target flow requirements for the No Action Alternative. The Wetland and Arkansas River alternatives would result in flows of 190 cfs at the Portland Gage nearly 100 percent of the time due to releases from the return flow pipeline. At the Salida WWTF, streamflows for Existing Conditions and all alternatives at the Wellsville gage (closest downstream gage to the WWTF) would exceed the target flows of 180 cfs to 239 cfs nearly 100 percent of the time.

Depths at the Portland Gage would be about 0.1 feet lower than Existing Conditions under the No Action Alternative and 0.1 to 0.2 feet higher than the No Action Alternative for all Action Alternatives except the Highway 115 Alternative. The Highway 115 Alternative would have depths about 0.1 feet lower than the No Action Alternative.

During dry years, effects at the Portland Gage would be slightly less than the overall average effects for all Action Alternatives, while during wet years, effects would be slightly greater than the overall average effects for all alternatives.

Arkansas River from Pueblo Reservoir to Fountain Creek

Due to the location of SDS Project intakes, return flow points, and operations of exchanges to provide water supply for the SDS Project, streamflow in the Arkansas River between Pueblo Reservoir and Fountain Creek would vary substantially among alternatives. A monthly summary of streamflow at the Above Pueblo Gage is presented in Table 42, while median daily streamflows for all alternatives are presented in Figure 48. Average monthly streamflow and streamflow depth for overall average, dry, and wet-year conditions is presented in Appendix E.

The No Action Alternative would have lower average annual streamflow than Existing Conditions because it would require exchanges through this reach. For those alternatives with an intake upstream of the Above Pueblo Gage (i.e., Pueblo Dam and Highway 115) and a return flow accrual location downstream of the Above Pueblo Gage (i.e., Fountain Creek), exchanges cause depletions of streamflow within the reach. For those alternatives with an intake below the Above Pueblo Gage (i.e., upstream or downstream of the Fountain Creek confluence) and a return flow accrual location upstream of the Above Pueblo Gage (i.e., Colorado 115), delivery of water from the return flow accrual location to the untreated water intake location would cause a general increase in flows through this reach and at the Above Pueblo Gage. Alternatives with the intake and accrual locations either both upstream or both downstream of the gage would have the least effect.

Median daily streamflow at the Above Pueblo Gage for the No Action Alternative would be about 60 cfs less than Existing Conditions, while average annual streamflow would be about 69 cfs less. This decrease would be due to increased exchanges from Fountain Creek to the upper Arkansas River Basin. Differences between the No Action Alternative and Existing Conditions would be the greatest in the summer months when most exchanges are being made within the reach between Pueblo Reservoir and Fountain Creek.

The Participants' Proposed Action, Fountain Creek, and Highway 115 alternatives would result in an overall decrease in median daily streamflow relative to the No Action Alternative. Each of these alternatives would include an intake at or upstream of Pueblo Dam with return flow locations at Fountain Creek. Consequently, all reusable return flows would be exchanged into Pueblo Reservoir causing streamflow depletions within the exchange reach. Exchanges would be greater for these alternatives than the No Action Alternative primarily due to the availability of excess storage capacity in Pueblo Reservoir to store exchanged water. Effects would be the greatest from April through July when a majority of the exchanges from return flow storage would occur. The greatest percentage of effects would occur in the spring and fall when reusable return flow exchanges would be made while native streamflow is lower.

Table 42. Average Monthly Streamflow Direct Effects – Above Pueblo Gage.

Month	Existing Conditions	Alt 1	Alt 2	Alt 3	Alt 4	Alt 5	Alt 6	Alt 7
Simulated Streamflow (cfs)								
Oct	279	249	196	283	394	202	294	211
Nov	244	216	181	248	329	180	249	198
Dec	151	138	132	158	200	131	140	125
Jan	162	148	135	169	201	132	143	131
Feb	196	168	170	203	227	168	168	164
Mar	256	207	219	297	337	225	228	171
Apr	569	480	426	572	660	436	555	456
May	1,053	899	874	1,061	1,176	870	1,067	926
Jun	2,098	1,933	1,953	2,103	2,224	1,943	2,105	1,962
Jul	1,366	1,241	1,251	1,354	1,471	1,251	1,366	1,242
Aug	866	784	761	836	951	762	861	769
Sep	311	273	256	317	415	251	331	251
Average	631	562	547	635	717	547	627	552
Difference in Streamflow (cfs) (Alternative - Alternative 1)								
Oct	---	---	-54	34	145	-48	45	-38
Nov	---	---	-35	33	114	-35	33	-18
Dec	---	---	-5	21	62	-6	3	-13
Jan	---	---	-13	21	53	-15	-5	-16
Feb	---	---	2	35	59	0	0	-4
Mar	---	---	12	90	129	18	21	-37
Apr	---	---	-53	93	180	-44	75	-23
May	---	---	-25	161	277	-29	167	27
Jun	---	---	20	170	291	10	172	29
Jul	---	---	11	114	231	10	125	2
Aug	---	---	-23	52	167	-22	77	-15
Sep	---	---	-17	44	142	-21	58	-21
Average	---	---	-15	72	154	-15	65	-11
Difference in Streamflow (%) [(Alternative-Alternative 1) / Alternative 1]								
Oct	---	---	-21%	14%	58%	-19%	18%	-15%
Nov	---	---	-16%	15%	53%	-16%	15%	-8%
Dec	---	---	-4%	15%	45%	-5%	2%	-9%
Jan	---	---	-9%	14%	36%	-10%	-3%	-11%
Feb	---	---	1%	21%	35%	0%	0%	-3%
Mar	---	---	6%	43%	62%	9%	10%	-18%
Apr	---	---	-11%	19%	38%	-9%	16%	-5%
May	---	---	-3%	18%	31%	-3%	19%	3%
Jun	---	---	1%	9%	15%	1%	9%	1%
Jul	---	---	1%	9%	19%	1%	10%	0%
Aug	---	---	-3%	7%	21%	-3%	10%	-2%
Sep	---	---	-6%	16%	52%	-8%	21%	-8%
Average	---	---	-3%	13%	27%	-3%	11%	-2%

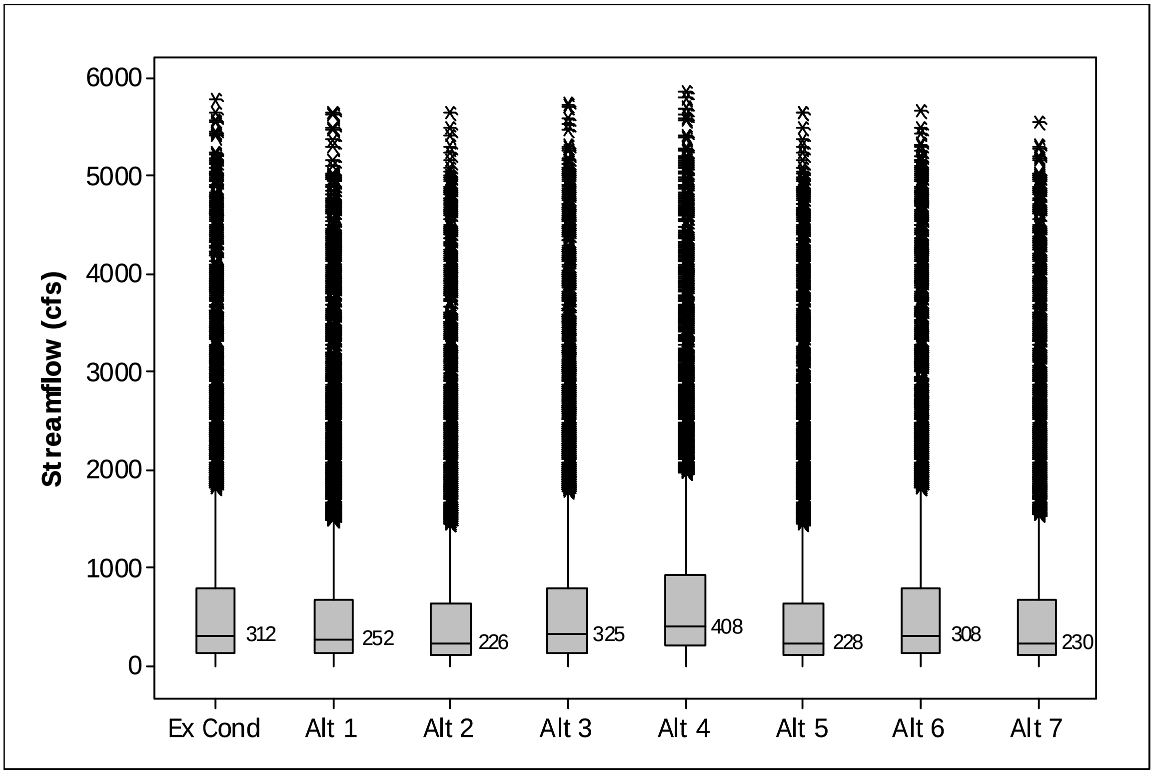


Figure 48. Boxplot of Daily Streamflow Direct Effects – Arkansas River above Pueblo.

Median daily streamflow for the Wetland Alternative would increase by about 73 cfs relative to the streamflow for the No Action Alternative. Both the untreated water intake and return flow pipeline for this alternative would be located upstream of the Above Pueblo Gage, with releases from the Highway 115 Return Flow Pipeline flowing to the intake at Pueblo Dam. The increase in streamflow would occur due to differences in the amount of water that would be exchanged to Pueblo Reservoir. For the No Action Alternative, exchanges would be made from Fountain Creek and Colorado Canal to the upper Arkansas River Basin. For the Wetland Alternative, reusable return flows would be conveyed in the return flow pipeline and the Arkansas River directly to Pueblo Reservoir with no need for exchange. Reduced reusable return flow exchanges would result in slightly higher Colorado Canal exchanges during peak flow months of May and June causing smaller increases or decreases in streamflow.

The Arkansas River Alternative would have the most substantial increase in streamflow among the alternatives, with a median daily streamflow of 156 cfs greater than the median daily streamflow for the No Action Alternative. This increase would occur because reusable return flows would be conveyed to the Arkansas River through the Highway 115 Return Flow Pipeline and would then flow through the city of Pueblo before being diverted by the untreated water intake immediately above the Fountain Creek confluence. Higher streamflow would occur throughout the year.

Compared to the No Action Alternative, the Downstream Intake Alternative would increase streamflow during the summer, fall, and spring months and be about the same during the winter months. Increases in streamflow would primarily occur due to decreased exchanges into Pueblo Reservoir because diversions of reusable return flows from Fountain Creek could be made directly from the Arkansas River without need for exchange to Pueblo Reservoir. During the winter when deliveries through the SDS Project would be less (Appendix D), reusable return flows not directly diverted by the SDS Project would be exchanged upstream to Pueblo Reservoir for storage.

Compared to the No Action Alternative, the Highway 115 Alternative would have lower streamflow. The primary cause of decreased streamflow for the Highway 115 Alternative is that more reusable return flows could be exchanged to Pueblo Reservoir from Fountain Creek into excess capacity storage space in Pueblo Reservoir, whereas the No Action Alternative does not include excess capacity storage space in Pueblo Reservoir. This is the only Action Alternative that would convey return flows down Fountain Creek for exchange into excess capacity storage in Pueblo Reservoir that would not be subject to the PFMP. The Arkansas River and Downstream Intake alternatives, which do not participate in the PFMP, do not need to exchange reusable return flows through this reach and, therefore, would not reduce flows as would the Highway 115 Alternative.

Table 43 summarizes the percentage of time that each alternative would meet the target flows for the PFMP. Overall, target flows would be met about 1.3 percent (average of about 5 days per year) less frequently under the No Action Alternative than Existing Conditions. The No Action Alternative would not include participation in the PFMP. The Participants' Proposed Action, Wetland, Arkansas River, and Fountain Creek alternatives would meet the target flows more frequently than the No Action Alternative or Existing Conditions. The Downstream Intake Alternative would meet the target flows slightly less than the No Action Alternative because exchanges to Pueblo Reservoir would not be restricted by the PFMP target flows. The Highway 115 Alternative would result in a substantial decrease in the amount of time that the target flows would be met. When compared to the No Action Alternative, PFMP target flows would be met 9.2 percent less frequently, or an average of 34 days per year. The Highway 115 Alternative would exchange return flows to excess capacity space in Pueblo Reservoir and then to the upper Arkansas River Basin where the flows could be diverted to the untreated water system. The excess capacity space in Pueblo Reservoir is critical for optimizing exchanges to the upper

Table 43. Percent of Time Target Flows Met for Direct Effects Scenario – Arkansas River above Pueblo at PFMP Measurement Location.

Period	Existing Conditions	Alt 1	Alt 2†	Alt 3†	Alt 4	Alt 5†	Alt 6	Alt 7
Non Winter Water Season	92%	90%	93%	94%	97%	93%	91%	81%
Winter Water Season ‡	69%	68%	72%	74%	83%	72%	63%	58%
Overall	84%	83%	86%	87%	92%	86%	82%	73%

† PFMP is in effect.

‡ Winter Water Season is November 15 through March 15.

Arkansas River Basin. The timing of streamflow available for making exchanges is different upstream and downstream of Pueblo Reservoir. The excess capacity storage in Pueblo Reservoir would allow reusable return flows to be exchanged into the reservoir when exchanges could not be made all the way to the upper Arkansas River Basin. The return flows would then be held in storage until flows between Twin Lakes or the Ark-Otero Intake and Pueblo Reservoir would be favorable for exchanges up basin into the untreated water system.

Changes in streamflow at the Above Pueblo Gage would correspond to changes in streamflow depth. Average annual depth would be 0.2 feet lower for the No Action Alternative than for Existing Conditions. The Participants' Proposed Action, Fountain Creek, Downstream Intake, and the Highway 115 alternatives would have average annual depths about equal to or slightly greater (0.1 feet) than the No Action Alternative. The Wetland and Arkansas River alternatives would have slightly greater average annual depth (0.2 to 0.4 feet).

During dry years, average annual effects would be nearly identical to those described for average years. For wet years, streamflow effects would be less for alternatives that show negative effects when compared with the No Action Alternative (Participants' Proposed Action, Fountain Creek, and Highway 115 alternatives) and greater for alternatives that show positive effects (Wetland, Arkansas River, and Downstream Intake alternatives). This is because of generally slightly higher exchanges during wet years by the No Action Alternative when compared with the Action Alternatives.

Arkansas River Downstream of Fountain Creek

The Avondale Gage is downstream of all proposed SDS Project infrastructure. However, streamflow at the Avondale Gage would be influenced by the operation of alternatives, primarily due to exchanges of Colorado Canal water and exchanges of reusable return flows that may be temporarily stored in the Colorado Canal System or ROY storage. Median daily streamflow for the Avondale Gage is presented in Figure 49, while average monthly streamflow is presented in Table 44. Average monthly streamflow and streamflow depth for overall average, dry, and wet years at the Avondale Gage is presented in Appendix E.

Median daily streamflow at the Avondale Gage for the No Action Alternative would increase by about 1 cfs relative to Existing Conditions, while average daily streamflow would decrease by about 10 cfs. All Action Alternatives would have minor decreases in median and average streamflow relative to the No Action Alternative because excess capacity space in Pueblo Reservoir is not included in the No Action Alternative, resulting in fewer exchanges. More reusable return flows would be passed to Colorado Canal and ROY storage in the No Action Alternative when exchange potential to the upper Arkansas River Basin would be low and there would be no available space in Williams Creek Reservoir (Figure 49). Differences between streamflow for the Action Alternatives and the No Action Alternative would be relatively minor (maximum 19 cfs).

The Participants' Proposed Action and the Fountain Creek alternatives would each have smaller decreases in streamflow than other Action Alternatives during winter months because, like the No Action Alternative, the upstream exchange from the confluence of the Arkansas River and Fountain Creek is a critical

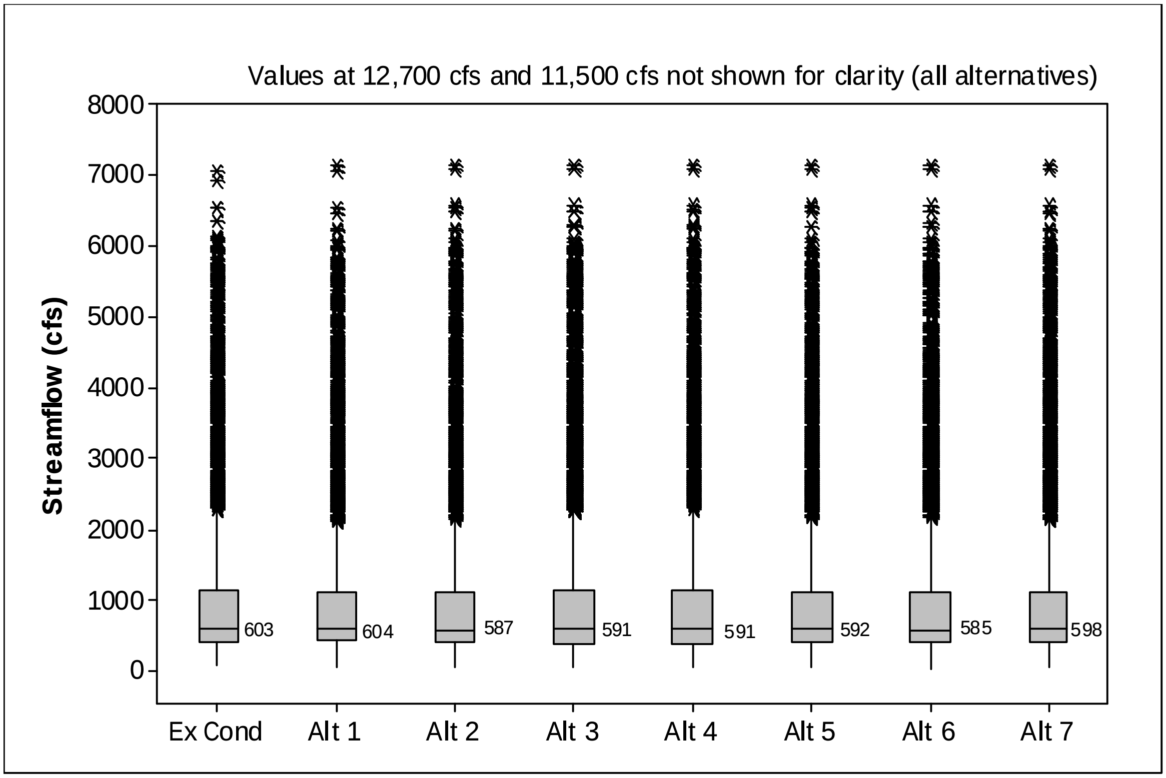


Figure 49. Boxplot of Daily Streamflow Direct Effects – Arkansas River near Avondale.

component of the operations of these alternatives. Occasionally in the winter, reusable return flows could not be exchanged or diverted into return flow storage (because Williams Creek Reservoir would be full); these reusable return flows would be subsequently stored in either ROY storage or the Colorado Canal System. The reusable return flows would then be exchanged during the early spring months, resulting in lower flows compared to the No Action Alternative.

Median daily streamflow for the Wetland Alternative and the Arkansas River Alternative would be lower in the winter months compared to the No Action Alternative because the return flows would be delivered upstream of both the untreated water intake and Pueblo Reservoir storage. Therefore, fewer flows would pass to Colorado Canal or ROY storage during the winter. The flows would be higher in the summer because they would not need to be exchanged from Colorado Canal and ROY storage to Pueblo Reservoir as they would in the No Action Alternative.

The Downstream Intake Alternative would convey reusable return flows to Colorado Canal and ROY storage for subsequent exchange to Pueblo Reservoir in a similar manner as the No Action Alternative. However, the Downstream Intake Alternative would have an untreated water intake downstream of Fountain Creek. Therefore, return flows would only be conveyed to these reservoirs when they are greater than the capacity of the intake.

Table 44. Average Monthly Streamflow Direct Effects — Arkansas River near Avondale Gage.

Month	Existing Conditions	Alt 1	Alt 2	Alt 3	Alt 4	Alt 5	Alt 6	Alt 7
Simulated Streamflow (cfs)								
Oct	539	542	506	518	527	515	517	534
Nov	542	542	531	519	515	537	526	555
Dec	420	434	426	402	395	431	423	443
Jan	435	469	438	416	412	439	442	455
Feb	469	497	471	451	448	473	474	462
Mar	556	564	553	569	567	561	548	563
Apr	939	924	898	924	938	902	916	892
May	1,601	1,557	1,559	1,592	1,596	1,556	1,565	1,554
Jun	2,560	2,486	2,537	2,548	2,555	2,544	2,516	2,505
Jul	1,723	1,676	1,675	1,695	1,697	1,687	1,674	1,665
Aug	1,264	1,244	1,219	1,213	1,214	1,225	1,211	1,230
Sep	584	586	577	566	556	580	560	587
Average	971	961	951	953	953	956	949	955
Difference in Streamflow (cfs) (Alternative - Alternative 1)								
Oct	---	---	-36	-24	-15	-26	-24	-8
Nov	---	---	-11	-23	-26	-5	-16	14
Dec	---	---	-8	-32	-39	-3	-10	9
Jan	---	---	-30	-53	-56	-30	-26	-14
Feb	---	---	-26	-46	-49	-24	-23	-35
Mar	---	---	-11	5	3	-4	-16	-1
Apr	---	---	-26	-1	14	-22	-8	-32
May	---	---	2	35	39	-1	9	-2
Jun	---	---	51	63	69	58	30	20
Jul	---	---	-1	19	21	11	-1	-11
Aug	---	---	-24	-31	-30	-18	-32	-14
Sep	---	---	-9	-19	-30	-5	-25	1
Average	---	---	-11	-9	-8	-6	-12	-6
Difference in Streamflow (%) [(Alternative-Alternative 1) / Alternative 1]								
Oct	---	---	-7%	-4%	-3%	-5%	-4%	-1%
Nov	---	---	-2%	-4%	-5%	-1%	-3%	2%
Dec	---	---	-2%	-7%	-9%	-1%	-2%	2%
Jan	---	---	-6%	-11%	-12%	-6%	-6%	-3%
Feb	---	---	-5%	-9%	-10%	-5%	-5%	-7%
Mar	---	---	-2%	1%	0%	-1%	-3%	0%
Apr	---	---	-3%	0%	1%	-2%	-1%	-3%
May	---	---	0%	2%	3%	0%	1%	0%
Jun	---	---	2%	3%	3%	2%	1%	1%
Jul	---	---	0%	1%	1%	1%	0%	-1%
Aug	---	---	-2%	-2%	-2%	-1%	-3%	-1%
Sep	---	---	-1%	-3%	-5%	-1%	-4%	0%
Average	---	---	-1%	-1%	-1%	-1%	-1%	-1%

The Highway 115 Alternative would operate similarly to the No Action Alternative except that it would have excess capacity storage in Pueblo Reservoir. The excess capacity storage generally allows more of the Participants' water in the Colorado Canal system to be exchanged upstream, resulting in lower flows at the Avondale Gage than the No Action Alternative during most months.

Changes in streamflow at the Avondale Gage would correspond to changes in streamflow depth. Although average monthly depths would vary slightly among alternatives (within 0.1 feet), average annual depth would be nearly identical for Existing Conditions and all alternatives.

During dry years, average annual effects at the Avondale Gage would be greater during dry years (more adverse) by 4 to 8 cfs than during average years. During wet years, average annual streamflow for all Action Alternatives except the Participants' Proposed Action would be 3 to 5 cfs greater than the No Action Alternative. For the Participants' Proposed Action average annual streamflow would be 1 cfs less than the No Action Alternative. The differences from average conditions occur because the No Action Alternative is unable to exchange during many dry years, resulting in higher streamflows than the Action Alternatives. This is made up by generally higher exchanges during wet years for the No Action Alternative, resulting in lower streamflows than the Action Alternatives.

Arkansas River at Las Animas

The Daily Model is constructed to always meet the historical flows at the Las Animas Gage except during times when there is excess streamflow in the river, which is defined as times when the historical call is junior to the John Martin Reservoir water right (typically when John Martin Reservoir is full). This ensures that the Daily Model does not alter operations downstream of the Las Animas Gage. The result of this construction is that simulated streamflow at the Las Animas Gage is not less than historical streamflow at the Las Animas Gage except during wet years when the historical call is junior to the John Martin Reservoir storage priority. Simulated streamflow at the Las Animas Gage is occasionally higher than historical streamflow if excess streamflow could not be diverted by other water rights upstream of Las Animas.

The No Action Alternative would have an average annual streamflow 11 cfs lower than the average annual streamflow for Existing Conditions. For the Action Alternatives, effects at the Las Animas Gage would be within 4 cfs of the No Action Alternative (Table 33). Differences between the alternatives would be relatively minor and would be due primarily to differences in timing of diversions made during periods when the call is junior to the John Martin Reservoir storage rights. Average monthly streamflow and streamflow depth for overall average, dry, and wet years at the Las Animas Gage is presented in Appendix E.

Monument Creek and Fountain Creek Upstream of Las Vegas Street Wastewater Treatment Facility

Average annual streamflow and depth in Monument Creek and Fountain Creek upstream of Colorado Springs' LVSWWTF would be slightly higher for the No Action Alternative than Existing Conditions. Streamflows would be nearly identical to the No Action Alternative for all Action Alternatives. Any minor differences would be due to differences in simulated return flow accrual to the river from the wastewater treatment plants upstream of the LVSWWTF.

Fountain Creek Downstream of the LVSWWTF and Upstream of the Return Flow Reservoir Diversion

The Security Gage is located downstream of LVSWWTF and upstream of the Chilcotte Ditch intake, which would be included in some alternatives to convey reusable return flows to return flow storage. Additionally, this gage is downstream of the proposed intake for the Highway 115 Return Flow Pipeline. Median daily streamflow for the Security Gage is presented in Figure 50. Average monthly streamflow and streamflow depth for overall average, dry- and wet-year conditions at the Security Gage are presented in Appendix E.

Median daily streamflow for the No Action Alternative would be about 68 cfs (53 percent) higher than Existing Conditions due to increased municipal return flows and increased flows from land use changes within the basin. The increases would occur consistently throughout the year. In general, median daily streamflow would be equal to or slightly greater (2 cfs) than the No Action Alternative for those alternatives that do not include the Highway 115 Return Flow Pipeline (Participants' Proposed Action, Fountain Creek, Downstream Intake, and Highway 115 alternatives).

For those alternatives that include the Highway 115 Return Flow Pipeline (Wetland and Arkansas River alternatives), median daily streamflow at the Security Gage would be about 100 cfs, or 49 percent, less than the No Action Alternative. The difference in streamflow is the amount of reusable return flows that the pipeline would divert from Colorado Springs' J.D. Phillips WRF and

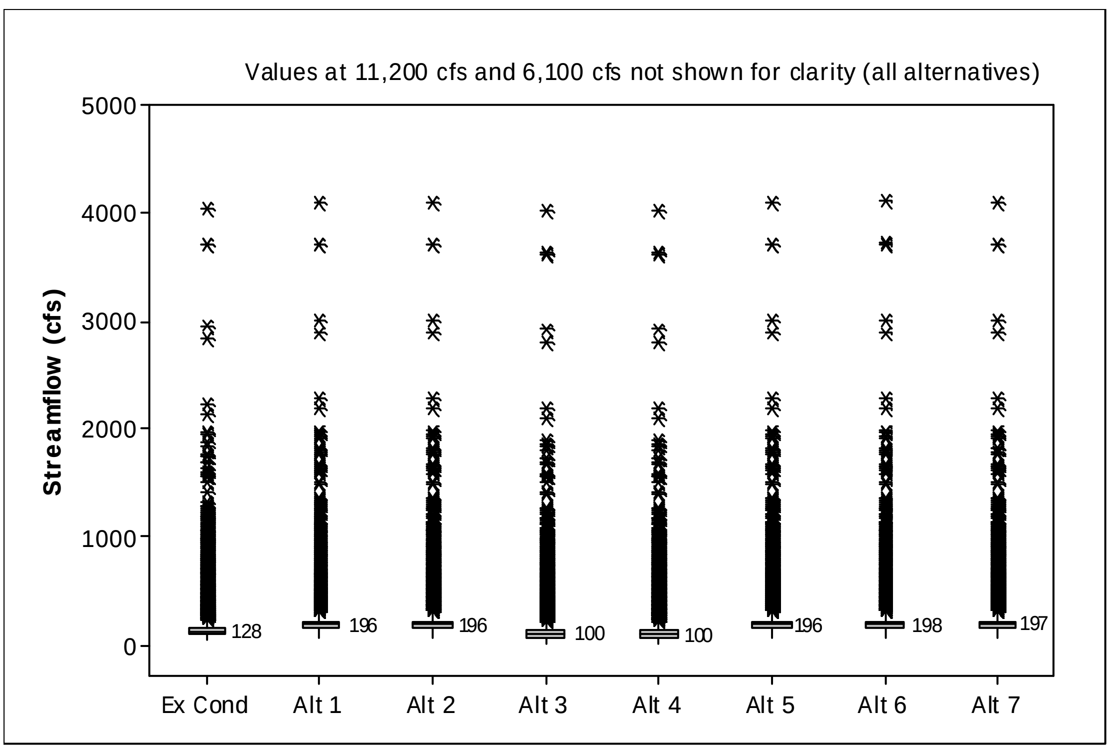


Figure 50. Boxplot of Daily Streamflow Direct Effects – Fountain Creek at Security.

LVSWWTF before the return flows are released to Fountain Creek. Differences in streamflow would remain fairly constant throughout the year, with slightly larger differences during the winter when the proportion of reusable water that would be delivered to the water treatment plants would be slightly higher.

Changes in streamflow at the Security Gage would correspond to changes in streamflow depth. Average annual depths would increase by about 0.2 feet for the No Action Alternative when compared to Existing Conditions. All Action Alternatives would be similar to the No Action Alternative except the Wetland and Arkansas River alternatives. These alternatives would decrease the depth by about 0.4 feet compared to the No Action Alternative.

Because effects of the alternatives are based primarily on wastewater effluent, the effects were assumed to be consistent whether hydrologic conditions are dry or wet, and the effects would be nearly identical to average conditions for both dry- and wet-year conditions

Fountain Creek between Return Flow Reservoir Diversion and Release

There is no streamflow gaging station located between the return flow reservoir diversion location at the Chilcotte Ditch and release location downstream of the Owen & Hall Ditch. However, the Daily Model contains several intermediate nodes between streamflow gaging stations that can be used to estimate streamflow within the reach. For purposes of this reach, Daily Model results for the node immediately above the Williams Creek Return Flow Conveyance Pipeline into Fountain Creek (immediately downstream of the Owen & Hall Ditch) were used to analyze general effects of the alternatives for this reach.

As with the other reaches of Fountain Creek, streamflow and depth for the No Action Alternative would be higher than that for Existing Conditions due to increased return flows in 2046. The increase would be slightly less within this reach (52 cfs) than the upstream or downstream reaches because some of the reusable return flows would be diverted at the Chilcotte Ditch to the return flow storage reservoir.

For the Participants' Proposed Action, streamflow would generally be less through this reach, especially during the winter months, because participation in the PFMP would result in more restrictions on exchanges and increased diversions to the return flow reservoir than the No Action Alternative. Streamflow would be 1 to 10 cfs less in May through September, and December, and be 19 to 35 cfs less during January through April.

As with the Wetland and Arkansas River alternatives, which include the Highway 115 Return Flow Pipeline, the Fountain Creek Alternative would result in 57 to 88 cfs less streamflow during all months of the year because all reusable return flows would be diverted out of Fountain Creek upstream of this reach and delivered to the Arkansas River via a pipeline.

Streamflow for the Downstream Intake Alternative would be higher than the No Action Alternative during all months of the year. From September through January, streamflow would be 19 to 44 cfs higher, while from February through August, streamflow would be 3 to 12 cfs higher. This is because reusable return flows typically would not be diverted to the return flow reservoir for this alternative and would flow through the reach.

For the Highway 115 Alternative, streamflow would vary depending upon the differences in the timing of exchanges compared to those for with the No Action Alternative. Because the Highway 115 Alternative would include an excess capacity storage account in Pueblo Reservoir, more direct exchanges (i.e., exchanges that are not released from return flow storage) could be made during the fall and early winter, resulting in between 23 and 35 cfs greater streamflow from September through December. During the winter months, more water would be stored in the Williams Creek Reservoir, resulting in 31 to 32 cfs less streamflow in February and March, and 6 cfs less during April. The remaining months would have up to 4 cfs more streamflow in this reach due to slight increases in direct exchanges during these months.

Fountain Creek Downstream of Return Flow Reservoir Release

The Fountain Creek at Pueblo Gage is within the city of Pueblo and represents flows in Fountain Creek near its confluence with the Arkansas River. Streamflow at this gage would include the effects of all SDS Project facilities on Fountain Creek. Median streamflow at the Fountain Creek at Pueblo Gage is presented in Figure 51, while average monthly streamflow is presented in Table 45.

Median daily streamflow for the No Action Alternative would be about 61 cfs (43 percent) higher than Existing Conditions. Similar increases would occur in all months. These increases would occur due to increased return flows in 2046.

The Participants' Proposed Action, Downstream Intake, and Highway 115 alternatives would have similar median daily streamflow at the Fountain Creek at Pueblo Gage relative to the No Action Alternative

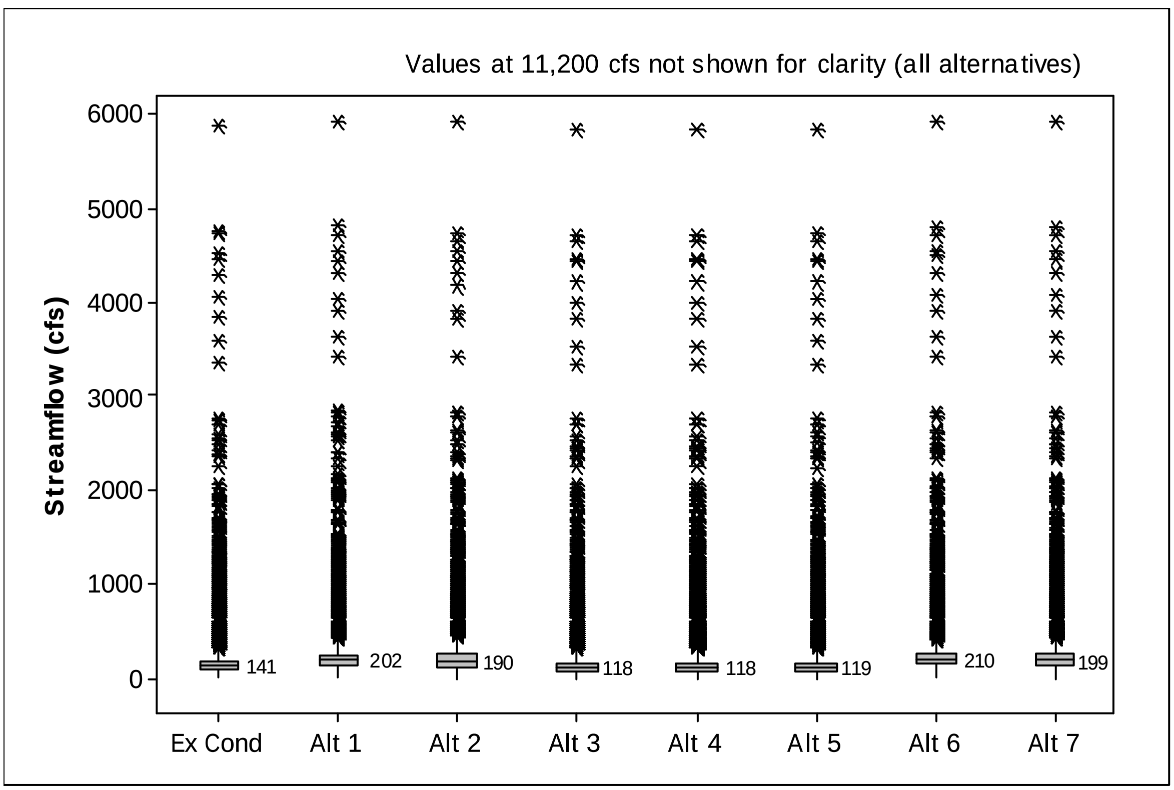


Figure 51. Boxplot of Daily Streamflow Direct Effects – Fountain Creek at Pueblo.

Table 45. Average Monthly Streamflow Direct Effects – Fountain Creek at Pueblo Gage.

Month	Existing Conditions	Alt 1	Alt 2	Alt 3	Alt 4	Alt 5	Alt 6	Alt 7
Simulated Streamflow (cfs)								
Oct	138	173	189	114	114	112	209	203
Nov	168	199	222	143	144	143	239	230
Dec	150	180	177	127	127	126	219	202
Jan	152	202	184	128	128	127	220	206
Feb	162	221	191	138	138	137	226	190
Mar	179	239	214	153	153	153	247	277
Apr	196	271	298	179	179	189	265	264
May	307	419	446	294	294	311	375	389
Jun	269	361	393	255	255	269	335	351
Jul	180	259	248	166	166	167	248	246
Aug	231	294	292	211	211	211	298	294
Sep	125	167	175	104	104	106	192	190
Average	188	249	253	168	168	171	256	254
Difference in Streamflow (cfs) (Alternative - Alternative 1)								
Oct	---	---	16	-59	-58	-60	36	30
Nov	---	---	24	-55	-55	-56	40	32
Dec	---	---	-2	-53	-53	-54	39	22
Jan	---	---	-18	-74	-74	-75	18	4
Feb	---	---	-30	-83	-83	-84	6	-31
Mar	---	---	-25	-86	-86	-86	8	38
Apr	---	---	27	-92	-92	-83	-6	-8
May	---	---	28	-125	-125	-108	-44	-29
Jun	---	---	32	-106	-106	-92	-26	-10
Jul	---	---	-11	-94	-94	-93	-11	-14
Aug	---	---	-2	-83	-83	-83	4	0
Sep	---	---	8	-63	-63	-61	26	23
Average	---	---	4	-81	-81	-78	7	5
Difference in Streamflow (%) [(Alternative-Alternative 1) / Alternative 1]								
Oct	---	---	9%	-34%	-34%	-35%	21%	18%
Nov	---	---	12%	-28%	-28%	-28%	20%	16%
Dec	---	---	-1%	-29%	-29%	-30%	22%	12%
Jan	---	---	-9%	-37%	-37%	-37%	9%	2%
Feb	---	---	-13%	-38%	-38%	-38%	3%	-14%
Mar	---	---	-11%	-36%	-36%	-36%	3%	16%
Apr	---	---	10%	-34%	-34%	-31%	-2%	-3%
May	---	---	7%	-30%	-30%	-26%	-10%	-7%
Jun	---	---	9%	-29%	-29%	-25%	-7%	-3%
Jul	---	---	-4%	-36%	-36%	-36%	-4%	-5%
Aug	---	---	-1%	-28%	-28%	-28%	1%	0%
Sep	---	---	5%	-38%	-38%	-37%	15%	14%
Average	---	---	2%	-33%	-33%	-31%	3%	2%

(within 12 cfs). Like the No Action Alternative, these alternatives would include the Williams Creek Return Flow Conveyance Pipeline. All return flows would be conveyed in Fountain Creek and streamflow at the Fountain Creek at Pueblo Gage would be similar to the No Action Alternative.

The Wetland and Arkansas River alternatives would have the same streamflow effects at the Fountain Creek at Pueblo Gage. Both of these alternatives would include the Highway 115 Return Flow Pipeline. Median daily streamflow would decrease by 84 cfs for these alternatives relative to the No Action Alternative.

The Fountain Creek Alternative would be similar to the Wetland Alternative and the Arkansas River Alternative, with 83 cfs less streamflow than the No Action Alternative. The Fountain Creek Alternative would convey return flows from Williams Creek Reservoir to the confluence of Fountain Creek and the Arkansas River through a return flow pipeline rather than in Fountain Creek. However, the amount of return flows available in Fountain Creek would occasionally exceed the pipeline capacity at times when Williams Creek Reservoir would also be at maximum capacity. Thus, return flows would be conveyed downstream causing a slight increase in streamflow at the Fountain Creek at Pueblo Gage compared to the alternatives with the Highway 115 Return Flow Pipeline.

Changes in streamflow depth at the Fountain Creek at Pueblo Gage would correspond to changes in streamflow. Average annual depths would increase by about 0.2 feet for the No Action Alternative compared with Existing Conditions. The Participants' Proposed Action, Downstream Intake, and Highway 115 alternatives would have similar depths as the No Action Alternative. Average annual depth would be about 0.3 feet less than the No Action Alternative and identical to Existing Conditions for the Wetland, Arkansas River, and Fountain Creek alternatives.

Jimmy Camp Creek

All alternatives would result in nearly identical monthly streamflow in Jimmy Camp Creek and would have annual averages of 8 cfs at the mouth compared to 2 cfs for Existing Conditions (Table 33). There would be no operational differences among alternatives for this stream. Very small differences would occur on a monthly basis among alternatives because not all alternatives fully meet water treatment plant demands through the entire study period, which then affects simulated non-sewered (mostly landscape) return flow contributions to Jimmy Camp Creek streamflow. These shortages would occur during drought periods, would be small, and would continue for a short duration. Average annual streamflow depths would be 0.7 feet for all alternatives and 0.4 feet for Existing Conditions. The Participants' Proposed Action and Wetland alternatives would have the same effects as the other alternatives even though there would be no terminal storage facility on Jimmy Camp Creek. The increased flows would be caused by non-sewered return flows, which would be the same for all alternatives.

Average monthly streamflow effects would be similar for dry and wet years (within 6 cfs of the overall average). Streamflow depths for the Wetland, Arkansas River, and Fountain Creek alternatives would be 0.1 to 0.2 feet lower during dry years due to lower base streamflow stage during these years.

Williams Creek at the Mouth

There would be no effect on average annual, monthly, or daily streamflow in Williams Creek downstream of Upper Williams Creek Reservoir or Williams Creek Reservoir. As discussed in Section 2.2 seepage would likely occur from both reservoirs. However, seepage for the reservoirs would be relatively low (less than 1 cfs), and was not included in the Daily Model. There could be some effects in Williams Creek below the proposed reservoirs due to incidental flood attenuation during peak flow events. Incidental flood attenuation in the reservoirs is not simulated by the Daily Model. The effects due to incidental flood flow attenuation downstream of the reservoirs are discussed in Section 3.8.5.

Reservoirs

Table 46 presents a summary of average annual simulated reservoir storage for the direct effects analysis. Because operations of the SDS Project components would be directly or indirectly tied to operations throughout the analysis area, each of the alternatives would have a different magnitude of effects in reservoirs throughout the analysis area. Average monthly reservoir contents, water surface elevation, and surface area for the reservoirs shown in Table 46 are presented in Appendix E.

Homestake Reservoir

Average annual reservoir storage for Homestake Reservoir would be about 3,700 ac-ft less for the No Action Alternative than for Existing Conditions because of increased Western Slope diversions for this alternative. Homestake Reservoir storage would be highest for the Wetland, Arkansas River, Downstream Intake, and Highway 115 alternatives, with about 15 percent higher storage contents when compared to the No Action Alternative. Average annual Homestake Reservoir storage would be about 9 percent greater for the Participants' Proposed Action and Fountain Creek alternatives compared to the No Action Alternative. Effects on average annual water surface elevation and surface area would be similar to those for storage, but would be slightly less on a percentage basis than those for reservoir storage.

Turquoise Lake and Twin Lakes

Average annual reservoir storage volumes for the No Action Alternative would be less than 1 percent less than Existing Conditions for Turquoise Lake and about 9 percent less for Twin Lakes. Average monthly storage volumes for all Action Alternatives when compared to the No Action Alternative would be higher at Twin Lakes and slightly lower at Turquoise Reservoir. Net contents would be higher for all Action Alternatives except for the Highway 115 Alternative, which would be slightly lower than the No Action Alternative. The Action Alternatives except the Highway 115 Alternative would be higher because the Highway 115 Alternative would be supplied by releases from upper Arkansas River Basin storage, primarily Twin Lakes. Without excess capacity storage in Pueblo Reservoir, exchanges to the upper Arkansas River Basin to replenish these releases would be difficult under the No Action Alternative. Alternatives that incorporate reusable return flow accruals to the Arkansas River downstream of the intake (No Action, Participants' Proposed Action, Fountain Creek, and Highway 115 alternatives) would have slightly lower contents than those alternatives that incorporate return flow accruals upstream of Pueblo Reservoir (Wetland and Arkansas River alternatives). These downstream accrual alternatives would require exchanges to meet the water supply needs. Exchanges would be vulnerable to shortfalls during drought years, and upper Arkansas River Basin storage would be drawn down to meet these shortfalls during drought years. For all alternatives, typically, Twin Lakes storage would be drawn down before Turquoise Lake storage. Therefore,

Table 46. Mean Annual Simulated Reservoir Volumes – Direct Effects.

Location	Existing Conditions	Alt 1	Alt 2	Alt 3	Alt 4	Alt 5	Alt 6	Alt 7
Storage (ac-ft)								
Homestake Reservoir	18,800	15,600	15,800	16,400	16,500	15,500	16,100	17,200
Turquoise Reservoir	90,300	89,900	88,200	89,000	89,000	88,700	88,500	88,700
Twin Lakes	111,700	101,600	106,900	108,500	108,300	106,100	107,900	102,100
Pueblo Reservoir	170,700	159,300	153,200	158,700	161,000	156,600	147,800	154,600
Total Fry-Ark	372,700	350,800	348,300	356,200	358,300	351,400	344,200	345,400
Lake Henry	6,300	6,300	4,400	4,600	4,600	4,800	5,100	5,900
Lake Meredith	25,600	26,300	23,500	21,600	21,500	24,700	24,400	27,600
Total Colorado Canal	31,900	32,600	27,900	26,200	26,100	29,500	29,500	33,500
Holbrook Reservoir	3,400	3,700	3,000	2,900	2,900	3,000	2,900	3,000
Difference in Storage (ac-ft) (Alternative – Alternative 1)								
Homestake Reservoir	-	-	200	800	900	-100	500	1,600
Turquoise Reservoir	---	---	-1,700	-900	-900	-1,200	-1,400	-1,200
Twin Lakes	---	---	5,300	6,900	6,700	4,500	6,300	500
Pueblo Reservoir	---	---	-6,100	-600	1,700	-2,700	-11,500	-4,700
Total Fry-Ark	---	---	-2,500	5,400	7,500	600	-6,600	-5,400
Lake Henry	---	---	-1,900	-1,700	-1,700	-1,500	-1,200	-400
Lake Meredith	---	---	-2,800	-4,700	-4,800	-1,600	-1,900	1,300
Total Colorado Canal	---	---	-4,700	-6,400	-6,500	-3,100	-3,100	900
Holbrook Reservoir	---	---	-700	-800	-800	-700	-800	-700
Difference in Storage (ac-ft) [(Alternative – Alternative 1) / Alternative 1]								
Homestake Reservoir	-	-	1%	5%	6%	-1%	3%	10%
Turquoise Reservoir	---	---	-2%	-1%	-1%	-1%	-2%	-1%
Twin Lakes	---	---	5%	7%	7%	4%	6%	0%
Pueblo Reservoir	---	---	-4%	0%	1%	-2%	-7%	-3%
Total Fry-Ark	---	---	-1%	2%	2%	0%	-2%	-2%
Lake Henry	---	---	-30%	-27%	-27%	-24%	-19%	-6%
Lake Meredith	---	---	-11%	-18%	-18%	-6%	-7%	5%
Total Colorado Canal	---	---	-14%	-20%	-20%	-10%	-10%	3%
Holbrook Reservoir	---	---	-19%	-22%	-22%	-19%	-22%	-19%

effects of upper Arkansas River Basin storage deliveries for the No Action and Highway 115 alternatives would mostly affect Twin Lakes storage volumes.

Average annual water surface elevations and depths for Turquoise Lake and Twin Lakes would vary similar to storage volumes. The No Action Alternative would reduce average annual water surface elevation and depth for Turquoise Lake by about 0.1 feet relative to Existing Conditions. Average annual water surface elevations and depths for the Action Alternatives, would decrease by 0.7 to 1.3 feet compared to the No Action Alternative. The No Action Alternative would reduce average annual water surface elevation and depth in

Twin Lakes by about 4.7 feet relative to Existing Conditions. Average annual water surface elevations and depths for the Action Alternatives except the Highway 115 Alternative would increase by 2.4 to 3.1 feet from the No Action Alternative. The Highway 115 Alternative would increase average annual water surface elevation and depth by 0.2 feet from the No Action Alternative.

Pueblo Reservoir

Average annual storage in Pueblo Reservoir for the No Action Alternative would be about as about 7 percent, or 11,400 acre-feet, lower than Existing Conditions (Figure 52, Table 46) Higher demands from Fry-Ark and non Fry-Ark storage accounts in Pueblo Reservoir in 2046 by the Project Participants would lead to lower reservoir contents than Existing Conditions.

Except for the Arkansas River Alternative, the Action Alternatives would have slightly lower average reservoir contents in Pueblo Reservoir than the No Action Alternative. The No Action Alternative would not include any excess capacity storage in Pueblo Reservoir for any of the Project Participants. Without excess capacity storage in Pueblo Reservoir, the exchange stipulation between Colorado Springs and the winter water entities would no longer be viable during the WWSP (see MWH 2007c for discussion of exchange stipulation). Therefore, Colorado Springs would revert to its in-priority water right and would only exchange against flows released from or passed through Pueblo Reservoir during the winter months. Consequently, the WWSP participants would not have to compete with Colorado Springs for flows during this time, and they would be able to store more native Arkansas River water in Pueblo Reservoir under the No Action Alternative during the winter than they would be able to store under the other alternatives. Additionally, due to increased availability of the Participants' unused reusable return flows for the No Action Alternative, demands from Fry-Ark and Winter Water storage accounts in Pueblo Reservoir would be slightly less.

The Participants' Proposed Action and Fountain Creek alternatives, both of which would incorporate an untreated water intake from Pueblo Dam and reusable return flows accruing to the Arkansas River at the confluence with Fountain Creek, would have an intermediate reduction in overall average simulated reservoir storage when compared to the No Action Alternative. All reusable return flows for these alternatives would be exchanged into Pueblo Reservoir. Exchanges, however, would be affected by low streamflow conditions and would be subject to the PFMP target flows.

The Wetland and Arkansas River alternatives would incorporate a return flow pipeline to the Arkansas River upstream of Pueblo Reservoir and diversions downstream of the pipeline so that reusable return flows would either be directly diverted or directly stored in excess capacity storage space without the need for exchange. Therefore, in general, there would be more water available to store, and reservoir storage would be similar to the No Action Alternative for the Wetland Alternative and slightly greater for the Arkansas River Alternative.

The Downstream Intake Alternative would result in the lowest reservoir storage when compared with the No Action Alternative. This alternative would be able to take direct delivery of reusable return flows; therefore, the use of regulating storage would be reduced. However, return flows would still need to be exchanged upstream for storage in Pueblo Reservoir during times when the return flows would be greater than the amount of water that could be conveyed in the untreated water pipeline. This water would be exchanged to upper Arkansas River Basin storage as soon as exchange potential allows.

The Highway 115 Alternative would result in intermediate levels of storage volume reduction in Pueblo Reservoir. Because exchanges to the upper basin reservoirs would be an important aspect of this alternative, return flows would not remain in Pueblo Reservoir for very long before they would be exchanged to upper basin storage. Use of excess capacity in Pueblo Reservoir would facilitate exchanges to the upper Arkansas River Basin (as compared with the No Action Alternative, in which the Participants would not have an excess capacity contract), and, in this alternative, would operate more like an exchange reservoir than a regulating storage reservoir. Also, because the Highway 115 Alternative would not be constrained by the PFMP target flows, winter exchanges by Colorado Springs into Pueblo Reservoir would be increased (yet still remain within its water rights decrees) and would reduce the amount of WWSP storage in Pueblo Reservoir.

None of the alternatives would affect the flood control pool or the ability to store in the flood control pool (Section 3.8).

Average annual water surface elevations and depths for Pueblo Reservoir would vary similar to storage volumes (Figure 53). The No Action Alternative would have 3.8 feet lower average water surface elevation and depth than Existing Conditions. Average water surface elevations and depths for the Action Alternatives would be between 0.2 feet higher and 4.2 feet lower than the No Action Alternative.

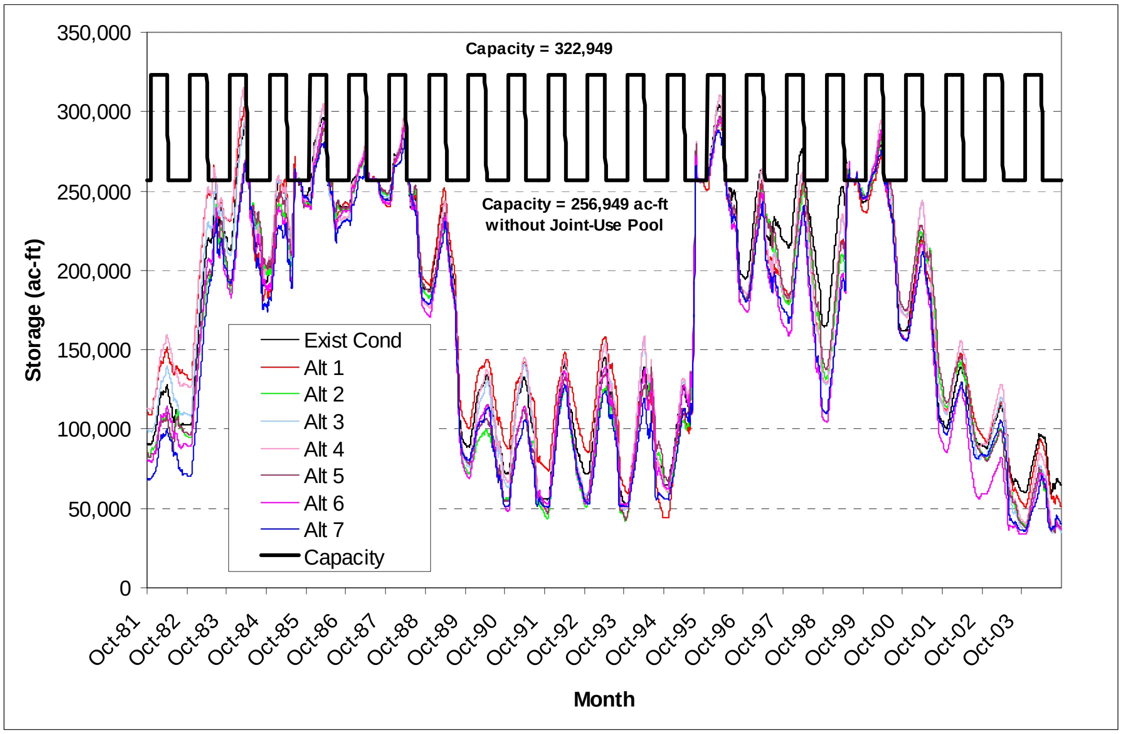


Figure 52. Storage in Pueblo Reservoir for All Alternatives – Direct Effects.

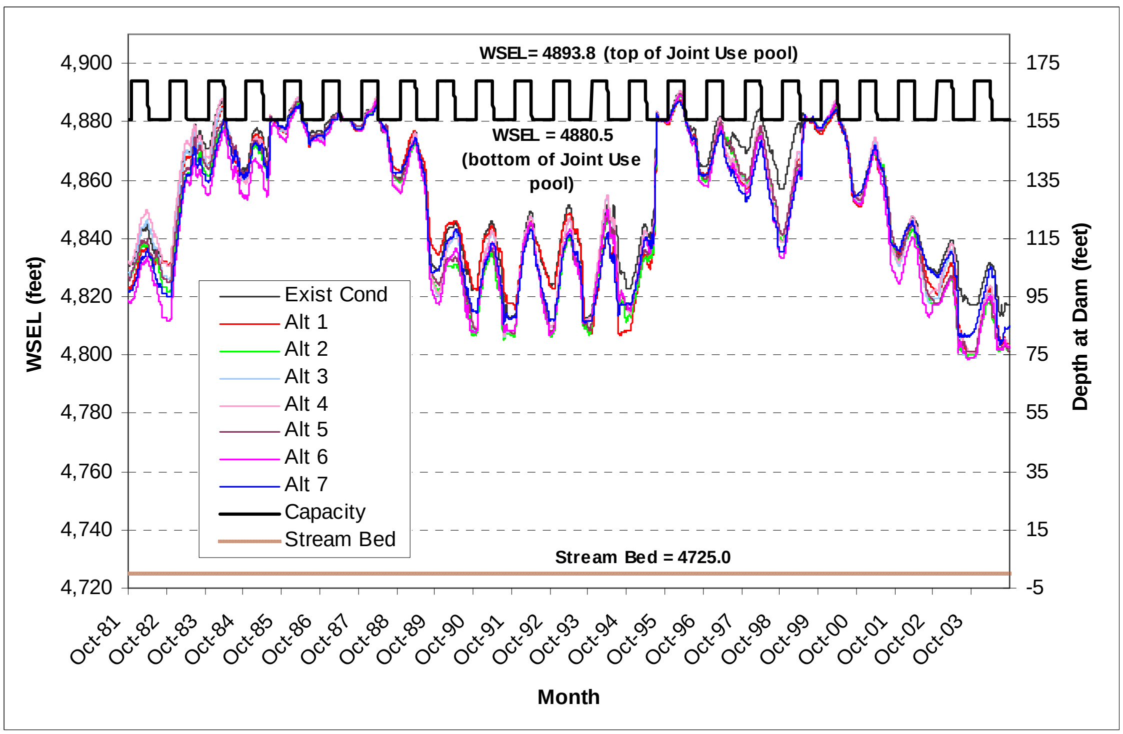


Figure 53. Water Surface Elevation (WSEL) in Pueblo Reservoir for All Alternatives – Direct Effects.

Lake Henry and Lake Meredith

Effects on reservoir storage volumes for Lake Henry and Lake Meredith would be comparable; only effects for Lake Meredith are described below but would generally apply to Lake Henry. Storage volumes for Lake Meredith are shown in Figure 54. Average annual storage for the No Action Alternative would be about 700 ac-ft, or 3 percent, greater than Existing Conditions (Table 46). Overall effects would be reduced in summer and fall when the No Action Alternative could exchange from Colorado Canal to the upper Arkansas River Basin. Differences typically would be greater in dry year summer months when there would be less exchange potential to upper Arkansas River Basin facilities, and less during wet years when there would be more exchange potential to the upper Arkansas River Basin.

All Action Alternatives except the Highway 115 Alternative would have lower reservoir storage in Lake Meredith than the No Action Alternative. Average annual reservoir storage would be lowest for the Wetland Alternative and the Arkansas River Alternative. These alternatives incorporate return flow pipelines to the Arkansas River upstream of Pueblo Reservoir and diversions downstream of the pipeline so that reusable return flows could be directly diverted by the SDS Project. This would eliminate exchanges of reusable return flows and increase exchange potential to move Colorado Canal System water to Pueblo Reservoir, resulting in decreased storage volumes in Lake Meredith.

The Participants' Proposed Action and Fountain Creek alternatives, which would exchange reusable return flows from Fountain Creek to Pueblo Reservoir to provide water supplies to the SDS Project, would reduce the potential to exchange Colorado Canal System water into Pueblo Reservoir. Therefore, Colorado Canal water would remain in the Colorado Canal System for these alternatives. Like the No Action Alternative, there would be times when exchanges upstream would be limited, and some reusable return flows would have to be diverted into the Colorado Canal System for storage and subsequent upstream exchange. Reusable return flows for the Downstream Intake Alternative typically would be delivered directly to the intake from Fountain Creek. When return flows were greater than the intake capacity, excess streamflow would be stored in Colorado Canal for subsequent exchange upstream. Therefore, average annual reservoir storage for the Downstream Intake Alternative would be comparable to the No Action Alternative.

The Highway 115 Alternative would have greater overall average storage volume when compared with the No Action Alternative. As previously discussed, the Highway 115 Alternative would not be required to meet the flow targets of the PFMP. Therefore, most of the exchanges would occur between Fountain Creek and Pueblo, reducing exchange potential between Colorado Canal and Pueblo Reservoir. Return flows stored in Colorado Canal would remain in storage for longer periods.

Average annual water surface elevations and depths for Lake Meredith would vary, similar to storage volumes (Figure 55). The No Action Alternative would decrease average water surface elevation and depth by about 0.1 feet relative to Existing Conditions. The Action Alternatives except the Highway 115 Alternative would each have average water surface elevations and depths 0.2 feet to 1.1 feet less than the No Action Alternative. The Highway 115 alternative would increase depth by 0.2 feet when compared to the No Action Alternative.

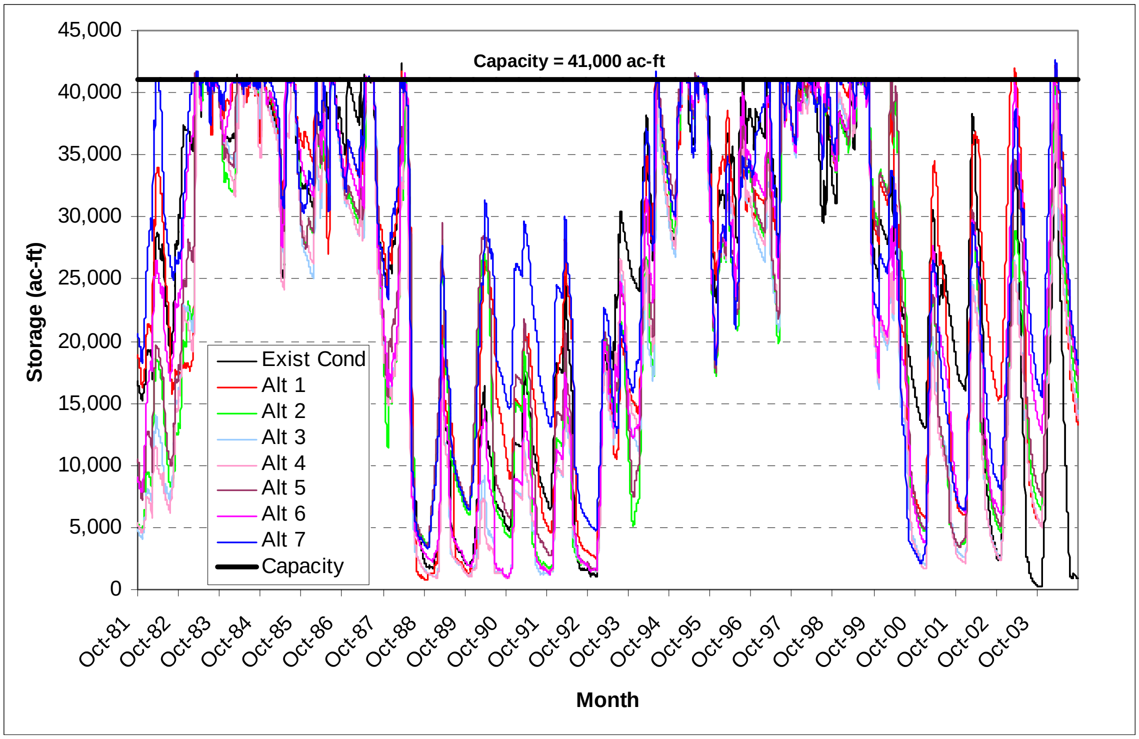


Figure 54. Storage in Lake Meredith for All Alternatives – Direct Effects.

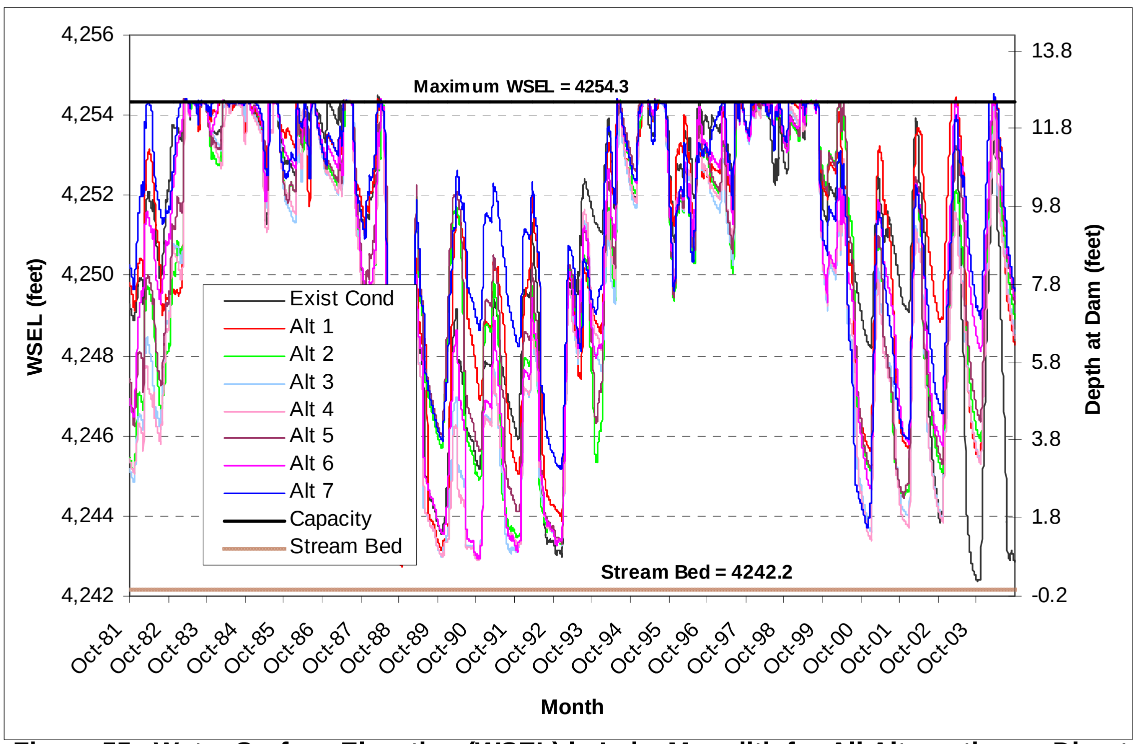


Figure 55. Water Surface Elevation (WSEL) in Lake Meredith for All Alternatives – Direct Effects.

Holbrook Reservoir

The Holbrook system would be used as part of the ROY program to store water that could not be diverted or exchanged to upstream locations due to inadequate exchange potential. Therefore, the amount of storage in Holbrook Reservoir would be affected by the differences among alternatives in the amount of water that would be exchanged.

Average annual storage volumes in Holbrook Reservoir for the No Action Alternative would be about 300 ac-ft, or 9 percent, greater than Existing Conditions due to operations of Colorado Springs' ROY storage (Table 46). Average monthly reservoir volumes typically would be lower for the Action Alternatives than the storage volumes for the No Action Alternative (700 ac-ft to 800 ac-ft). For most alternatives, effects would be greatest during the winter months primarily because the No Action Alternative would have the most storage. The No Action Alternative would not have excess capacity storage in Pueblo Reservoir and, therefore, would store more reusable return flows in ROY storage during the winter months when exchange potential was low.

3.5.5.2 Cumulative Effects

Reasonably foreseeable activities that would affect surface water hydrologic conditions within the study area include municipal demands by non-SDS Project participants within the Arkansas River Basin and changes in operations due to expected future projects. Cumulative effects and resulting output were developed and analyzed in the same manner as the direct effects analysis. Summaries of average annual streamflow for the cumulative effects analysis in the Arkansas River Basin are presented in Table 47. Average monthly streamflow and streamflow depth, and reservoir storage, water surface elevation and depth for overall average, dry,- and wet-year conditions, are presented in Appendix E.

Table 47. Average Annual Simulated Streamflow – Cumulative Effects.

Location	Existing Conditions	Alt 1	Alt 2	Alt 3	Alt 4	Alt 5	Alt 6	Alt 7
Streamflow (cfs)								
Lake Creek Below Twin Lakes Reservoir	172	241	179	175	175	179	176	248
Arkansas River At Granite	352	423	360	356	356	360	357	430
Arkansas River Near Wellsville	677	691	683	679	678	683	680	687
Arkansas River At Portland	766	707	767	856	856	767	763	691
Arkansas River Above Pueblo	631	551	531	617	699	531	609	536
Arkansas River Near Avondale	971	953	937	938	939	942	934	942
Arkansas River At Las Animas	321	305	303	306	306	305	303	302
Fountain Creek At Security	170	230	230	137	137	230	231	231
Fountain Creek At Pueblo	188	245	250	165	165	168	253	251
Jimmy Camp Creek At Fountain	2	8	8	8	8	8	8	8
Difference in Streamflow (cfs) (Alternative – Alternative 1)								
Lake Creek Below Twin Lakes Reservoir	---	---	-62	-66	-66	-62	-65	7
Arkansas River At Granite	---	---	-63	-67	-68	-63	-66	7
Arkansas River Near Wellsville	---	---	-8	-12	-12	-8	-11	-3
Arkansas River At Portland	---	---	60	149	149	60	56	-16
Arkansas River Above Pueblo	---	---	-20	66	148	-20	58	-16
Arkansas River Near Avondale	---	---	-16	-15	-14	-11	-19	-10
Arkansas River At Las Animas	---	---	-2	1	1	0	-2	-3
Fountain Creek At Security	---	---	0	-93	-93	0	1	1
Fountain Creek At Pueblo	---	---	4	-81	-81	-78	7	5
Jimmy Camp Creek At Fountain	---	---	0	0	0	0	0	0
Difference in Streamflow (%) [(Alternative – Alternative 1) / Alternative 1]								
Lake Creek Below Twin Lakes Reservoir	---	---	-26%	-27%	-28%	-26%	-27%	3%
Arkansas River At Granite	---	---	-15%	-16%	-16%	-15%	-16%	2%
Arkansas River Near Wellsville	---	---	-1%	-2%	-2%	-1%	-2%	0%
Arkansas River At Portland	---	---	9%	21%	21%	8%	8%	-2%
Arkansas River Above Pueblo	---	---	-4%	12%	27%	-4%	10%	-3%
Arkansas River Near Avondale	---	---	-2%	-2%	-1%	-1%	-2%	-1%
Arkansas River At Las Animas	---	---	-1%	0%	0%	0%	-1%	-1%
Fountain Creek At Security	---	---	0%	-41%	-41%	0%	1%	0%
Fountain Creek At Pueblo	---	---	2%	-33%	-33%	-32%	3%	2%
Jimmy Camp Creek At Fountain	---	---	0%	0%	0%	0%	0%	0%

Western Slope streamflow and differences in cfs are rounded values to reflect accuracy of measurements and calculations. Percent differences are based on unrounded values to reflect relative differences between alternatives.

None of the reasonably foreseeable activities discussed in Section 3.1.3.1 with the possible exception of climate change (see discussion later in this subsection), would occur on the Western Slope. Therefore, differences between direct and cumulative effects for streamflow and reservoir contents on the Western Slope are attributable to the reasonably foreseeable activities in the Arkansas River Basin. In general, absolute and relative effects on would be very similar between direct and cumulative effects. Average annual streamflow for all locations would be within 1 cfs of the streamflow simulated for the direct effects analysis.

For the Arkansas River upstream of the Highway 115 Intake, average annual streamflow would generally be 3 to 7 cfs higher than the direct effects analysis due to increased releases from upper basin storage to meet demands. The percent of time that general UAVFMP flow targets would be met is presented in Table 48. In general, the UAVFMP targets would be met the same amount of time as the direct effects analysis for most alternatives and most targets. There would be minor variations due to differences in future exchanges and upper basin storage releases for non-SDS entities. Due to increased deliveries of Fry-Ark water to municipal entities, the amount of Fry-Ark water available in storage to meet UAVFMP targets would be less for the cumulative effects analysis than the direct effects analysis. The average Fry-Ark storage available in upper basin storage on July 1 for the Action Alternatives would range from 59,300 to 61,500 ac-ft, while the minimum simulated July 1 storage for the Action Alternatives would range from 23,000 to 36,800 ac-ft. However, these values would be greater than the 10,000 ac-ft that Reclamation has committed to meet the UAVFMP recreational target flows and would not affect the ability to meet the flow targets of the program.

Between the Highway 115 Intake and Pueblo

Table 48. Percent of Time Target Flows Met – Cumulative Effects.

Period	Existing Conditions§	Alt 1	Alt 2†	Alt 3§†	Alt 4§	Alt 5§†	Alt 6§	Alt 7§
UAVFMP								
Year-round flows (250 cfs) ‡	95%	94%	95%	96%	96%	96%	96%	97%
Recreation flow (700 cfs) ‡	91%	91%	88%	90%	91%	90%	91%	93%
Overall*	79%	74%	76%	80%	80%	77%	80%	78%
Overall (250/700) Φ	94%	93%	94%	94%	95%	95%	95%	96%
PFMP								
Non Winter Water Season	92%	90%	92%	93%	96%	92%	90%	79%
Winter Water Season ‡	69%	77%	83%	84%	90%	82%	78%	74%
Overall	84%	86%	89%	90%	94%	89%	86%	78%

§ UAVFMP is in effect.

† PFMP is in effect.

‡ Winter Water Season is November 15 through March 15.

‡ Directly simulated as a flow target in Daily Model.

* Includes all target flow components.

Φ Includes only those flows directly simulated in the model (year-round and recreation flows).

Reservoir, streamflow would be 4 cfs higher than the direct effects analysis for the No Action Alternative, and 1 to 4 cfs lower than the direct effects analysis for the Action Alternatives. Higher streamflow for the No Action Alternative would be a result of slightly fewer exchanges under the cumulative effects scenario for No Action Alternative. Lower streamflow for Action Alternatives would be due to increased municipal demands in Fremont County. Relative differences in effects of alternatives would remain the same.

In the lower Arkansas River, streamflow would generally be less than the direct effects analysis. Between Pueblo Reservoir and the Lake Meredith outlet, streamflow would be 9 to 18 cfs lower than the direct effects analysis for all alternatives due to increased exchanges within this reach by non-SDS municipal entities and decreased delivery of agricultural Fry-Ark water. Downstream of Lake Meredith, streamflow would be 5 to 8 cfs less than the direct effects analysis due to a combination of decreased deliveries and fewer spills from Pueblo Reservoir. The percent of time that the PFMP target flows would be met is presented in Table 48. Generally, winter and overall targets would be met more often due to increased releases to meet the reasonably foreseeable Comanche Power Plant demands. Summer targets would be met slightly less often due to slightly decreased storage deliveries to agricultural entities. Relative differences in effects between alternatives would be similar as the direct effects analysis.

In the Fountain Creek Basin, streamflows would be 3 to 5 cfs lower for the cumulative effects analysis than the direct effects analysis. This is primarily due to reasonably foreseeable action of the Cherokee Metropolitan District relocating its wastewater outfall to a different basin. Relative differences in effects between alternatives would be similar to the direct effects analysis.

Summaries of average annual reservoir storage for the cumulative effects analysis is presented in Table 49 for reservoir storage. In general, storage contents would be lower in the cumulative effects analysis than the direct effects analysis, particularly in Fry-Ark reservoirs, due to increased Fry-Ark deliveries to municipal entities. In general, upper basin storage facilities would have 1,900 to 4,800 ac-ft less storage than the direct effects analysis. In Pueblo Reservoir, the cumulative effects analysis shows 18,700 ac-ft to 23,200 ac-ft less storage in Pueblo Reservoir than the direct effects analysis. Alternatives that involve more exchanges to Pueblo Reservoir (Participants' Proposed Action, Fountain Creek, and Highway 115 alternatives) would have more adverse cumulative effects when compared with the No Action Alternative than direct effects. Simulated Pueblo Reservoir storage contents for the cumulative effects analysis is presented in Figure 56.

Table 49. Average Annual Simulated Reservoir Storage – Cumulative Effects.

Location	Existing Conditions	Alt 1	Alt 2	Alt 3	Alt 4	Alt 5	Alt 6	Alt 7
Storage (ac-ft)								
Homestake Reservoir	18,800	15,100	16,400	17,300	17,400	16,400	17,300	17,400
Turquoise Lake	90,300	87,500	84,500	86,700	87,100	85,300	86,000	83,900
Twin Lakes	111,700	98,600	103,100	104,400	104,500	102,500	103,700	97,600
Pueblo Reservoir	170,700	139,300	130,000	138,500	140,900	133,600	129,100	133,400
Total Fry-Ark	372,700	325,400	317,600	329,600	332,500	321,400	318,800	314,900
Lake Henry	6,300	6,100	4,200	4,300	4,400	4,400	4,500	5,400
Lake Meredith	25,600	25,700	22,900	20,800	20,700	24,700	23,500	26,800
Total Colorado Canal	31,900	31,800	27,100	25,100	25,100	29,100	28,000	32,200
Holbrook Reservoir	3,400	3,500	3,000	2,900	2,900	3,000	2,900	2,900
Difference in Storage (ac-ft) (Alternative – Alternative 1)								
Turquoise Lake	---	---	-3,000	-800	-400	-2,200	-1,500	-3,600
Twin Lakes	---	---	4,500	5,800	5,900	3,900	5,100	-1,000
Pueblo Reservoir	---	---	-9,300	-800	1,600	-5,700	-10,200	-5,900
Total Fry-Ark	---	---	-7,800	4,200	7,100	-4,000	-6,600	-10,500
Lake Henry	---	---	-1,900	-1,800	-1,700	-1,700	-1,600	-700
Lake Meredith	---	---	-2,800	-4,900	-5,000	-1,000	-2,200	1,100
Total Colorado Canal	---	---	4,700	-6,700	-6,700	-2,700	-3,800	400
Holbrook Reservoir	---	---	-500	-600	-600	-500	-600	-600
Difference in Storage (ac-ft) [(Alternative – Alternative 1) / Alternative 1]								
Turquoise Lake	---	---	-3%	-1%	0%	-3%	-2%	-4%
Twin Lakes	---	---	5%	6%	6%	4%	5%	-1%
Pueblo Reservoir	---	---	-7%	-1%	1%	-4%	-7%	-4%
Total Fry-Ark	---	---	-2%	1%	2%	-1%	-2%	-3%
Lake Henry	---	---	-31%	-30%	-28%	-28%	-26%	-11%
Lake Meredith	---	---	-11%	-19%	-19%	-4%	-9%	4%
Total Colorado Canal	---	---	-15%	-21%	-21%	-8%	-12%	1%
Holbrook Reservoir	---	---	-14%	-17%	-17%	-14%	-17%	-17%

Studies of the Colorado River Basin have estimated higher temperatures, resulting in a shift in the timing of runoff to earlier in the year. Predictions for precipitation range from slight increases to substantial decreases. Also predicted are more extreme dry periods and flooding events. However, without specific climate-altered hydrology in the study area, it was not possible to incorporate modified flows into the Daily Model. It is believed that climate change would not likely favor a particular alternative. Because each of the alternatives was designed with similar amounts of storage and uses the same water rights portfolio, no one alternative should be able to better adapt to climate variability.

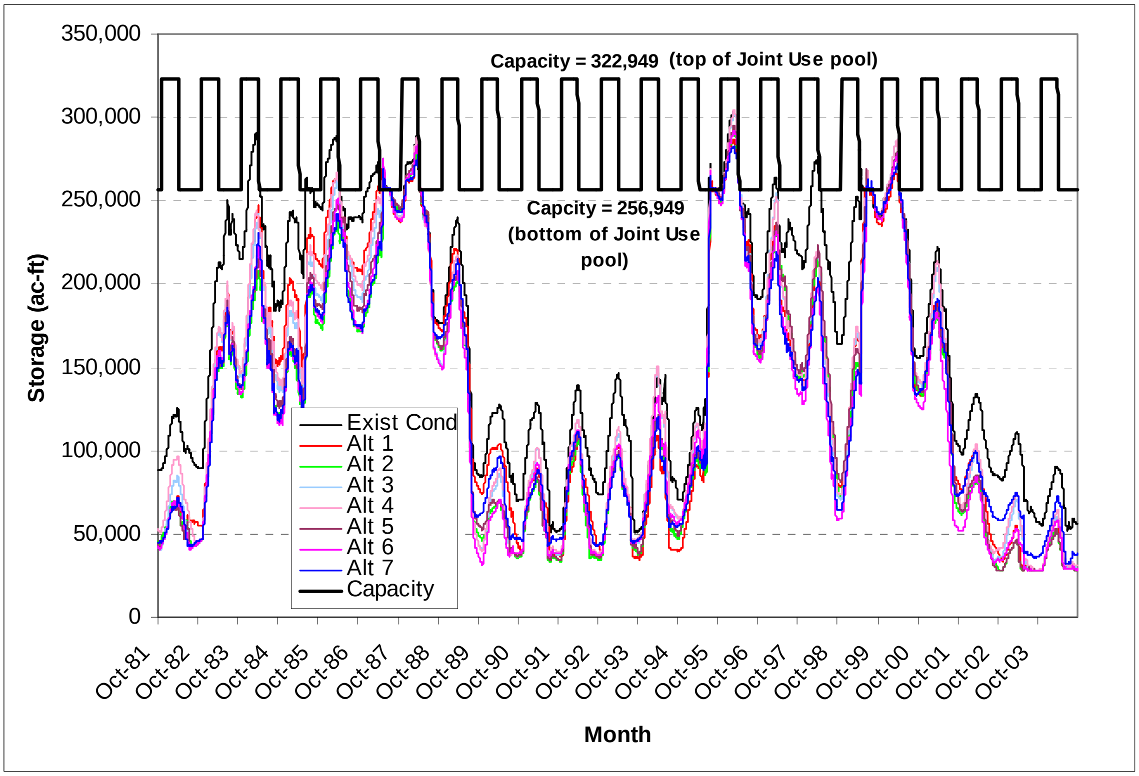


Figure 56. Storage in Pueblo Reservoir for All Alternatives – Cumulative Effects.

For streamflow under a climate change scenario, it is assumed that the cumulative effects would have greater flows in the winter and spring months due to increased winter precipitation and earlier snow melt runoff. Dry years would have lower flows due to potentially more extreme droughts; wet years would have higher flows due to more extreme precipitation events resulting in floods.

With climate change, it is assumed that storage in all reservoirs would be greater in winter and spring months and lower in summer and fall months. Reservoirs also would have greater volumes during wet years as more extreme precipitation events are expected, resulting in flooding that would be captured in storage facilities. Drought periods are projected to be longer and drier in the future and would, therefore, result in lower reservoir volumes during dry years.

3.5.5.3 Resource Commitments

Irretrievable commitments of resources would include changes in surface water hydrologic patterns. Potential consequences for water-dependent resources are discussed in the resource-specific sections of this FEIS. No other irreversible commitments of surface water resources are anticipated.

3.5.5.4 Mitigation Measures

Proposed Measures

If Reclamation and the Participants receive credible information that project operations are impairing physical diversion of a senior water right, the Participants will immediately initiate discussions among the parties, including the party alleging the impairment and Reclamation, to develop a solution and remedy the impairment. No other mitigation measures are proposed in the Surface Water Hydrology section. Evaluation of effects due to changes in surface water hydrology and proposed mitigation measures for those effects are presented in resource-specific sections within Chapter 3 of the FEIS.

Mitigated Effects

When implemented this mitigation measure would resolve adverse effects to physical diversions of senior water rights. None of the mitigation measures proposed for other resources would affect the surface water hydrology effects analysis discussed in this section.

3.6 Ground Water Hydrology

This section describes the existing ground water conditions in the analysis area and the effects of the alternatives on ground water levels. Effects on Fountain Creek and Arkansas River alluvial ground water and effects on non-tributary Denver Basin ground water were determined. Changes in ground water levels from the alternatives may affect ground water conditions, such as the ability of the associated aquifers to be used for existing and future water supplies. Ground water indicators used in this analysis are:

- Changes in ground water levels for alluvial and Denver Basin aquifers (i.e., the measurement of the reduction in ground water levels associated with ground water pumping or the increase in ground water levels associated with increased aquifer infiltration)
- The proximity of homes with basements to areas where increased alluvial ground water levels are expected (i.e., to evaluate the potential for flooding of basements)

Some tables and figures in this section use the following numbers to identify the alternatives:

- Alternative 1 (No Action Alternative)
- Alternative 2 (Participants' Proposed Action)
- Alternative 3 (Wetland Alternative)
- Alternative 4 (Arkansas River Alternative)
- Alternative 5 (Fountain Creek Alternative)
- Alternative 6 (Downstream Intake Alternative)
- Alternative 7 (Highway 115 Alternative)

3.6.1 Summary of Effects

Alluvial ground water levels for the Fountain Creek alluvial aquifer near Fountain and the Widefield Aquifer near Security would be lower for the No Action Alternative than for Existing Conditions because of alluvial ground water pumping that would be implemented for these communities under the No Action Alternative. Security would pump about 3,400 ac-ft/yr from the Widefield Aquifer for the No Action Alternative (compared to 2,800 ac-ft/yr for Existing Conditions), which would result in about 4 feet of drawdown relative to Existing Conditions under a worst-case scenario assuming only one ground water production well for the No Action Alternative. Fountain would pump about 11,200 ac-ft/yr from the Fountain Creek alluvial aquifer for the No Action Alternative (compared to 1,300 ac-ft/yr for Existing Conditions), which would result in drawdown effects of about 17 feet relative to Existing Conditions under a worst-case scenario assuming a single ground water production well each for Fountain and Security. Because the exact design of the wellfields is unknown, the worst-case scenario of a single well (which would produce the most aquifer drawdown) was assumed.

Alluvial ground water effects would also occur at the Williams Creek Reservoir site for the No Action Alternative relative to Existing Conditions (up to 20 foot higher ground water levels for the No Action Alternative). Alluvial ground water levels at the Williams Creek Reservoir site would be the same as the No Action Alternative for all Action Alternatives except for the Wetland Alternative and the Arkansas River Alternative, which do not include the reservoir. There would be negligible effects for the remaining Action Alternatives relative to the No Action Alternative.

For the No Action Alternative, Colorado Springs would pump Denver Basin ground water starting in 2044 (112 ac-ft/yr) increasing to the maximum pumping in 2046 (5,040 ac-ft/yr). Effects on Denver Basin ground water levels as a result of Colorado Springs' No Action Alternative would be maximum drawdowns at some locations of 63 feet for the Denver Aquifer, 314 feet for the Arapahoe Aquifer, and 553 feet for the Laramie-Fox Hills Aquifer relative to Existing Conditions. Average drawdown associated with Colorado Springs' No Action Alternative pumping would be 0 feet for the Denver Aquifer, 23 feet for the Arapahoe Aquifer, and 21 feet for the Laramie-Fox Hills Aquifer for the No Action Alternative relative to Existing Conditions. Denver Basin ground water levels for the Action Alternatives would the same as the Existing Conditions ground water levels because there would be no SDS Project Denver Basin ground water pumping under the Action Alternatives.

An **aquifer** is an underground water-bearing geologic formation. Water contained in and extracted from an aquifer (typically through a well) is referred to as **ground water**.

Denver Basin aquifers are a group of consolidated deep bedrock aquifers that extend from Greeley south to Colorado Springs, and from the foothills east to Limon, and include the following aquifers in a layered formation listed in order from shallow to deep.

- Dawson Aquifer
- Denver Aquifer
- Arapahoe Aquifer
- Laramie-Fox Hills Aquifer

Alluvial aquifers are shallow unconsolidated sand and gravel deposits adjacent to a stream that contain ground water that is generally hydraulically connected to the adjacent stream. The following alluvial aquifers are within the study area:

- Fountain Creek alluvial aquifer
- Widefield Aquifer
- Williams Creek alluvial aquifer
- Jimmy Camp Creek alluvial aquifer
- Arkansas River alluvial aquifer

3.6.2 Regulatory Framework

Regulations that apply to ground water use that would be part of some of the alternatives include rules applicable to both alluvial ground water use and Denver Basin ground water use. The Colorado Water Right Determination and Administration Act of 1969 (1969 Act) integrated alluvial ground water that is in hydrologic connection with surface water (i.e., tributary water) into the prior appropriation doctrine used for surface water rights (Colo. Rev. Stat. §§ 37-92-101 to -602). A result of the 1969 Act is that alluvial ground water pumped from the Fountain Creek and Widefield aquifers is regulated by the same priority system used to administer surface water rights. Additionally, the Colorado Division of Water Resources promulgated rules in 1994 for the pumping of ground water hydraulically connected to the Arkansas River. These rules required State-approved augmentation plans for any ground water pumping rights obtained after 1948 that were junior to the Arkansas River Compact of 1948. Ground water stored within the Denver Basin aquifers is primarily classified as non-tributary water and is regulated by the Colorado Department of Natural Resources Denver Basin Rules (2 CCR 402-6) as well as Colorado Senate Bill 5, which allocated Denver Basin ground water on the basis of overlying land ownership and a 100-year life of the aquifers.

3.6.3 Analysis Area and Methods

3.6.3.1 Analysis Area

Effects on alluvial ground water were analyzed for the following alluvial aquifer systems (Figure 57):

- The Arkansas River alluvial aquifer between Pueblo Reservoir and the Wildhorse Creek confluence in the city of Pueblo
- The Arkansas River alluvial aquifer between the Fountain Creek confluence and the Catlin Dam Gage
- Fountain Creek between Colorado Springs and the Arkansas River confluence
- Jimmy Camp Creek from the Jimmy Camp Creek Reservoir site to the Fountain Creek confluence
- Williams Creek from the Upper Williams Creek Reservoir site to the Fountain Creek confluence

The Arkansas River alluvial aquifer between Lake Fork and Salida was not included in the alluvial ground water effects analysis because all alternatives would have minimal effects on stream stage in this reach compared to historical ground water fluctuations (MWH 2007c, 2008a). Estimated effects on average monthly stream stage range from a reduction of 0.4 feet to an increase of 0.1 feet. Historical ground water level data from the USGS for alluvial wells in this reach indicate average monthly ground water level variations between 0.4 feet and 29.5 feet (USGS 2006a). The potential effects on streamflow stage would result in effects on ground water levels that are smaller than historical variations in ground water levels. Consequently, no detectable effects from the alternatives are anticipated. For the same reason, the Arkansas River alluvial aquifers between Cañon City and Pueblo Reservoir and between Catlin Dam near Fowler and Las Animas were not included in the analysis. Ground water levels in this lowest reach of the Arkansas River upstream of John Martin Reservoir are influenced primarily by irrigation practices. The alternatives would not affect irrigation diversions or practices and, hence, would not affect ground water levels in this region. The Arkansas River alluvial aquifer between the Wildhorse Creek confluence and the Fountain Creek confluence was not included in the analysis because the channel would be concrete lined in this reach. As a result, the hydrologic connection between surface and ground water in this reach is reduced and unpredictable. Consequently, no detectable effects from the alternatives are anticipated.

Western Slope streams were not included in the analysis area because of minimal alluvial ground water systems associated with these streams. The Western Slope streams are high gradient mountain streams with coarse grained bed material and are predominantly underlain by consolidated bedrock material with minimal hydraulic connection. Surficial geologic material near Homestake Creek, Roaring Fork River, Lincoln Creek, and tributaries to these streams is primarily consolidated bedrock, with minor amounts of unconsolidated glacial drift material (Tweto 1979). As a result of the predominance of consolidated rocks adjacent to the Western Slope streams, seepage from surface water streams to ground water systems is minimal, and these streams were not included in the ground water effects analysis area.

3.6.3.2 Methods

Because alluvial aquifers and Denver Basin aquifers are different types of hydraulic systems, the methods used to analyze effects differ between the two systems. The methods used for each are described below.

Alluvial Aquifers

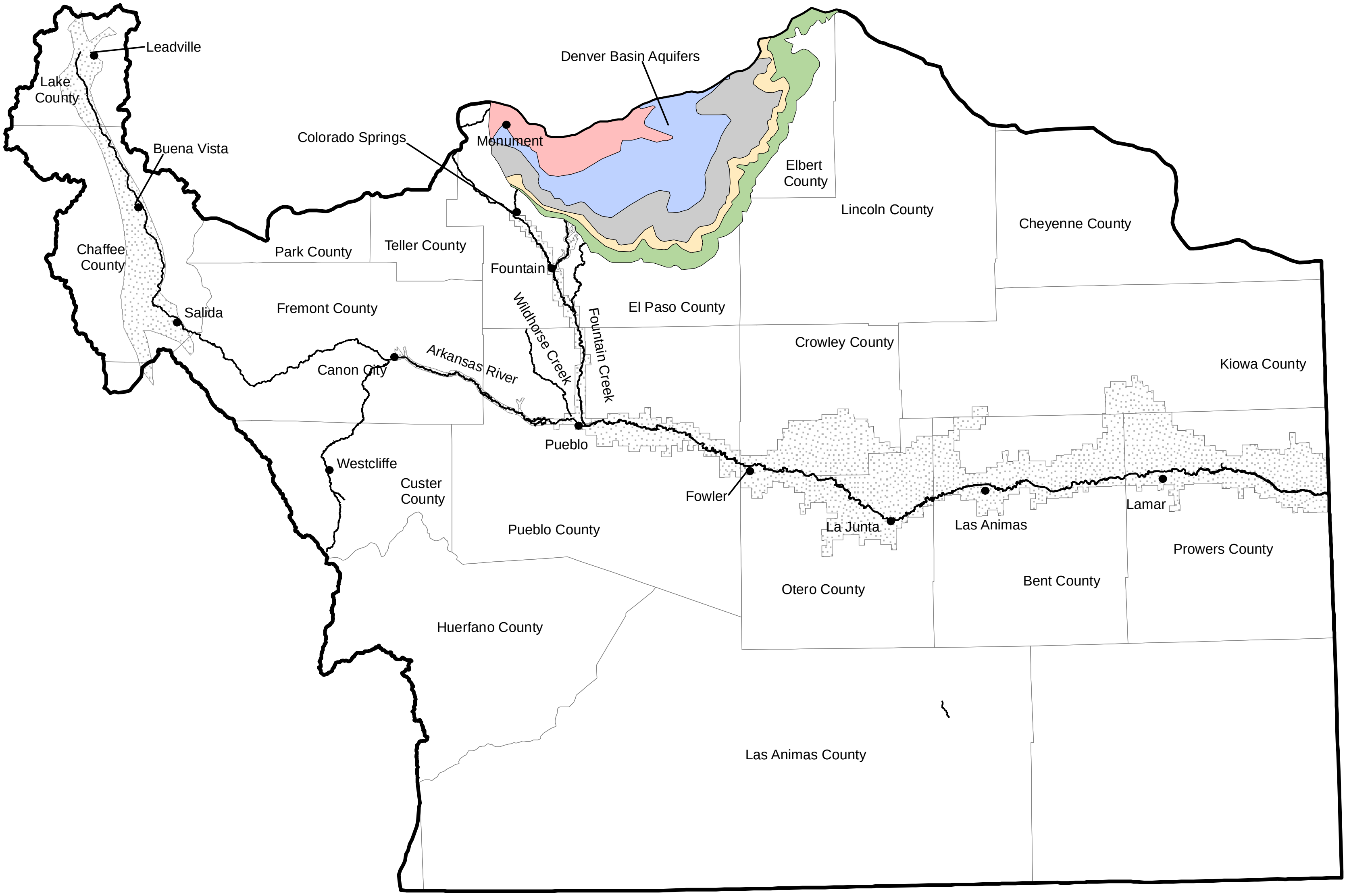
Ground water pumping effects were calculated for alluvial ground water withdrawal that would occur under the No Action Alternative and for reasonably foreseeable actions for the cumulative effects analysis. Future Fountain Creek alluvial ground water development by Fountain (Section 3.1.3.1), independent of the SDS Project, was simulated as the only reasonably foreseeable action under the alluvial ground water cumulative effects analysis.

A study period of 1982 to 2004 was used for the alluvial ground water effects analyses to be consistent with the study period used in the Daily Model (MWH 2007d, 2008d). One of the factors that influences alluvial ground water levels is the change in river stage (i.e., the height of water in the river) associated with hydrologic conditions and surface water demands. Consequently, use of the 1982 to 2004 study period incorporates the range of potential river stages that occur under various hydrologic conditions such as drought and stormwater runoff.

Effects of additional Fountain Creek alluvial ground water withdrawal for the No Action Alternative and cumulative effects analysis were calculated using equations for ground water levels that consider the effects of ground water well pumping. Effects of pumping and long-term ground water withdrawals were estimated based on the assumed ground water development for the No Action Alternative and for the cumulative effects analysis. No Action Alternative alluvial ground water effects were calculated for the reaches of Fountain Creek near Fountain and Security.

The amount of ground water pumping that would occur for Security and Fountain under the No Action Alternative has been estimated and was used in the alluvial ground water effects analysis. However, the number and locations of wells that would be used for the No Action Alternative ground water pumping have not been determined. In lieu of specific information for the number of wells that would be used, a conservative assumption was made that Fountain and Security would use only one well to pump ground water under the No Action Alternative. The resulting estimate of effects for the No Action Alternative is likely an overestimate of the actual drawdown that would occur.

Effects on alluvial ground water levels associated with changes in river stage were determined using basic ground water flow equations for an unconfined aquifer (an aquifer with a water level below the top of the aquifer, e.g., an alluvial aquifer). The water levels at a distance from the river were calculated as a function of river stage and aquifer properties such as hydraulic conductivity. An increase in river stage was assumed to increase recharge to the shallow aquifer, and a decrease in river stage was assumed to reduce recharge to the shallow aquifer. Analyses were conducted at stream gage locations where changes in river stage were estimated as part of the surface water hydrology analysis. A calibrated ground water model (e.g., finite difference ground water model) was not used to determine alluvial ground water effects because of the large study area and the lack of available historical ground water level data to accurately calibrate such a model over the large study area.



Project: Southern Delivery System EIS
Source: CO DWR
Date: February, 2008

Denver Basin Aquifers

- Lower Dawson Aquifer
- Denver Aquifer
- Arapahoe Aquifer
- Laramie Formation
- Laramie-Fox Hills Aquifer

- Major River/Creek
- Major City
- County Boundary
- Arkansas River Basin Boundary within Colorado
- Alluvium and Glacial Deposits

Note: Alluvium and glacial deposit extent is approximate

N

0 5 10 20 Miles

Figure 57. Location and Extent of Major Aquifers.

SDS EIS\GIS\projects\ground water model study area 2.mxd

Calculated alluvial ground water effects were classified into four groups:

- Negligible – less than 6 inches change in mean water levels over the 1982 to 2004 study period
- Minor – 6 inches to 1 foot change in mean water levels over the 1982 to 2004 study period
- Moderate – drop in water level up to 30 percent of saturated thickness at a municipal well user location; or increase in water level between 1 foot and 1.5 feet and the depth to water less than 8 feet below ground surface (bgs) in residential area (basement flooding condition)
- Major – drop in water level that results in greater than 30 percent reduction of saturated thickness at municipal well user location; or increase in water level greater than 1.5 feet and depth to water less than 8 feet bgs in residential area (basement flooding condition)

Several simplifications were made in the alluvial ground water effects analysis to efficiently estimate effects on ground water levels for the large geographic area within the study area. The resulting limitations include the reach-averaged nature of the analysis, the assumption that the No Action Alternative ground water pumping for Fountain and Security would occur from only one well, and that only long-term averaged ground water level fluctuations were considered.

Denver Basin Aquifers

Effects on ground water levels of the Denver Basin aquifers were simulated by HRS (2007). The Senate Bill 74 Denver Basin aquifers ground water model was completed by the Colorado State Engineers Office. A modified version of this model was used to simulate Denver Basin ground water levels for Colorado Springs' No Action Alternative pumping. The existing model was updated with recent data (aquifer physical properties such as hydraulic conductivity) and the model analysis area was truncated to the southern portion of the Denver Basin aquifers near Colorado Springs. The model was then recalibrated and used to determine the number of wells that would be needed and to estimate the drawdown effects (i.e., change in ground water levels).

Effects classifications for changes in Denver Basin ground water levels were not developed because of the lack of detailed information to evaluate predicted effects on each potential Denver Basin aquifer water user. Effects on Denver Basin ground water levels could increase pumping costs for existing ground

> The following terms are used in subsequent subsections to describe aquifer properties for aquifers within the analysis area:
>
> **Water table** - an underground surface below which the ground is saturated with water.
> **Well yield** - the rate at which a ground water well can be pumped (typically measured in gallons per minute, gpm).
> **Depth to ground water** - the depth below the ground surface to the water table (typically measured in feet).
> **Saturated thickness** - the thickness of the aquifer from the very bottom to the water table (typically measured in feet).
> **Hydraulic conductivity** - a measure of the rate at which water will move through a permeable soil or rock layer (typically measured in feet per day, ft/d).
> **Transmissivity** - a property of an aquifer that represents its capacity to transmit water over the thickness of the aquifer (the product of hydraulic conductivity and the aquifer thickness).
> **Storativity** - the ability of an aquifer to store or release water.
> **Potentiometric Surface Elevation** - the height of the water level within an aquifer measured as a distance above sea level.

water users, reduce maximum well yield from the aquifers, and reduce water levels to a point below existing well screens. Changes in ground water levels would vary greatly throughout the modeled area and affect each individual Denver Basin ground water user differently. Rather than effects classifications, absolute maximum water level effects near the proposed Denver Basin ground water facilities are presented.

Limitations of the Denver Basin ground water modeling results should be considered when reviewing the simulated effects of the No Action Alternative pumping on Denver Basin ground water levels. These limitations include inaccuracies associated with the limited calibration data that was available to accurately calibrate the model (e.g., historical water levels and aquifer hydraulic properties), the approximation of boundary conditions for the simulations, and limited data for future ground water pumping rates by entities other than the Project Participants.

3.6.4 Affected Environment

This section summarizes ground water information for the study area, including ground water use, aquifer types, and ground water levels. Ground water conditions throughout the Arkansas River Basin including areas outside of the water resources study area, are discussed due to the interconnected nature of alluvial ground water systems and the Denver Basin aquifers. This information is described in detail in the SDS Project Water Resources Technical Report (MWH 2007a). Irrigation is the most prevalent ground water use throughout the Arkansas River Basin. Within the lower Arkansas River Basin, ground water use in 2000 was greatest in El Paso, Kiowa, and Prowers counties. Counties in the study area derived between 0.5 to 93 percent of total water supply from ground water.

Two types of aquifers are present in the study area: unconsolidated sediment aquifers and consolidated rock aquifers. Unconsolidated aquifers include alluvial aquifers, which can be pumped at high rates of withdrawal (e.g., up to 4,000 gallons per minute), and are hydraulically connected to surface water (tributary). Consolidated rock aquifers have a lower potential rate of ground water withdrawal, and are generally considered to be hydraulically disconnected from surface water (non-tributary).

Upper Arkansas River Basin

Alluvial aquifers and one major sandstone consolidated rock aquifer (Dakota-Purgatoire Formation) are present in the upper Arkansas River Basin. Alluvium in the upper Arkansas River Basin is up to 100 feet thick, and well yields are reported up to 500 gpm. Depth to ground water in the upper Arkansas River Basin alluvium ranged from 5 to 58 feet during the 1990s. Large seasonal fluctuations in alluvial ground water levels are common in the upper Arkansas River Basin as a result of effects from spring runoff. River stage along the upper Arkansas River is generally higher than alluvial ground water levels, which results in surface water recharge to alluvial aquifers.

Lower Arkansas River Basin

Alluvial aquifers in the lower Arkansas River Basin are more reliable as a source of ground water because they are more extensive and continuous than alluvium in the upper Arkansas River Basin. In Colorado, the lower Arkansas River alluvial aquifer extends about 150 miles from Pueblo Reservoir to the Kansas state line, is up to 250 feet thick, and is underlain by impermeable, Cretaceous-aged bedrock.

Depth to ground water in the lower Arkansas River Basin alluvial aquifer is generally 5 to 40 feet, with a shallower water table close to the Arkansas River. River stage is generally higher than alluvial ground water levels, resulting in river discharge to the alluvium. In addition to alluvial recharge from river discharge, percolation of agricultural water from ditches and fields contributes recharge to the alluvium. Irrigation is the largest ground water use in the lower Arkansas River Basin.

Fountain Creek Basin

The alluvial aquifer is the primary source of ground water supply in the Fountain Creek Basin. The Fountain Creek alluvial aquifer is 0.75 to 1.5 miles wide, and varies from a few feet to 100 feet thick. Saturated thickness is up to 45 feet. Depth to alluvial ground water ranges from a few feet to 50 feet, and is greater in the northern section of the basin. Domestic supply, from Denver Basin aquifers and from the Fountain Creek alluvial aquifer, is the largest ground water use in El Paso County. Irrigation, primarily from Fountain Creek and Arkansas River alluvium, is the largest ground water use in Pueblo County.

The Widefield Aquifer is a shallow, very permeable part of the surrounding Fountain Creek alluvial aquifer. The aquifer begins 5 miles south of Colorado Springs and runs southeast along Fountain Creek to the town of Widefield. Water use in the Widefield Aquifer was historically agricultural, but expanding population in the mid to late 1950s led to predominantly municipal and industrial use. The communities of Colorado Springs, Security, Stratmoor Hills, and Widefield pump ground water from the Widefield Aquifer for municipal supply. Table 50 presents a summary of annual pumping from the Widefield Aquifer by local municipalities from 1999 to 2003.

Denver Basin Aquifers

The Denver Basin aquifers in the study area (Denver, Arapahoe, Dawson, and Laramie-Fox Hills aquifers) are consolidated rock aquifers present in the northern section of El Paso County (Figure 58). The aquifers are composed primarily of sandstone and shale and, thus, have a lower hydraulic conductivity than the alluvial aquifers in the study area. Well yields in the Denver Basin aquifers range from 0 gpm in the shale formations to 700 gpm in the Arapahoe Aquifer sandstone formation. Denver Basin aquifers are used for municipal supply, with heavy use in the southeastern metropolitan Denver area. The Arapahoe

Table 50. Summary of Municipal Ground Water Pumping from the Widefield Aquifer.

Year	Annual Ground Water Pumping (ac-ft)				
	Colorado Springs	Security	Stratmoor Hills	Widefield	Total
1999	623	1,777	342	702	3,444
2000	1,051	1,957	512	894	4,413
2001	422	2,207	340	741	3,711
2002	1,354	2,140	332	1,105	4,931
2003	848	1,492	231	682	3,253
5-year Average	860	1,915	351	825	3,950

Totals are accurate to within 1 ac-ft because of rounding.

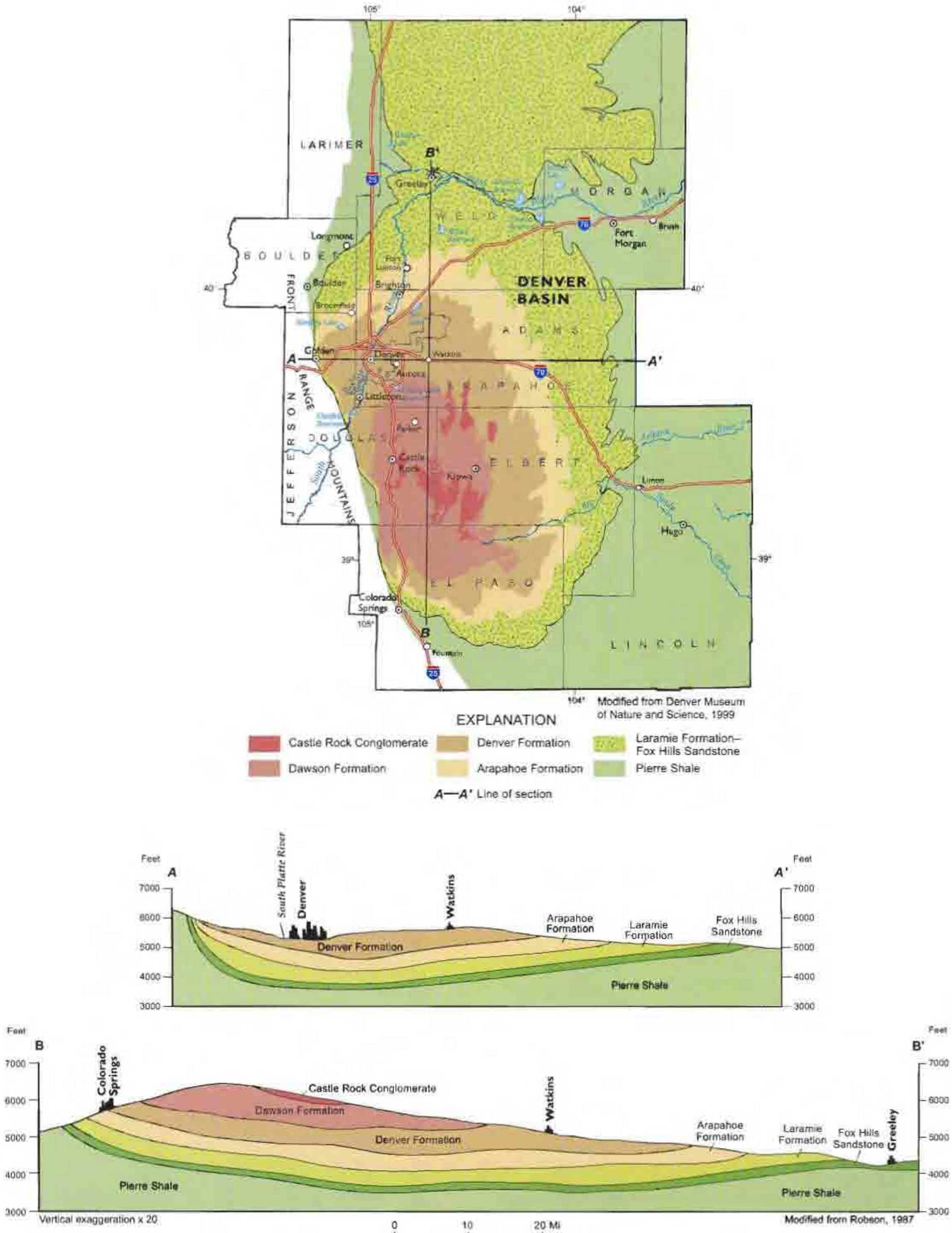


Figure 58. Denver Basin Cross Section and Cross Section Location.

Source: CGS 2003.

Aquifer is the most used Denver Basin aquifer. While ground water levels have declined elsewhere in the Denver Basin aquifers, water levels have remained nearly stable near Colorado Springs (CGS 2003). Properties of the Denver, Arapahoe, and Laramie-Fox Hills formations, which are the three Denver Basin aquifers associated with the No Action Alternative, are summarized for northern El Paso County in Table 51.

3.6.5 Environmental Consequences

3.6.5.1 Direct and Indirect Effects

This section summarizes direct and cumulative effects of the alternatives on alluvial ground water and Denver Basin ground water. A more detailed description of the analysis methods and results is contained in the Ground Water Effects Analysis (MWH 2007b) and the Denver Basin Ground Water Modeling Technical Memorandum (HRS 2007).

Alluvial Ground Water

Alluvial ground water effects are summarized in Table 52. Effects would be negligible for the Arkansas River reaches in the analysis area, with increases or decreases in water levels that would be less than 0.1 feet for all alternatives. The only exception would occur near the Above Pueblo Gage (representative of the alluvial aquifer between Pueblo Reservoir and the Wildhorse Creek confluence), where effects within 100 feet of the river would be a slight decrease of 0.1 feet for the No Action, Participants' Proposed Action, Fountain Creek, and Highway 115 alternatives, a 0.1 foot increase for the Wetland and Downstream Intake alternatives, and a 0.3 foot increase for the Arkansas River Alternative. The increased ground water levels for the Wetland and Arkansas River alternatives would result from an increase in river stage caused by increased streamflow through the city of Pueblo due to the return flow pipeline at Colorado 115 (Section 3.5.5.1).

Larger effects would occur along Fountain Creek near Fountain and Security for the No Action Alternative. Alluvial ground water near Security and Fountain would be affected by additional alluvial ground water pumping for the No Action Alternative. Near the Security Gage, the No Action Alternative would decrease ground water levels by a maximum of about 3 feet as a result of Security's No Action Alternative ground water pumping from Widefield Aquifer alluvial wells. Alluvial ground water near the Fountain

Table 51. Denver and Arapahoe Aquifer Properties for Northern El Paso County.

Aquifer Property	Denver Formation	Arapahoe Formation	Laramie-Fox Hills Formation
Transmissivity (gpd/foot) †	0 to 1,120	370 to 2,270	520
Storativity (dimensionless) †	0 to 0.0006	0.0002 to 0.0006	0.0002
Potentiometric Surface Elevation (feet) †	6,600 to 6,800	6,200 to 6,400	5,800
Aquifer Top Elevation (feet) †	6,600 to 6,800	5,700 to 6,200	5,000 to 5,600
Aquifer Bottom Elevation (feet) †	5,800 to 6,300	5,300 to 5,900	4,800 to 5,300
Net Sand Thickness (feet) ‡	50 to 200	0 to 300	0 to 100
Average Well Production (gpm/foot) ‡	50 to 200	100 to 600	50 to 100

†Source: CWCB 2006.

‡Source: HRS 2005.

Gage would decrease by a maximum of 17 feet for the No Action Alternative. The effects near the Fountain Gage would result from Fountain's No Action Alternative alluvial ground water pumping from the Fountain Creek alluvial aquifer. Augmentation plans would be obtained by Fountain and Security to offset any depletions to surface water that would occur as a result of the No Action Alternative ground water pumping. The decreases in ground water levels near Security and Fountain described above are the maximum decreases that would occur at these locations. However, drawdown would decrease at a distance from the hypothetical pumping wells as in a typical ground water pumping drawdown cone. A cross-section of the drawdown cone associated with Security's No Action Alternative alluvial ground water pumping is shown in Figure 59 as an example. As shown in the cross-section, the cone of drawdown has a maximum drawdown of about 4 feet at the pumping well and rapidly decreasing drawdown at a distance away from the well. Fountain Creek was assumed to be at the far left of Figure 59, and provides a source of water on the left side of the figure that dramatically decreases drawdown to less than 1 foot within about 200 feet from the hypothetical pumping well. To the right of the hypothetical pumping well (i.e., away from the river), drawdown would decrease to less than 1

Table 52. Average Annual Change in Alluvial Ground Water Level – Direct Effects.

Location	Change in Water Level (feet)†‡						
	Alt 1	Alt 2	Alt 3	Alt 4	Alt 5	Alt 6	Alt 7
Arkansas River							
Above Pueblo	-0.1	-0.1	0.1	0.3	<0.1	0.1	-0.1
Near Avondale	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Near Fowler	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Fountain Creek							
At Colorado Springs	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Below Janitell Road	0.2	<0.1	-0.4	-0.4	<0.1	<0.1	<0.1
At Security	-3.4	2.5	2.1	2.1	2.5	8.6	2.5
Near Fountain	-16.5	10.1	11.4	12.4	11.4	19.1	11.7
Near Piñon	0.3	<0.1	-0.4	-0.4	-0.4	0.1	<0.1
At Pueblo	0.2	<0.1	-0.3	-0.3	-0.3	<0.1	<0.1
Jimmy Camp Creek							
Jimmy Camp Creek Reservoir	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Jimmy Camp Creek at Fountain	0.4	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Williams Creek							
At Upper Williams Creek Reservoir	0.0	0.0	0.0	0.0	0.0	0.0	0.0
At Williams Creek Reservoir	20	<0.1	-20	-20	<0.1	<0.1	<0.1
At Fountain Creek	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1

† Effects for Alternative 1 are calculated relative to Existing Conditions. Effects for Alternatives 2 through 7 are calculated relative to Alternative 1

‡ Positive numbers indicate an increase in ground water level, negative numbers indicate a decrease.

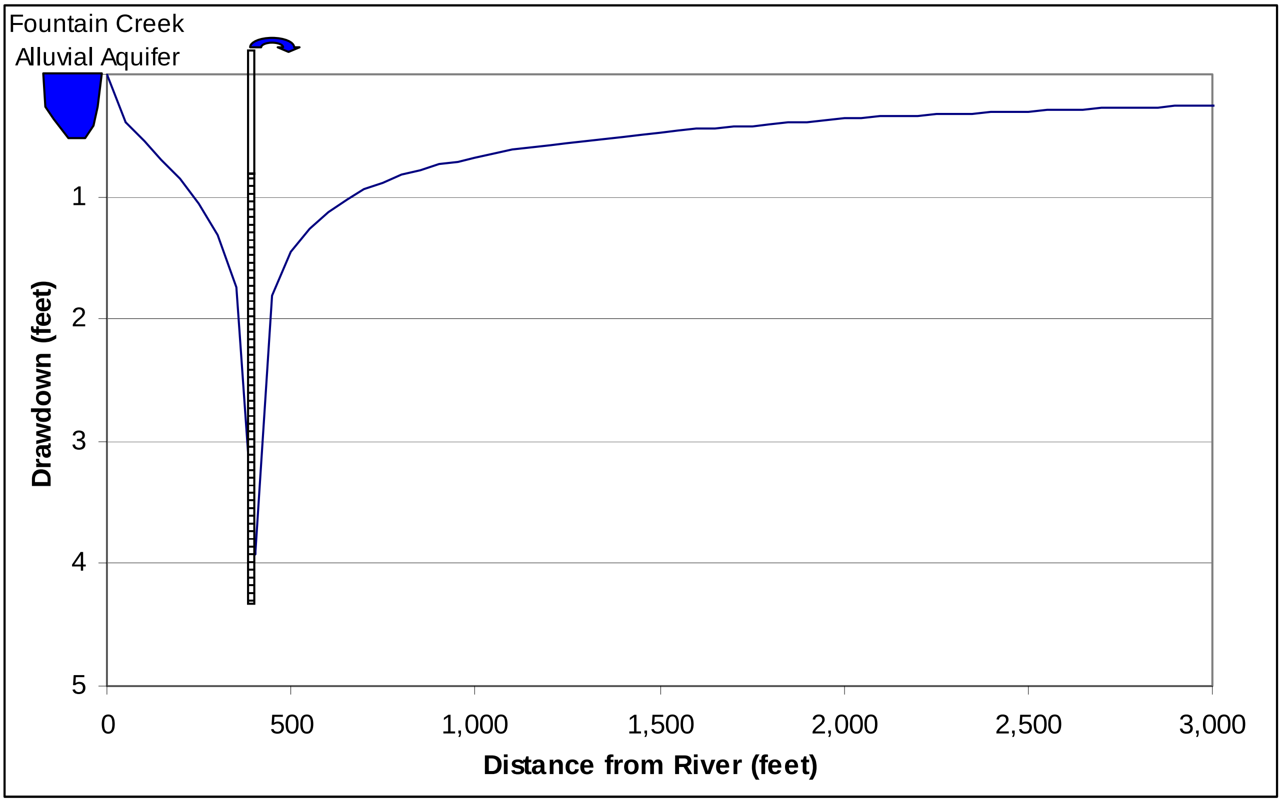


Figure 59. Drawdown Cone Cross-Section for Security's No Action Alternative Ground Water Pumping.

foot about 300 feet from the well and to less than 6 inches about 1,000 feet from the well. The shape of the drawdown cone for Fountain's No Action Alternative ground water pumping would be similar to the shape of Security's pumping shown in Figure 59, but would be more u-shaped with more widespread drawdown in either direction from the well (from higher pumping rates), with a maximum drawdown of 16.5 feet as described above.

The ground water effects for the No Action Alternative near Fountain and Security are worst-case estimates of ground water effects because the effects were calculated using a single alluvial ground water well each for Fountain and Security. However, proper design of the wellfield for the No Action Alternative for Fountain and Security could reduce ground water effects to a minimal amount (i.e., use of several wells properly spaced would reduce drawdown). Alluvial ground water effects for the Action Alternatives for the Widefield and Fountain Creek alluvial aquifers near Security and Fountain would be an increase in ground water levels relative to the No Action Alternative of up to 9 feet and 19 feet, respectively.

Effects would include changes in alluvial ground water levels at the Williams Creek Reservoir site as a result of seepage from the reservoir. The No Action Alternative would have an increase in alluvial ground water of 20 feet compared with Existing Conditions. Alluvial ground water levels for the Participants' Proposed Action, Fountain Creek, Downstream Intake, and Highway 115 alternatives at the reservoir site would be the same as those for the No Action Alternative.

Alluvial ground water levels for the Wetland Alternative and the Arkansas River Alternative would be 20 feet lower than those for the No Action Alternative. However, alluvial ground water levels for the Wetland and the Arkansas River alternatives would be the same as those under Existing Conditions.

Differences between ground water levels for the No Action Alternative and Existing Conditions would be negligible (i.e., less than 0.5 feet), except for the effects associated with the No Action Alternative alluvial ground water pumping near Security and Fountain described above. Fountain Creek alluvial ground water levels would generally increase or decrease less than 0.4 feet for all alternatives. Slight decreases in Fountain Creek alluvial ground water levels, relative to the No Action Alternative, would generally occur for the Wetland, Arkansas River, and Fountain Creek alternatives, as a result of removing reusable return flows from the Fountain Creek Basin. Alluvial ground water levels for the Downstream Intake Alternative in Fountain Creek within the analysis area would generally slightly increase relative to the No Action Alternative. Alluvial ground water level effects for the Participants' Proposed Action and Highway 115 alternatives would be less than 0.1 feet along Fountain Creek

Ground Water at Proposed Reservoir Sites

Consolidated Denver Basin formations and the Pierre Shale are the predominant geologic materials at the Jimmy Camp Creek Reservoir, Upper Williams Creek Reservoir, and Williams Creek Reservoir sites. Because these materials are relatively impermeable, the hydraulic connection between the reservoirs and adjacent ground water would be minimal.

The Williams Creek Reservoir site has the highest percentage of alluvial material (15 percent) of the three proposed reservoir sites. As a result, the hydraulic connection (and associated seepage) between the reservoir and the adjacent shallow ground water would be greatest for the Williams Creek Reservoir site.

Seepage from Williams Creek Reservoir would result in increased ground water levels directly adjacent to the reservoir by about 20 feet for the No Action Alternative relative to Existing Conditions. Consequently, ground water would be within a few feet of the ground surface. These effects likely would diminish downstream of the dam and upstream of the Fountain Creek confluence. Ground water levels would be about 20 feet lower for the Wetland and Arkansas River alternatives relative to the No Action Alternative, and levels for the Participants' Proposed Action, Fountain Creek, Downstream Intake, and Highway 115 alternatives would be the same as those for the No Action Alternative. However, ground water levels for the Wetland and Arkansas River alternatives would be the same as those under Existing Conditions. Increased ground water levels likely would not cause any basement flooding because there are no homes near the Williams Creek Reservoir site. The nearest home is about 4 miles downstream of the reservoir site, near the confluence with Fountain Creek.

Because of limited alluvial material near the Jimmy Camp Creek Reservoir (all alternatives except the Participants' Proposed Action and Wetland alternatives) and Upper Williams Creek Reservoir (the Participants' Proposed Action and Wetland alternatives) sites, there would be minimal hydraulic connection and limited effects such as seepage to ground water systems adjacent to these reservoirs. Effects of the No Action Alternative relative to Existing Conditions and the Action Alternatives relative to the No Action Alternative would be negligible (less than 0.5 feet in change in ground water levels).

Denver Basin Ground Water

The No Action Alternative would be the only alternative with Denver Basin ground water pumping simulated as part of the alternative.

By 2046, little drawdown in the Denver Aquifer would occur outside of the Colorado Springs service area. The drawdown in the Arapahoe and Laramie-Fox Hills aquifers would be of greater magnitude and extend into northern El Paso County. Table 53 shows the average and maximum drawdown by 2046 for the three main aquifers in the Denver Basin system. Average drawdown is the average of the drawdown values within the model analysis area and maximum drawdown is the maximum. A maximum drawdown of 285 feet could occur in the Denver Aquifer, of which about 63 feet may be attributed to the No Action Alternative pumping and 222 feet would be attributable to the continued pumping by other entities at existing pumping rates. A maximum of 605 feet of decline would occur in the Arapahoe Aquifer, of which 314 feet could be attributed to No Action Alternative pumping and 291 feet would be attributable to the continued pumping by other entities at existing pumping rates. In the Laramie-Fox Hills Aquifer, a maximum of 572 feet would occur, most of which would be due to the No Action Alternative pumping (553 feet). The remaining 19 feet would be attributable to the continued pumping by other entities at existing pumping rates. In order to provide context for the effects summarized in Table 53 the range of saturated thickness for each of the Denver Basin aquifers is provided below (CGS 2003; HRS 2007):

- Denver Aquifer – 0 to 825 feet
- Arapahoe Aquifer – 0 to 650 feet
- Laramie-Fox Hills Aquifer – 0 to 650 feet

The maximum and average drawdown data summarized in Table 53 can be compared to the saturated thickness values above to approximate the portion of the aquifers that would become dry as a result of the No Action Alternative pumping. For example, the maximum drawdown for the Denver Aquifer provided in Table 53 is 285 feet, which indicates that 540 feet of the maximum saturated thickness would remain following the No Action Alternative pumping (825 to 285 feet). The drawdown around each of the proposed Denver Basin ground water pumping wells would be greatest at the pumping wells and decrease with distance from the pumping wells as discussed for alluvial ground water effects above. However, drawdown cones within the Denver Basin aquifers would be more complex than for the alluvial aquifers because of the effects of well-to-well interference, and because of confined aquifer hydraulic conditions of the Denver Basin aquifers.

For the Action Alternatives, Denver Basin ground water effects would be higher by 0, 23, and 21 feet for the Denver, Arapahoe, and Laramie-Fox Hills aquifers relative to the No Action Alternative. Ground water levels in 2046 for the Action Alternatives were simulated by assuming existing conditions ground water pumping throughout the aquifers continues into the future at existing pumping rates. As a result, ground water levels for the Action Alternatives would be reduced relative to Existing Conditions.

3.6.5.2 Cumulative Effects

Reasonably foreseeable activities that would affect alluvial ground water levels would be the same as those for surface water. Cumulative effects would be similar to those described for the direct and indirect effects analysis (Table 54).

Table 53. Average and Maximum Denver Basin Aquifer Drawdown – Direct Effects.

Aquifer	Water Level Drawdown (feet)† ‡						
	Alt 1	Alt 2	Alt 3	Alt 4	Alt 5	Alt 6	Alt 7
Average Drawdown (ft)							
Denver	48	0	0	0	0	0	0
Arapahoe	129	-23	-23	-23	-23	-23	-23
Laramie - Fox Hills	39	-21	-21	-21	-21	-21	-21
Maximum Drawdown (ft)							
Denver	285	-63	-63	-63	-63	-63	-63
Arapahoe	605	-314	-314	-314	-314	-314	-314
Laramie - Fox Hills	572	-553	-553	-553	-553	-553	-553

† Effects for Alternative 1 are calculated relative to Existing Conditions. Effects for Alternatives 2 through 7 are calculated relative to Alternative 1.

‡ Positive values indicate lower ground water levels, and negative values indicate higher ground water levels.

Table 54. Alluvial Ground Water – Cumulative Effects.

Location	Change in Water Level (feet)†						
	Alt 1	Alt 2	Alt 3	Alt 4	Alt 5	Alt 6	Alt 7
Arkansas River Above Pueblo	-0.1	-0.1	-0.1	0.3	-0.1	0.1	-0.1
Arkansas River near Avondale	<0.1	<0.1	<-0.1	<0.1	<0.1	<0.1	<0.1
Arkansas River near Fowler	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Fountain Creek at Colorado Springs	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Fountain Creek below Janitell Road	0.2	<0.1	-0.4	-0.4	<0.1	<0.1	<0.1
Fountain Creek at Security	-3.5	2.5	2.0	2.0	2.5	8.0	2.5
Fountain Creek near Fountain	-16.5	11.6	12.4	12.4	11.4	19.1	12.7
Fountain Creek near Piñon	0.3	<0.1	-0.4	-0.4	-0.4	0.1	<0.1
Fountain Creek at Pueblo	0.2	<0.1	-0.3	-0.3	-0.3	0.1	<0.1
Jimmy Camp Creek at Jimmy Camp Creek Reservoir	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Jimmy Camp Creek at Fountain	0.4	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Williams Creek at Upper Williams Creek Reservoir	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Williams Creek at Williams Creek Reservoir	20	<0.1	-20	-20	<0.1	<0.1	<0.1
Williams Creek at Fountain Creek	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1

† Effects for Alternative 1 are calculated relative to Existing Conditions. Effects for Alternatives 2 through 7 are calculated relative to Alternative 1.

‡ Positive numbers indicate an increase in ground water level, negative numbers indicate a decrease.

Pumping of Denver Basin ground water would show effects under the cumulative effects analysis similar to those seen under the direct effects analysis (Table 55). The No Action Alternative would have more drawdown compared with Existing Conditions for cumulative effects due to increased ground water pumping throughout the basin and a

Table 55. Average and Maximum Denver Basin Aquifer Drawdown – Cumulative Effects.

Aquifer	Water Level Drawdown (feet)† ‡						
	Alt 1	Alt 2	Alt 3	Alt 4	Alt 5	Alt 6	Alt 7
Average Drawdown (ft)							
Denver	60	0	0	0	0	0	0
Arapahoe	183	-21	-21	-21	-21	-21	-21
Laramie - Fox Hills	66	-17	-17	-17	-17	-17	-17
Maximum Drawdown (ft)							
Denver	285	-63	-63	-63	-63	-63	-63
Arapahoe	605	-266	-266	-266	-266	-266	-266
Laramie - Fox Hills	606	-552	-552	-552	-552	-552	-552

† Effects for Alternative 1 are calculated relative to Existing Conditions. Effects for Alternatives 2 through 7 are calculated relative to Alternative 1.

‡ Positive values indicate lower ground water levels, and negative values indicate higher ground water levels.

declining boundary condition across the El Paso County line. Increased pumping by other Denver Basin ground water users is calculated based upon the original SB74 model assumptions of future production (HRS 2007). The declining boundary condition is a model setting that simulates the contribution of regional Denver Basin ground water level decline from pumping in the northern portion of the Denver Basin aquifers. As described in Section 3.6.3.2, the model analysis area for the original SB74 Denver Basin aquifers model was truncated for evaluation of effects associated with the SDS Project. As a result, the ground water users in the northern portion of the Denver Basin aquifers were not explicitly simulated, but instead the declining head boundary, based on observations of historical decline as described by HRS (2007), was used to indirectly simulate effects from the users north of the truncated model analysis area.

The magnitude of the drawdown values provided in Table 55 can be estimated by comparing the simulated drawdown with the approximate existing saturated thickness for each of the Denver Basin aquifers as described in Section 3.6.5.1. The effects of continued pumping by existing Denver Basin ground water pumpers were simulated using an approximated drop in water levels at the northern edge of the SDS Project Denver Basin aquifers study area. In lieu of explicitly modeling each individual user, an average historical drop in water levels was assigned to the northern boundary to implicitly model these effects.

Denver Basin ground water cumulative effects for the Action Alternatives would be an increase in average water levels of 0 feet for the Denver Aquifer, 21 feet for the Arapahoe Aquifer, and Laramie-Fox Hills Aquifer relative to the No Action Alternative. The rise in ground water levels would be the difference between simulated water levels at 2046 ground water level conditions with and without the No Action Alternative ground water pumping. The ground water levels for the Action Alternatives would be lower than levels under Existing Conditions because of continued decline in ground water levels as a result of continued Existing Conditions pumping by other users and other reasonably foreseeable future Denver Basin ground water pumping.

3.6.5.3 Resource Commitments

Irreversible commitments of resources associated with surface and ground water hydrology would be limited to use of the Denver Basin aquifers under the No Action Alternative. No other irreversible commitments of resources are anticipated.

3.6.5.4 Mitigation

Proposed Measures

No mitigation is recommended for Action Alternatives that show alluvial ground water pumping effects associated with the No Action Alternative for Fountain and Security. Although the Action Alternatives show calculated effects when compared to the No Action Alternative, mitigation away from Existing Conditions is not recommended (i.e., mitigation to No Action would require lowering of ground water levels, which is not desirable in the alluvial aquifers).

Mitigated Effects

None of the mitigation measures proposed for other resources would affect the ground water hydrology effects analysis discussed in this section.

3.7 Water Quality

Water quality is being analyzed because changes in streamflow and the movement of water from one location to another can affect surface and ground water quality. Water quality is important for aquatic life, drinking water, agriculture, recreation, and other uses. Water quality indicators evaluated are:

- Overall Western Slope water quality
- Bacteria
- Dissolved selenium
- Sulfate
- Effluent limits at permitted discharge locations
- Salinity
- Metals
- Suspended sediment
- Lower Arkansas River total recoverable iron Temperature
- Nutrients
- Emerging contaminants
- Reservoir water quality including nutrients and eutrophication
- Alluvial and Denver Basin ground water quality

Some tables and figures in this section use the following numbers to identify the alternatives:

- Alternative 1 (No Action Alternative)
- Alternative 2 (Participants' Proposed Action)
- Alternative 3 (Wetland Alternative)
- Alternative 4 (Arkansas River Alternative)
- Alternative 5 (Fountain Creek Alternative)
- Alternative 6 (Downstream Intake Alternative)
- Alternative 7 (Highway 115 Alternative)

3.7.1 Summary of Effects

The water quality effects of each alternative would vary primarily based on the configuration of return flow conveyance. Alternatives including the Highway 115 Return Flow Pipeline (Wetland and Arkansas River alternatives) would have the most serious adverse effects. The Eastern Return Flow Pipeline (Fountain Creek Alternative) generally would have minor beneficial water quality effects.

Water Quality Standards (WQS)

Narrative or numeric restrictions set by the State of Colorado's Water Quality Control Commission to protect the beneficial uses of water. Colorado's stated beneficial uses include domestic water supplies, agricultural and recreational uses, and aquatic life as well as others.

Direct effects on water quality are summarized in Figure 60 and Figure 61. Changes in streamflow often directly affect concentrations of water quality indicators. All of the alternatives would likely result in higher streamflows and higher nutrient concentrations in certain stream segments due to increased return flows in 2046 compared to Existing Conditions. Generally, the Wetland and Arkansas River alternatives would result in minor adverse effects on water quality in the Arkansas River from Florence through Pueblo due to the conveyance of return flows from the Fountain Creek Basin to the upper Arkansas River. Slightly higher concentrations of parameters such as nutrients, algae, salinity, and selenium would adversely affect the water quality in Pueblo Reservoir. Water quality standards (WQS) from Florence through Pueblo Reservoir would likely still be attained.

Between Pueblo Reservoir and Fountain Creek, naturally elevated concentrations of selenium (CDPHE 2008a) would be moderately increased by all alternatives except the Arkansas River Alternative due to reduced streamflows. The chronic WQS for selenium is exceeded in this reach for Existing Conditions and would continue to be exceeded for all alternatives.

The No Action, Wetland, Arkansas River, and Fountain Creek alternatives may cause minor increases in salinity in different reaches of Fountain Creek, potentially affecting municipal and agricultural uses of water. The Wetland and Arkansas River alternatives may slightly reduce concentrations of suspended sediment and nutrients in Fountain Creek due to lower return flows, but slightly increase bacteria (*E. coli*) densities. By diverting reusable return flows away from Fountain Creek, the Wetland, Arkansas River, and Fountain Creek alternatives would increase dissolved selenium concentrations in Fountain Creek. Conversely, the increased return flows in Fountain Creek in the No Action, Participants' Proposed Action, Downstream Intake, and Highway 115 alternatives may result in slightly lower dissolved selenium and higher suspended sediment concentrations in Fountain Creek and higher total recoverable iron concentrations in the lower Arkansas River.

None of the alternatives would substantially affect water quality on the Western Slope or effluent limits for WWTFs on Fountain Creek or Arkansas River.

3.7.2 Regulatory Framework

The CDPHE Water Quality Control Division (WQCD) is Colorado's lead agency for protecting the quality of the state's waters and the safety of drinking water systems. The Water Quality Control Commission develops regulations and WQCD implements them to comply with federal and state laws including the Safe Drinking Water Act (SDWA), the Clean Water Act, and the Colorado Water Quality Control Act.

Regulation Number 32 (Classifications and Numeric Standards for Arkansas River Basin) (CDPHE 2008a) classifies waters in the Arkansas River Basin according to the uses for which they are presently suitable or intended to become suitable. Narrative and numerical WQS are then assigned to be protective of those uses. In Regulation 32, Pueblo Reservoir separates the upper and middle reaches of the Arkansas River and Fountain Creek separates the middle and lower reaches. Regulation Number 33 (Classifications and Numeric Standards for Upper Colorado River Basin and North Platte River) (CDPHE 2008b) classifies waters in the Upper Colorado River Basin.

Acute WQS are generally meant to be protective of beneficial uses under short-term, high concentration events. A chronic WQS is protective of uses for longer periods of time, generally the average of a 30-day period (CDPHE 2008c). The WQS and thresholds used in this water quality analysis are summarized in Table 56.

The SDWA is the principal federal law that ensures safe drinking water for the public by regulating water quality "at the tap." The SDWA requires that the EPA establish National Primary Drinking Water Regulations for contaminants that may cause adverse public health effects. Colorado's regulations include mandatory levels (Maximum Contaminant Levels) and nonenforceable health goals (Maximum Contaminant Level Goals) for each contaminant. In addition, pubic water systems must comply with specific treatment requirements, such as disinfection (CFWE 2003).

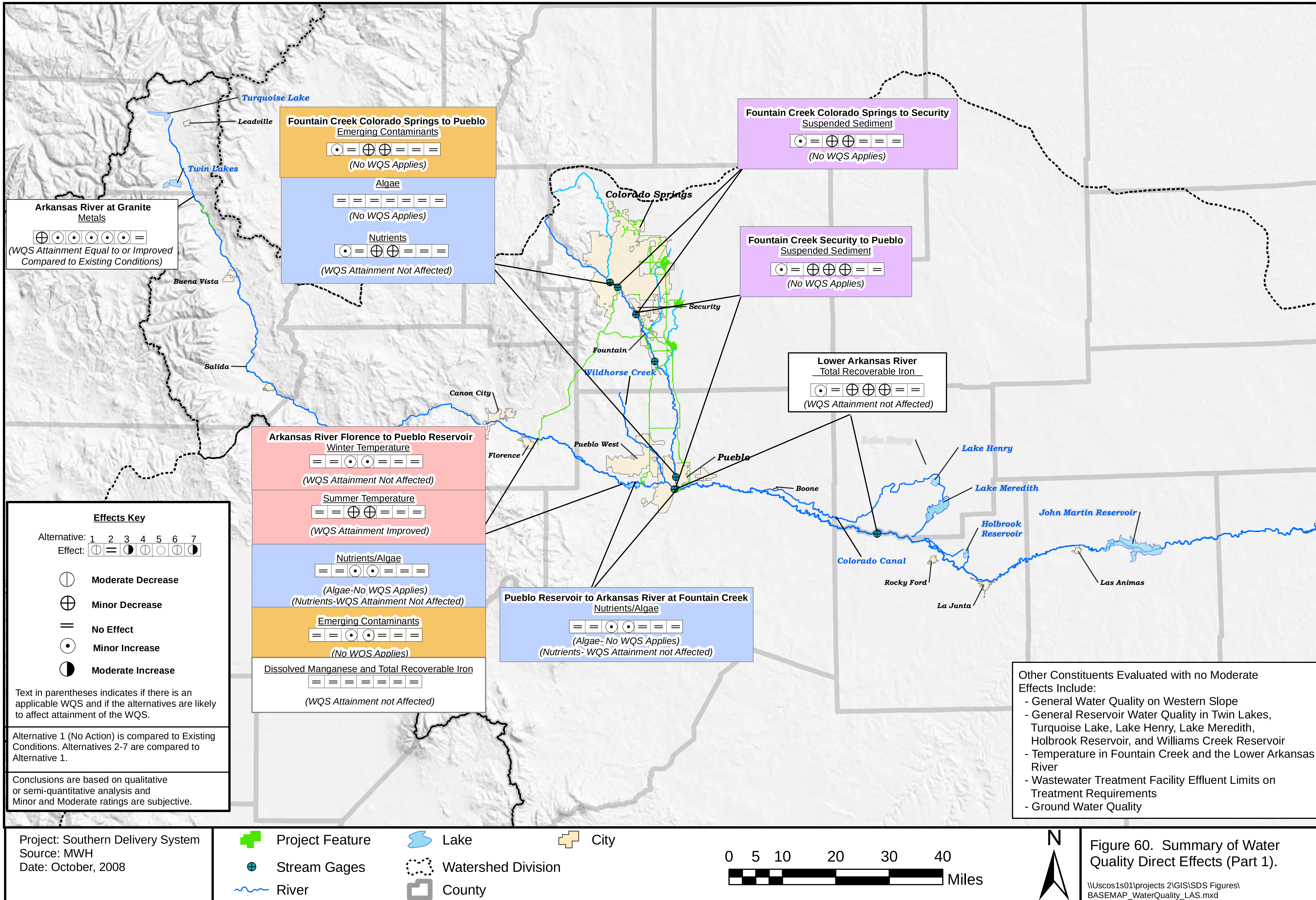


Figure 60. Summary of Water Quality Direct Effects (Part 1).

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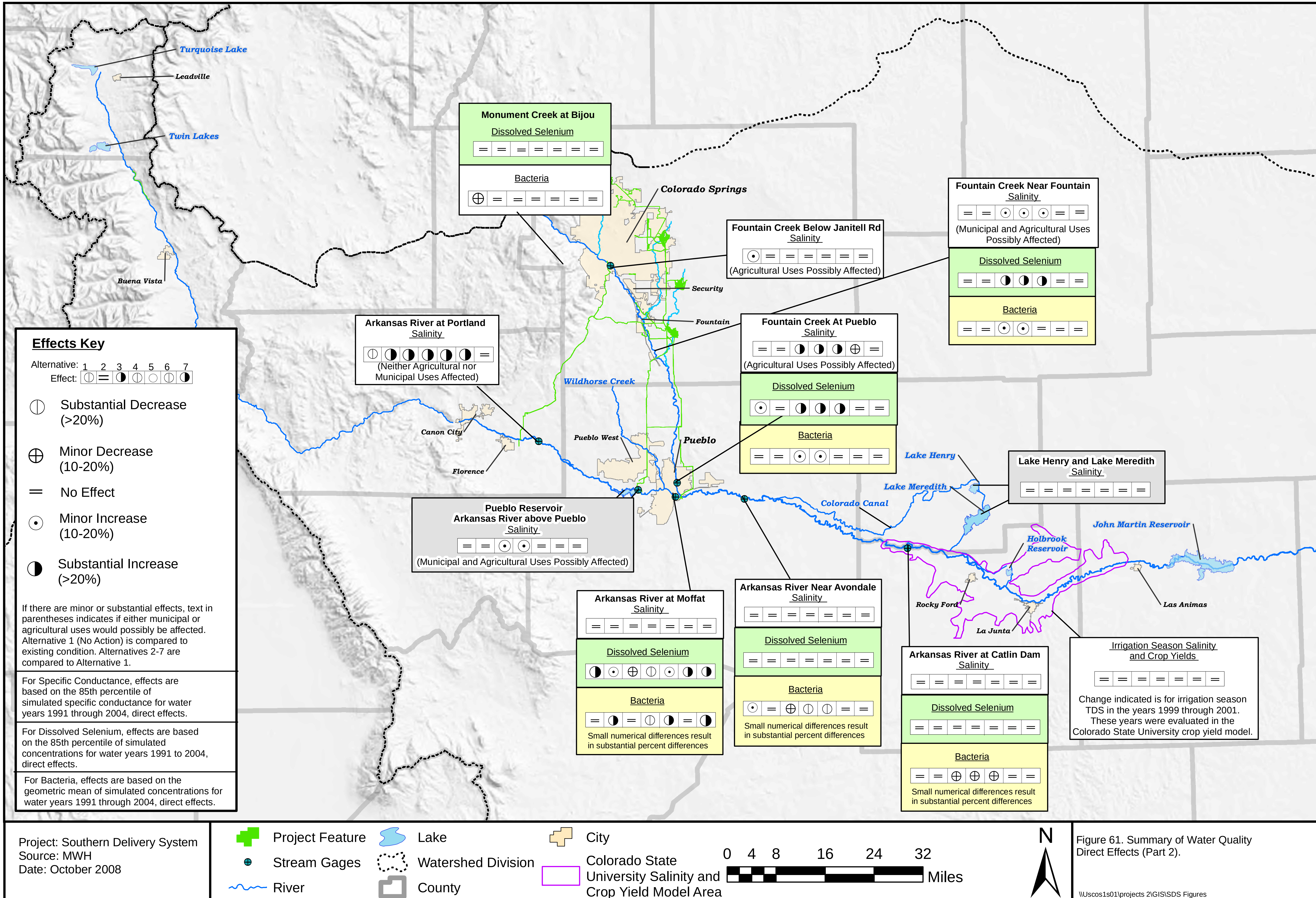

Figure 61. Summary of Water Quality Direct Effects (Part 2).

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Table 56. Water Quality Standards and Thresholds Used in Water Quality Analysis.

Parameter	WQS and Thresholds
Salinity	No WQS. Thresholds referenced are: Agricultural High Salinity Hazard = 750 µS/cm specific conductance (Richards 1954) Drinking Water Secondary MCL = 500 mg/L total dissolved solids (TDS) (EPA 1991)
Sulfate	250 mg/L or quality as of January 1, 2000 for waters with an actual water supply use. Site-specific ambient-based underlying standards for sulfate have been adopted for several segments in the analysis area (CDPHE 2008a).
Dissolved Selenium	chronic = 4.6 µg/L acute = 18.4 µg/L Site-specific ambient- and attainability-based underlying standards for selenium have been adopted for several segments in the analysis area based on data showing natural sources of selenium that are not exacerbated by human activity. In other segments, temporary modifications are in place because the underlying standards are not being met due to either correctable human-induced conditions, or significant uncertainty regarding the appropriate long-term underlying standard (CDPHE 2008a)
Metals	Most WQS are hardness dependent except the following Total recoverable iron (chronic) = 1,000 mg/L Dissolved manganese (chronic) = 50 mg/L (water supply segments only) (CDPHE 2008a, 2008c)
Bacteria	*Escherichia coli* (*E. coli*) = 126 colonies / 100 mL (recreation class E) (CDPHE 2007a)
Temperature	Maximum weekly average temperature (in °C) varies by waterbody type, use classification, expected fish species, and season (CDPHE 2008a)
Nutrients	Nitrate plus nitrite (acute) = 10 mg/L as nitrogen Reference streams for the region have nitrate plus nitrate concentrations ranging from below detection to 6.75 mg/L Ammonia, WQS are a function of pH and temperature Phosphorus, no WQS, reference streams for the region have total phosphorus concentrations ranging from below detection to 1.72 mg/L (Ecoregion IV, subecoregion 26 of EPA 2000; CDPHE 2008a, 2008c)
Dissolved Oxygen	Aquatic Life Class 1 warm and cold water = 6.0 mg/L, 7.0 mg/L spawning (minimum) Aquatic Life Class 2 = 5.0 mg/L (minimum) (CDPHE 2008a)
pH	Range between 6.5 to 9.0 (CDPHE 2008a)

Note: not all applicable WQS are summarized above, only those used in the water quality analysis.

The Clean Water Act requires that states submit to the EPA a list of those waters for which technology-based effluent limitations and other required controls are not stringent enough to attain WQS. The most recent list of water quality limited segments, known as the 303(d) list, was published by CDPHE in April 2008 (CDPHE 2008d).

The WQCD regulates the discharge of pollutants into the state's surface and ground waters. Discharge permits are issued via the Colorado Discharge Permit System (CDPS), with effluent limits on dischargers that protect attainment of WQS in receiving waters. These permits commonly include numeric limits for pollutants with WQS as well as requirements for compliance monitoring and reporting to CDPHE. This permitting process ensures that permitted dischargers, such as wastewater treatment facilities, will not cause impairment of the stream affecting beneficial uses, such as recreation, agriculture, and municipal water supply.

Communities in the study area with a population of at least 10,000 are required to implement stormwater quality controls through municipal stormwater permits (MS4s) issued by CDPHE. These controls generally address discharges from construction sites, industrial sites, and general urban runoff.

Water Quality Measurements

µg/L is micrograms per liter, which roughly translates to parts per billion.

mg/L is milligrams per liter or roughly parts per million.

µS/cm is a measure of electrical conductivity in microsiemens per centimeter, which is an indicator of the number and type of ions (or "salinity") in the water.

Regulation Number 41 (Basic Standards for Ground Water) (CDPHE 2008e) defines WQS for water supply and agricultural uses of ground water. Regulation Number 42 (Site-Specific Water Quality Classifications and Standards for Ground Water) specifically applies domestic and agricultural use classifications to three specific wellfields in the analysis area: Crowley County, La Junta, and Las Animas (CDPHE 2006c).

Salinity is one parameter of interest without a numerical WQS for analysis area surface waters. Therefore the water quality analysis relies on two other thresholds for comparison:

- The drinking water guideline, or secondary Maximum Contaminant Level (MCL), an aesthetic threshold above which taste may be affected (EPA 1991)
- The agricultural high salinity hazard indicates a range of salinity in which the productivity (or yield) of certain salt-sensitive crops may be diminished (Richards 1954)

Neither of these salinity guidelines are enforceable standards, but they provide information about levels of surface water salinity above which there may be adverse effects. The approach of evaluating the alternatives' potential salinity effects on crop yield is consistent with CDPHE's proposed guidance for developing effluent limits to protect irrigated crops (CDPHE 2007a).

Nutrients are another parameter group where water quality thresholds were used in addition to WQS, which are focused on drinking water uses of the water. To compare phosphorus and nitrogen levels to a threshold based on typical regional concentrations, nutrient concentrations in analysis area stream segments also were compared to the range of nutrient concentrations reported by EPA for regional reference streams (Ecoregion IV, subecoregion 26) (EPA 2000).

The term "emerging contaminants" refers to contaminants found in water that may have human and environmental effects but are not currently regulated by the state or federal government. Emerging contaminants include pharmaceuticals and personal care products, some of which include endocrine-disrupting compounds that can mimic hormones. These compounds do not have regulatory standards or generally accepted thresholds resulting in human health or aquatic life effects.

3.7.3 Analysis Area and Methods

3.7.3.1 Analysis Area

The analysis area for water quality is the same as for hydrology (Section 3.5).

3.7.3.2 Methods

Affected Environment

Several published studies were reviewed for water quality information in the analysis area. For most parameters, raw data collected by other entities for purposes other than this EIS were analyzed and compared to the thresholds shown in Table 56. Data for parameters with WQS were analyzed according to the methods listed in CDPHE's Section 303(d) Listing Methodology for the 2006 Cycle (CDPHE 2005b). Following CDPHE guidelines, in most cases, the 85^{th} percentile of the available surface water data was compared to the numeric WQS to determine attainment of WQS. For total metals, the median statistic is used and for bacteria, the geometric mean is used.

Data sources evaluated included USGS, Reclamation, CDPHE, EPA's STORET database, Colorado Springs Utilities, City of Pueblo, and Colorado Mountain College. No new water quality sampling was conducted for this FEIS.

Effects Analysis

Different methods of estimating effects were used depending on the parameter being evaluated, data availability, and potential effects. For some locations and parameters, models or specialized software were used to analyze water quality effects. For other parameters, mixing calculations were used to estimate stream concentrations and temperatures. For the remaining parameters, qualitative or semi-quantitative analysis was conducted. Semi-quantitative analyses use numerical values, but do not estimate future concentrations. The effects analysis methods are described in detail in technical documents (MWH 2008e, 2008h). The effects are documented in detail in the Water Quality Effects Analysis (MWH 2008f) and in the Water Quality Administrative Record Documentation (MWH 2008h).

Water Quality Statistics - Percentiles

Percentiles are frequently used to summarize water quality data. Percentiles are not affected by a few extreme values in a dataset. Statistics such as the average can be affected by extreme values.

50^{th} percentile (or median) is the value in a set of measurements at which 50 percent of the values are lower and 50 percent are higher.

85^{th} percentile is the value in a set of measurements at which 85 percent of the values are lower and 15 percent are higher. This statistic is frequently used by CDPHE to compare surface water quality to WQS.

Western Slope

Potential water quality effects in the Western Slope analysis area were evaluated qualitatively using simulated hydrologic data.

Selenium and E. coli

Potential effects on dissolved selenium and *E. coli* within Monument Creek, Fountain Creek, and the Arkansas River downstream of Pueblo Reservoir were determined through a mass balance analysis for the parameters within individual stream segments. A mass balance of dissolved selenium and *E. coli* was calculated for 100 randomly selected days from the Daily Model study period (1982 to 2004) in order to simulate a range of streamflow regimes (see Section 3.5.3 for a discussion of the Daily Model). Simulated streamflow, inflow, diversion, and ungaged gains from the Daily Model, which vary for Existing Conditions and each of the SDS alternatives, were used as the hydrologic inputs to the model. Simulated water quality input data were determined based on historical data for point source dischargers, surface water, ground water, and stormwater, and through a calibration process for ungaged gains. The mass balance calculation for dissolved selenium and *E. coli* was completed for the following segments.

- Monument Creek – Monument Creek above Woodmen Road to Monument Creek at Bijou Street
- Upper Fountain Creek – Fountain Creek at Colorado Springs (Nevada Street Gage) to Fountain Creek near Fountain
- Lower Fountain Creek – Fountain Creek near Fountain to Fountain Creek at Pueblo
- Middle Arkansas River – Arkansas River above Pueblo to Arkansas River at Moffat Street
- Lower Arkansas River Segment 1 – Arkansas River at Moffat Street to Arkansas River at Avondale
- Lower Arkansas River Segment 2 – Arkansas River at Avondale to Arkansas River at Catlin Dam at Fowler

Salinity

A salinity model, described in detail in the Water Quality Effects Analysis Approach (MWH 2008e), was used to estimate effects of the alternatives on surface water salinity in Fountain Creek and the Arkansas River. The salinity model uses a salt balance approach to estimate specific conductance, a measure of the ability of water to conduct electrical current, which is directly related to total dissolved solids (TDS). Daily Model-simulated streamflow, runoff, diversions, return flows, and reservoir storage are inputs to the salinity model. The model period is water years 1991 through 2004.

Salinity effects were evaluated for the Arkansas River between the Portland Gage and the Colorado Canal System, and on Fountain Creek from Monument Creek to the confluence with the Arkansas River. The model could not be calibrated downstream of the Colorado Canal System because of the large volume of irrigation return flows and a lack of data to characterize their quality. Because of limitations in the salinity model, only differences of at least 10 percent between calculated salinity under the various alternatives were considered meaningful (see discussion in Water Quality Effects Analysis Approach, MWH 2008e).

For the cumulative effects analysis, the salinity model simulates the effects of development on surface water salinity. The additional return flows caused by urban growth throughout the analysis area are included in the Daily Model. Those flows are in turn included in the salinity model. Return flows entering surface waters between salinity model nodes are assigned salinity concentrations equal to historical ungaged inflows.

Colorado State University's combined surface and ground water model for the lower Arkansas River (Crop Yield Model) was used to evaluate potential crop impacts of salinity changes in the vicinity of La Junta (Figure 61). A sensitivity analysis was conducted to determine crop yield effects from a range of increases in surface water TDS. The Crop

Yield Model is calibrated for 1999 through 2001). Relationships were developed relating surface water TDS increases in each of the model years to decreases in crop yield. The simulated irrigation season average TDS at the Catlin Dam Gage was used to estimate crop yield effects for each alternative in each of the three years.

Sulfate

Potential effects on sulfate concentrations for the lower Arkansas River downstream of the Fountain Creek confluence were estimated using results of the salinity model and a regression equation for sulfate concentrations as a function of specific conductance. The regression equation was developed using historical sulfate and specific conductance data from the Arkansas River near Avondale streamgage (07109500). The resulting regression equation is provided below.

$$\text{Sulfate} = (0.3659 * \text{specific conductance}) - 47.669,$$

where sulfate concentrations are in mg/L, and specific conductance is in µS/cm.

A high coefficient of determination resulted from the regression equation (r^2=0.97), indicating a good statistical fit for the regression equation.

Low Flows at Discharge Locations

Monthly chronic low flows were estimated at locations of major wastewater treatment facilities (WWTFs) (1 million gallon per day capacity or greater) within the SDS Project analysis area to determine the level of dilution available to the WWTFs for each alternative. Reductions in dilution could result in WQS non-attainment due to discharges and may change discharge requirements for WWTFs resulting in the need to change treatment processes. Low flows were estimated using the CDPHE version of the EPA DFLOW program. CDPHE's version of DFLOW calculates the 30-day average low flow with an average 1-in-3 year recurrence interval (referred to as the 30E3) (CDPHE 2008c). Simulated daily streamflow data for the last 10 years of the hydrologic model study period (water years 1995 to 2004) were used to calculate the monthly chronic low flows.

Wastewater Treatment Facility Effluent Limits

An analysis of potential indirect effects on effluent limits for WWTFs within the Fountain Creek and lower Arkansas River portions of the study area, where the potential for effects was greatest, was conducted. These effects could result from changes in streamflow or background water quality by the SDS Project. Effluent limits were estimated by completing a Water Quality Assessment (WQA) for potentially affected facilities. The procedure used for completing the WQAs was based on the CDPHE approach for discharge permitting, which involves calculating a mass balance of parameters of concern between ambient water quality upstream of a discharger and effluent from a discharger in order to achieve WQS downstream of the discharger. These evaluations generally used acute and chronic low flow calculations at discharge locations (see previous subsection), background water quality from the analyses described earlier in this section, and assumptions from existing WQAs prepared by CDPHE.

WQA analyses were completed for the following parameters and permitted dischargers along Fountain Creek and the Arkansas River:

- Colorado Springs J.D. Phillips Water Reclamation Facility (WRF) – dissolved selenium and *E. coli*

- Colorado Springs LVSWWTF – dissolved selenium and *E. coli*
- Fort Carson, Fountain, Security, and Widefield WWTFs – dissolved selenium and *E. coli*
- Pueblo WWTF – dissolved selenium, *E. coli*, and sulfate
- Rocky Ford WWTF – dissolved selenium and *E. coli*

The J.D. Phillips WRF is located on Monument Creek upstream of any potential effects of the proposed SDS project, and as a result low flows used in the calculation of effluent limits would be the same for Existing Conditions and all SDS alternatives. Additionally, ambient water quality would be unaffected by the proposed SDS operations within this reach. As a result, ambient water quality for Monument Creek upstream of the J.D. Phillips WRF was assumed to be equal to historical conditions for all alternatives.

Metals and Selenium in the Upper Arkansas River

Simulated streamflows for Existing Conditions and alternatives at the Granite Gage were compared to assess changes in metal concentrations in the upper Arkansas River. Streamflow and quality expected in the Highway 115 Return Flow Pipeline (Wetland and Arkansas River alternatives) and the upper Arkansas River were evaluated to determine whether releases from the Return Flow Pipeline would increase metals concentrations in the upper Arkansas River near the Portland Gage.

Suspended Sediment

Colorado has no numerical WQS or accepted thresholds for suspended sediment concentrations for the Arkansas River Basin. Suspended sediment effects were qualitatively evaluated based on changes in streamflow in Fountain Creek. Historically, positive correlations occurred between streamflow and suspended sediment concentrations in Fountain Creek (Bossong 2001; USGS 2005), indicating that higher streamflows corresponded with higher sediment concentrations. Of the three sources of suspended sediment to Fountain Creek (i.e., tributary contributions, channel erosion, and surface erosion in the watershed), SDS alternatives would primarily affect sediment contributed through channel erosion due to changes in streamflow. Operation of reservoirs on Jimmy Camp Creek and Williams Creek would affect the amount of sediment contributed from those tributaries, but sediment from other tributaries would not be affected. Sediment from surface erosion directly to Fountain Creek would be equal for all alternatives. Higher streamflows are likely to result in greater channel erosion in Fountain Creek and, therefore, the sediment analysis compares streamflows between alternatives to determine which alternatives would have the highest suspended sediment concentrations.

A regression equation between historical streamflow and suspended sediment at the Security Gage was used to determine the maximum potential effects on suspended sediment at Security. The historical regression equation accounts for all three sources of suspended sediment. Therefore, actual effects on suspended sediment due to changes in streamflow alone would be less than those estimated.

Lower Arkansas River Total Recoverable Iron

Total recoverable iron in Fountain Creek and other tributaries contributes to elevated iron concentrations in the lower Arkansas River. Iron that flows into Fountain Creek with runoff as well as other tributary sources of iron to the lower Arkansas River would not be affected by the alternatives. However, iron associated with sediments scoured from the Fountain Creek channel could be affected by the alternatives in the same manner as suspended sediments. The amounts of flow from Fountain Creek associated with the different alternatives were compared to provide a qualitative indication of total recoverable iron effects in the lower Arkansas River.

Temperature

Effects on stream temperature were evaluated using mixing calculations, where the combined temperature was calculated from individual temperatures and flows from two separate water sources. Stream temperature was determined for the following locations and alternatives:

- Highway 115 Return Flow Pipeline on upper Arkansas River near Portland in the Wetland and Arkansas River alternatives
- Fountain Creek from Williams Creek Reservoir releases in the No Action, Participants' Proposed Action, Downstream Intake, and Highway 115 alternatives
- Eastern Return Flow Pipeline on the lower Arkansas River downstream of Fountain Creek in the Fountain Creek Alternative

Emerging Contaminants

The emerging contaminants analysis is based on studies of these compounds in surface waters downstream of WWTFs and apparent effects to aquatic life (White et al. 1994; Jobling et al. 1998). Based on these studies, although human health may not be affected by small concentrations of emerging contaminants in source waters, public perception would likely favor alternatives with the least amount of wastewater discharge upstream of water supplies. A comparison of the discharge and source water locations for the different alternatives is included in the Direct and Cumulative Effects sections.

Nutrients in Stream Segments

Effects on nutrient concentrations in stream segments were analyzed semi-quantitatively and qualitatively. For alternatives with the Highway 115 Return Flow Pipeline, mixing calculations were performed for the upper Arkansas River near Portland, assuming that current Colorado Springs Utilities WWTF effluent nutrient concentrations would be similar to future concentrations. For the remaining stream segments in the analysis area, the relative contributions of nutrients from different configurations of return flows were discussed qualitatively.

Twin Lakes, Turquoise Lake, Lake Henry, Lake Meredith, and Holbrook Reservoir

Water quality at Twin Lakes, Turquoise Lake, Lake Henry, Lake Meredith, and Holbrook Reservoir was semi-quantitatively evaluated based on simulated changes to reservoir storage and likely changes in inflow water quality.

Pueblo Reservoir

The U.S. Army Corps of Engineers CE-QUAL-W2 model (ver. 3.2) was used to simulate water quality in Pueblo Reservoir for the alternatives and Existing Conditions. The following four scenarios, representative of the seven alternatives, were modeled:

- Scenario A – No Action Alternative
- Scenario B – Downstream Diversion (Participants' Proposed Action, Fountain Creek, and Downstream Intake alternatives)

- Scenario C – Upstream Return Flow (Wetland and Arkansas River alternatives)
- Scenario D – Upstream Diversion (Highway 115 Alternative)

The construction, calibration, and testing of the USGS Pueblo Reservoir model is documented in Galloway et al. (2008). The laterally averaged, two-dimensional model was calibrated using data collected from October 1985 to October 1987 (water years 1986 to 1987) and verified with data from water years 2000 to 2002. Lake operations, water temperature, dissolved oxygen, TDS, dissolved ammonia, dissolved nitrate (measured as dissolved nitrite plus nitrate), dissolved orthophosphorus, total phosphorus, algal biomass (measured as chlorophyll *a*), and total iron were modeled. Verification showed that the model captured the most important seasonal and spatial influences on reservoir water quality.

Each of the scenarios was modeled for three contiguous years, October 1999 to October 2002 (water years 2000 to 2002), representing a wet, average, and dry hydrologic cycle. Scenario-specific input files were created using simulated inflows, outflows, and inflow water quality.

Water quality input data for modeling alternatives scenarios were based primarily on the data from the verification period. However, changes were made to the input water quality data after nutrient concentrations were decayed, based on literature decay rates, along an upstream reach of the Arkansas River, beginning at Portland. The Existing Conditions scenario represented the results of the CE-QUAL-W2 model verification data with decayed nutrient input data.

Discussions of model results only consider the results of modeling at the model segment near the dam because results at this location represent the outflow and diversion water quality from the reservoir. Ortiz et al. (2008, in press) includes a more detailed discussion of the model results.

Terminal Storage

Water quality for the terminal storage reservoirs at Jimmy Camp Creek and Upper Williams Creek was assessed to identify probable stratification and dissolved oxygen conditions based on simulated storage. Stratification and dissolved oxygen conditions are important for aquatic life (Section 3.10). The Osgood Index, a function of reservoir depth and surface area, was calculated for the terminal storage reservoirs for each alternative. According to published data, reservoirs with an Osgood Index of greater than about 8 are likely to stratify (Osgood 1988).

No other water quality analysis was performed for these reservoirs because, except for passage of stormflows, the water would directly enter the Project Participants' water distribution systems and would not be released downstream.

Williams Creek Reservoir

A water quality model of Williams Creek Reservoir was developed using EPA's Aquatox software. The model is one dimensional, but can simulate stratification. Historical water quality data for Fountain Creek and the LVSWWTF were used to estimate the quality of inflowing water to Williams Creek Reservoir. The model was used to simulate water quality in the reservoir for the No Action, Participants' Proposed Action, Fountain Creek, Downstream Intake, and Highway 115 alternatives. Williams Creek Reservoir is not a component of the Wetland and Arkansas River alternatives. The model was simulated for October 1996 through

July 2003 to cover a range of hydrologic conditions. Model output was summarized and Carlson's Trophic State Index (TSI) (Carlson 1979) was calculated using monthly average simulated chlorophyll *a* concentrations.

Ground Water

Surface water quality changes also would affect alluvial ground water adjacent to that particular stream segment. Ground water pumping rates affect the extent to which alluvial ground water quality is affected by surface water quality. Differences in alluvial ground water pumping between alternatives were discussed along with relevant surface water effects to describe effects to alluvial ground water quality in the analysis area.

The effects analysis also includes a discussion of how pumping of the Denver Basin aquifers in the No Action Alternative may cause migration of water of different qualities from one area of the aquifer toward the well sites.

3.7.3.3 Limitations

Future contributions of pollutants such as bacteria and nutrients from the watershed and point sources to surface waters cannot be predicted. All of the quantitative analyses build on the results of the daily hydrologic model, which also has uncertainty. Although the models and numerical analyses present quantitative results, those results are best used for comparison of relative effects between alternatives, rather than as a prediction of likely future conditions.

3.7.4 Affected Environment

3.7.4.1 Surface Water Quality

This section summarizes surface water quality conditions on the Western Slope and in the Arkansas River and Fountain Creek basins, generally from upstream to downstream. A more detailed description of water quality within the analysis area is presented in the Water Quality Technical Report (MWH 2008g). Figure 62 is a summary of the water quality-limited segments and concerns in the analysis area. It was developed using CDPHE's 2008 303(d) list (CDPHE 2008d).

Water quality is generally good in the Western Slope study area. No segments in this portion of the study area are on the 2008 303(d) list of impaired waters. Homestake Reservoir is located high on the Western Slope and is operated for Eastern Slope water supply diversion except for in-basin releases to meet minimum streamflow requirements. Although water quality data were not available for Homestake Reservoir, water quality is expected to be good due to good quality of Homestake Creek and its tributaries, which supply the reservoir.

Water quality is generally good in the upper Arkansas River due to low levels of development. The exceptions are some water quality impairments and concerns for heavy metals due to historical mining activity near the Continental Divide. In the upper Arkansas River analysis area, zinc and cadmium are the only impairments on the 2008 303(d) list.

Historical data suggest that Lake Fork Creek exceeds WQS for cadmium, copper, manganese, lead, and zinc (Walton-Day et al. 2005; CMC 2005) and Lake Creek exceeds WQS for copper and cadmium (although the data for Lake Creek are more than 10 years old) (USGS 2006b). The 2008 303(d) list shows Lake Creek as impaired for pH, dissolved oxygen, and copper.

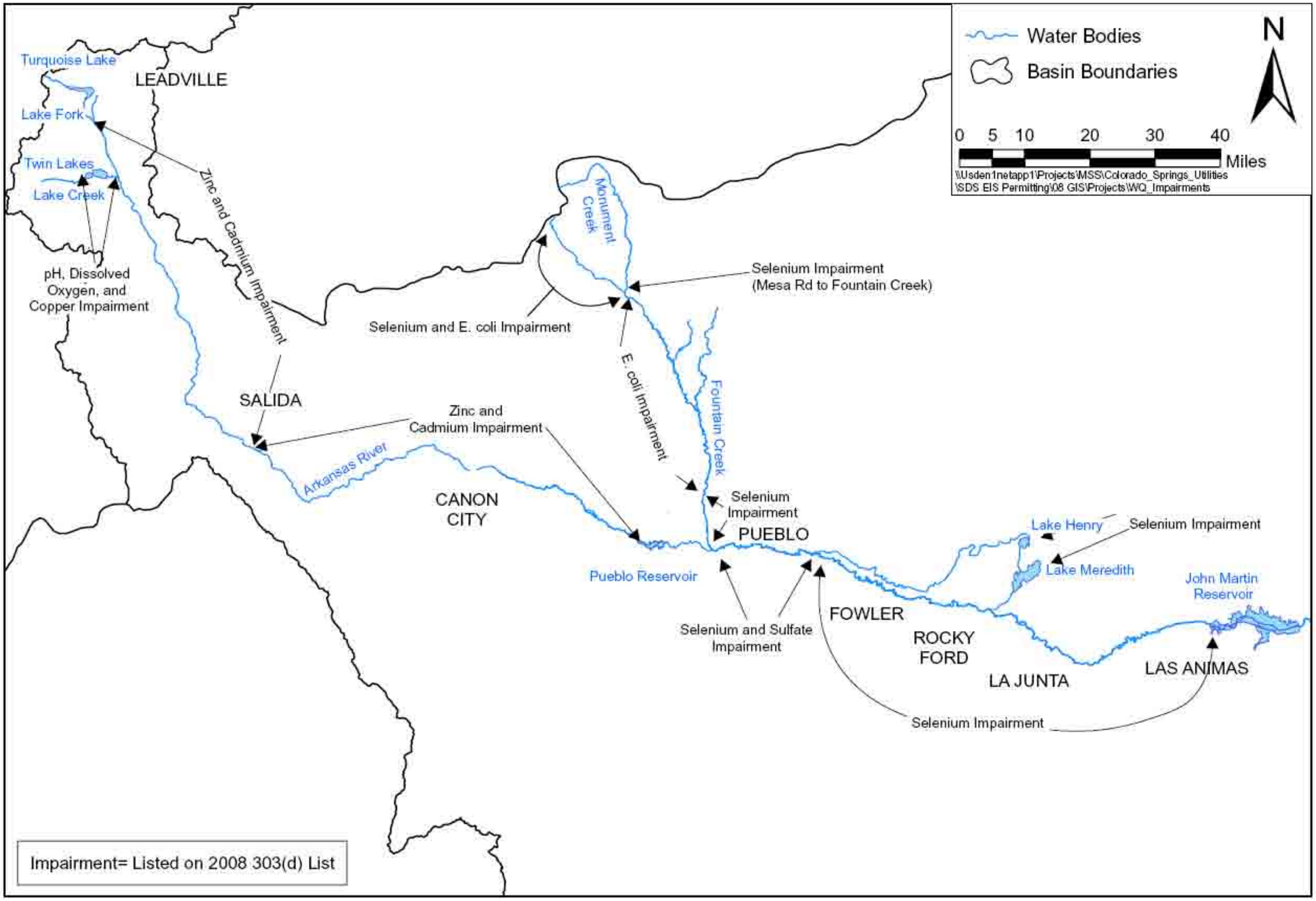


Figure 62. Summary of Current Water Quality Impairments and Concerns in the Analysis Area.

Source: CDPHE 2008d.

Turquoise Lake and Twin Lakes are located at high elevations with snowmelt runoff from the Western Slope (via transbasin diversions) and tributary watersheds as the main water sources. The 2008 303(d) list shows Twin Lakes as impaired for pH, dissolved oxygen, and copper. Twin Lakes and Turquoise Lake can be considered oligotrophic (see Figure 63 for the trophic state continuum), with clear water, low nutrient concentrations, and low production of organic matter. Lakes are classified according to their levels of production along the continuum of trophic state. The inputs of humans into a watershed can cause a lake to progress toward a more eutrophic condition. Eutrophication can result in the following water quality concerns:

- Low dissolved oxygen concentrations and consequent reduced aquatic life and releases of contaminants from bottom sediments
- Reduced aesthetic quality due to high plant growth, algal scums, and reduced visibility
- Taste and odor issues

The Arkansas River is classified for cold water aquatic life beneficial uses from its source downstream to Wildhorse Creek. An analysis of historical Arkansas River temperatures at the Portland and Above Pueblo gages indicates that historical maximum weekly average stream temperatures exceed the cold water aquatic life WQS of 20 ºC.

The quality of inflows to Pueblo Reservoir from the upper Arkansas River tends to be good and no impairments are listed for the reservoir (CDPHE 2008d). Pueblo Reservoir strongly stratifies during the summer (i.e., develops horizontal layers of differing water temperatures, Figure 64), which reduces mixing and can lead to periods of low dissolved oxygen near the bottom. The low dissolved oxygen causes some metals, particularly manganese, and nutrients to dissolve out of the sediments. This dissolution, however, historically has not been sufficiently widespread to affect water quality in the reservoir as a whole or releases downstream of the reservoir (Lewis and Edelmann 1994). Algae levels in Pueblo Reservoir are low to moderate; phosphorus is the limiting nutrient for algae growth (Lewis and Edelmann 1994). Chlorophyll *a* concentrations (a measure of algae levels) (USGS 2006b) indicate that Pueblo Reservoir borders between mesotrophic and eutrophic (Carlson 1979). Downstream of Pueblo

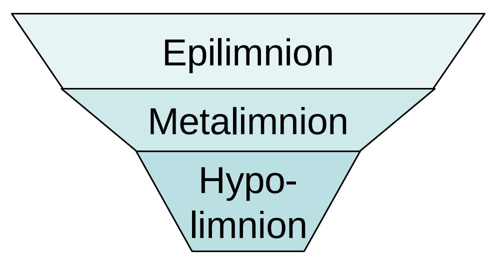


Figure 64. Layers of Stratified Reservoir

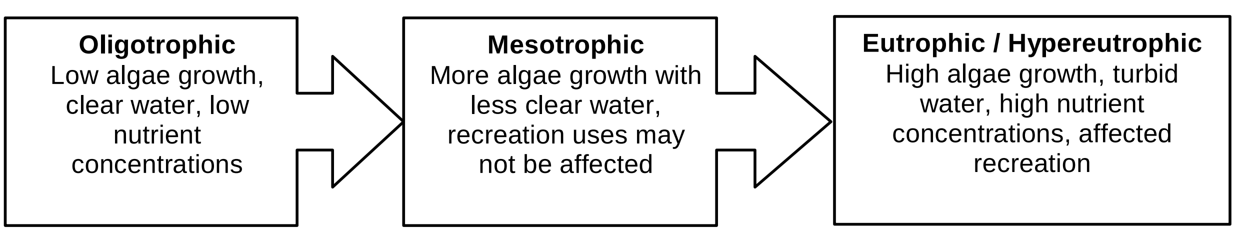


Figure 63. Trophic State Continuum.

Modified from Wetzel (2001) and Carlson (1979).

Reservoir, development in watersheds tributary to the Arkansas River increases and more parameters are either on the 303(d) list or are a concern as defined in Figure 62.

In 2007, selenium WQS based on ambient stream concentrations were implemented because selenium loading "results from natural sources and is not exacerbated by land use or other reversible, anthropogenic factor" were implemented in the middle Arkansas River, lower Fountain Creek, and the lower Arkansas River (CDPHE 2008a). The ambient-based WQS for selenium in the lower Arkansas River are temporary (expiring in 2009 or 2012). The underlying WQS were used for effects determinations in this FEIS. The middle Arkansas River, some segments in the Fountain Creek Basin, and the lower Arkansas River were previously on the 2006 303(d) list for dissolved selenium (CDPHE 2006a). Upper Monument Creek and the Arkansas River between Pueblo Reservoir and Fountain Creek were removed from the 2008 303(d) list (CDPHE 2008d).

Marine shale rock formations and soil derived of marine shales underlie much of the Fountain Creek and lower Arkansas River Basin (USGS 1992). Water from lawn watering, irrigation, and precipitation contacts selenium-containing rock and soils in the analysis area. Under some conditions, selenium can dissolve into this ground water, which eventually flows to Fountain Creek and the Arkansas River.

Elevated selenium concentrations can cause adverse health effects to egg-laying aquatic life and birds, which are more sensitive to selenium than mammals (Reclamation 1998). Although data indicate that ambient selenium concentrations in some analysis area segments exceed aquatic life-based WQS (as shown in Table 57), the limited studies of aquatic and semi-aquatic life in the analysis area have not documented adverse effects from selenium (Mueller et al. 1991; Keller 2005). Several stream segments in the analysis area have temporarily modified selenium WQS or permanent site-specific WQS (Table 56 and Table 57).

Downstream of Monument Creek, Fountain Creek is a source of municipal drinking water and irrigation water from both direct river diversions and recharge of alluvial aquifers connected to the river. Salinity levels tend to be greater than drinking water and agricultural high salinity hazard guidelines. Figure 65 summarizes Existing Conditions salinity levels in the analysis area.

Sulfate concentrations are related to salinity concentration in the Arkansas River (Ortiz et al. 1998). Sulfate was added as an impairment for the Arkansas River from Fountain Creek to the Colorado Canal on the 2008 303(d) list. A temporary modification to the sulfate WQS is in place for this segment because CDPHE and the City of Pueblo believe that some sulfate reduction is possible through implementation of best management practices (CDPHE 2008a). The underlying WQS was used for effect determinations in this FEIS.

Fountain Creek is characterized by high rates of erosion and the water tends to be turbid. As shown in Figure 66, suspended sediment concentrations tend to be at least 10 times greater during storm events than normal flows (May 1 through October 31, storm runoff removed) and base flows (November 1 through April 30, storm runoff removed). Several tributaries to Fountain Creek and Monument Creek, such as Sand Creek and Cottonwood Creek, contribute substantial amounts of sediment to Fountain Creek. Sand Creek was found to contribute from 23 to 37 percent of the sediment load at the Fountain Creek at Security Gage (Mau et al. 2007).

Table 57. Dissolved Selenium Historical Conditions (µg/L).

CDPHE Segment	Median	85th Percentile	Maximum	Chronic WQS†	Acute WQS†
UA2c. Upper Arkansas River - Lake Fork to Lake Creek	0	0	2.9	4.6	18.4
UA3. Upper Arkansas River - Lake Creek to Pueblo Reservoir	0	0	2.1	4.6	18.4
MA2. Middle Arkansas River - Pueblo Reservoir to Wildhorse Creek	5.0	**6.0**	7.0	4.6	18.4
MA3. Middle Arkansas River - Wildhorse Creek to Fountain Creek	7.4	13	36	17.4	50.9
FO01. Fountain Creek upstream of Monument Creek	3	**10**	15	4.6‡	18.4
FO06. Monument Creek	0.6	4.6	17	4.6	18.4
FO2a. Fountain Creek between Monument Creek and Colorado 47	4.1	7	**61**	8	18.4
FO2b. Fountain Creek between Colorado 47 and Arkansas River	17	**29**	**116**	28.1	42.3
LA1a. Lower Arkansas River - Fountain Creek to Colorado Canal	11	14	17	14.1§	19.1
LA1b. Lower Arkansas River - Colorado Canal to John Martin Reservoir	11	15	**36**	15.1 Φ	18.4

Exceedances are indicated by **bold** text.

†Acute WQS are compared to the maximum measured value. Chronic WQS are compared to the 85th percentile.

‡Temporary modification (8.7 µg/L) until 12/31/2012. The underlying WQS is 4.6 µg/L.

§WQS is a temporary modification to "existing quality" (14.2 µg/L) until 12/31/2012. The underlying WQS is 14.1 µg/L.

ΦWQS is a temporary modification to "current condition" (14.2 µg/L) until 12/31/2009, estimated according to the ambient statistic calculated by CDPHE for the 2006 303(d) process (CDPHE 2005a). The underlying WQS is 4.6 µg/L.

Data Source: MWH 2008g; WQS Source: CDPHE 2008a.

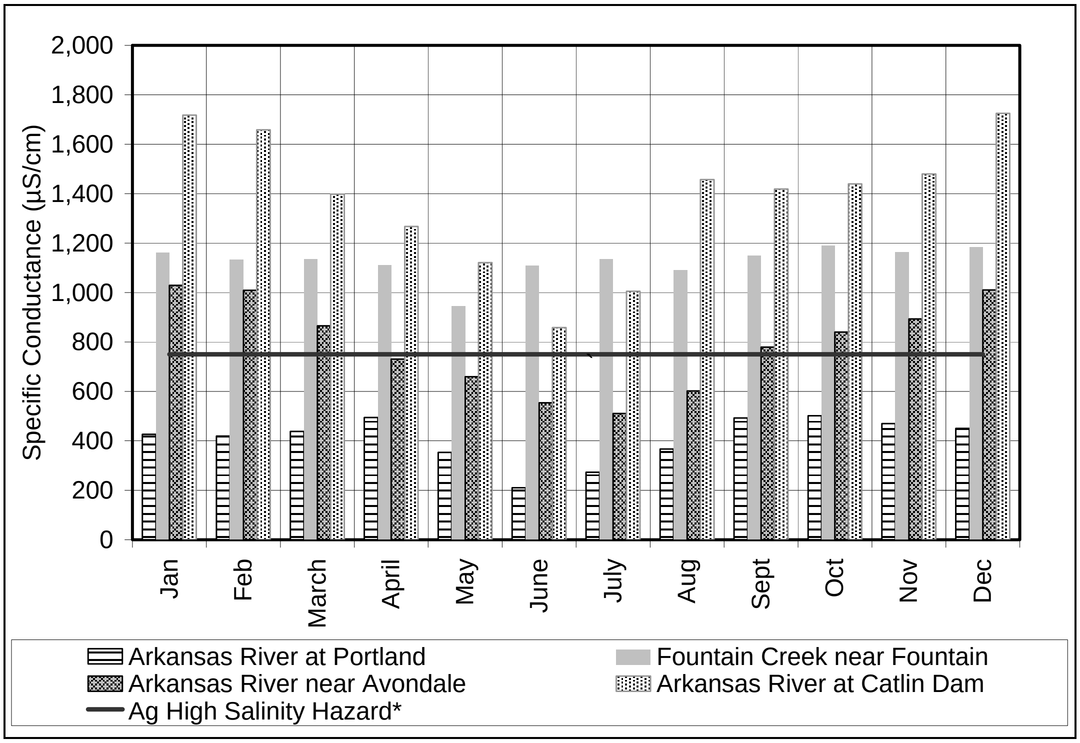


Figure 65. Average Monthly Specific Conductance at USGS Gages.

* Agricultural (Ag) High Salinity Hazard is generally a similar level of salinity to the drinking water secondary MCL, but the secondary MCL is measured in total dissolved solids and the conversion to specific conductance varies by location.
Data Source: USGS 2006b.

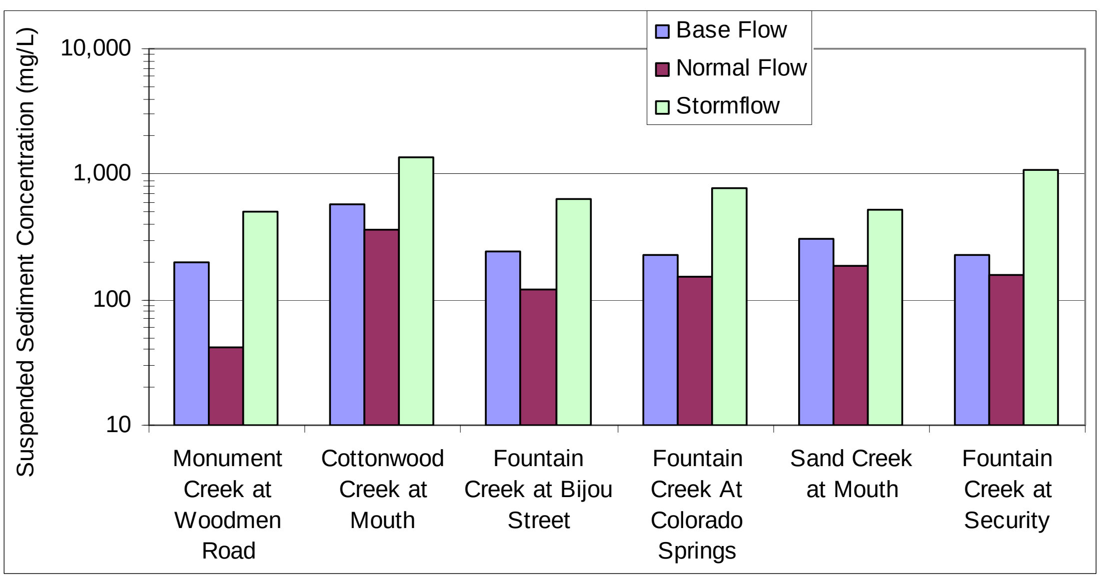


Figure 66. Median Suspended Sediment Concentrations – Fountain Creek Basin.

Normal flows (May 1 through October 31), base flows (November 1 through April 30), stormflows (storm events).

Data Source: Mau et al. 2007.

Particulate contaminants such as metals can be associated with suspended sediments. Total recoverable iron tends to adsorb to sediments and be transported in Fountain Creek at high levels during storm events (Edelmann et al. 2002). Concentrations of total recoverable iron tend to be higher in lower Fountain Creek and other tributaries than in the Arkansas River (Ortiz et al. 1998). In Fountain Creek and the lower Arkansas River, total recoverable iron WQS are set at ambient levels because the elevated concentrations are "due to natural and/or uncontrollable sources" (CDPHE 2008a).

Densities of *E. coli* bacteria are elevated in Fountain Creek. Bacteria densities in Fountain Creek are typically about 10 times higher during storm events than during baseflow conditions (Edelmann et al. 2002). Most segments of Fountain Creek are considered impaired by *E. coli* (CDPHE 2008d). Spatial analysis of historical bacteria data indicates both rural and urban sources of bacteria, and that storm runoff is a major source of bacteria in Fountain Creek (Edelmann et al. 2002). Tributaries such as Cottonwood Creek, Pine Creek, and Kettle Creek all have elevated bacteria concentrations during stormflows (Mau et al. 2007). Effluent data show that average bacteria concentrations in wastewater effluent are well below bacteria WQS (EPA 2007a) and likely dilute bacteria densities during stormflows.

During low flow periods, much of the flow in Fountain Creek downstream of Monument Creek is composed of wastewater return flows, with Colorado Springs' LVSWWTF being the largest discharger.. The quality of treated wastewater dischargers is regulated by CDPS permits. Figure 67 summarizes two years of monthly maximum and monthly average effluent quality for parameters of interest from Colorado Springs' LVSWWTF. Wastewater facilities in the Arkansas River Basin do not have salinity effluent limits and effluent salinity is rarely measured. However, historical data collected between 1997 and 2003 from the LVSWWTF showed median and maximum effluent specific conductance of 756 and 896 µS/cm, respectively (CSU 2005b).

Land uses in the lower Arkansas River watershed are primarily agricultural. The diversion and return flows from agricultural and municipal uses affect water quality between Fountain Creek and John Martin Reservoir. Salinity levels are above drinking water and agricultural high hazard guidelines downstream from the Avondale Gage. Salinity and selenium concentrations tend to be inversely related to streamflows, with the highest concentrations occurring during periods of low flow, generally in the winter (Figure 65 shows this seasonal trend in salinity).

Lake Henry and Lake Meredith do not stratify strongly for much of the year because of their shallow depth. Salinity levels typically exceed agricultural and drinking water guidelines in Lake Henry and Lake Meredith. Data analyzed for the FEIS, as well as the 2008 303(d) listing, suggest that dissolved selenium concentrations exceed WQS (Dahlberg 2005; CDPHE 2008b). Both reservoirs are eutrophic based on relatively low clarity and high phosphorus concentrations (Sullivan 1993). Little water quality data are available for Holbrook Reservoir, but its similar location, size, and water supply suggest that water quality is similar to Lake Henry and Lake Meredith.

Emerging contaminants are typically found in higher concentrations downstream of WWTFs than upstream of WWTFs. More study is necessary to determine human health effects and safe levels for consumption of most these contaminants; however, evidence suggests

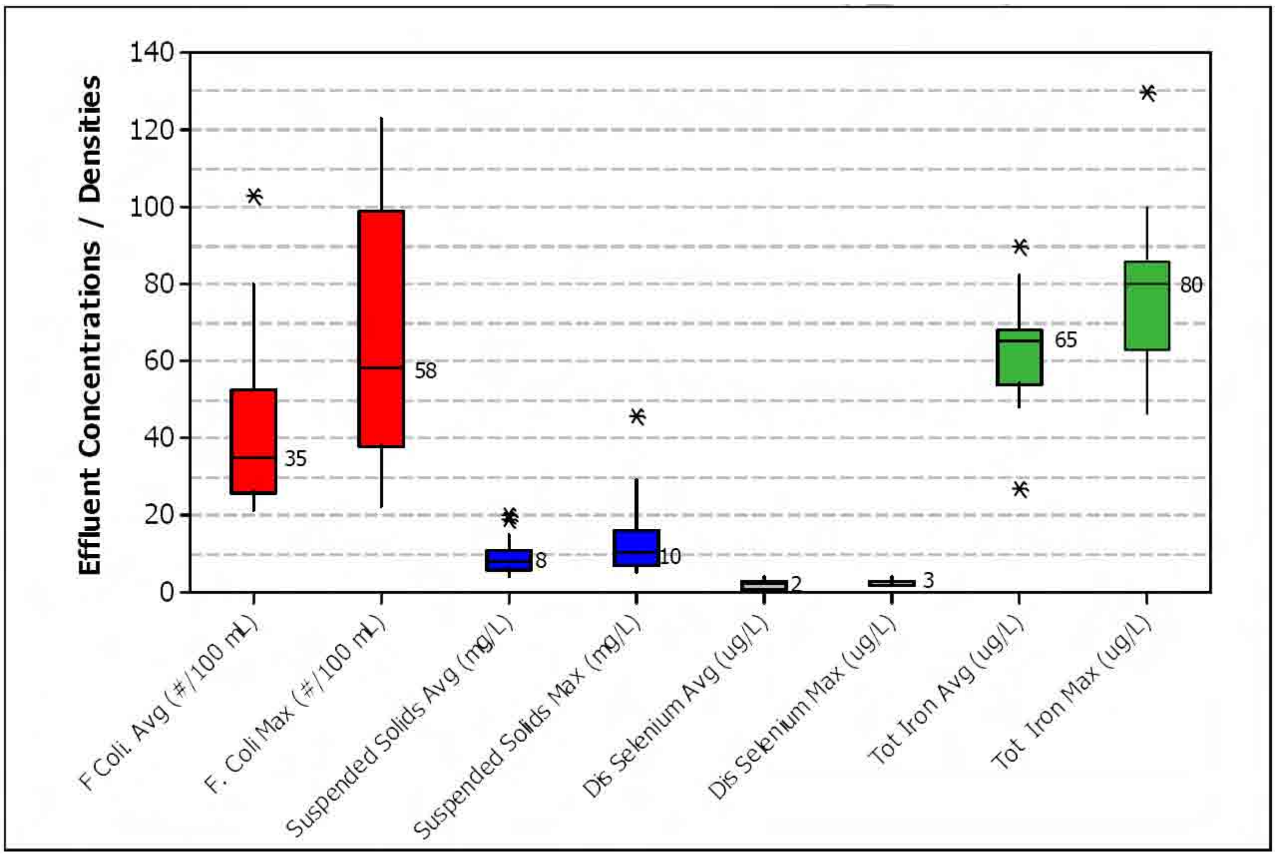


Figure 67. Las Vegas Street Wastewater Treatment Facility – Monthly Average and Maximum Effluent Statistics

† Data from February 2006 – February 2008

‡ Fecal coliform (F. coli) monthly maximum outliers not shown at: 202, 221, and 256 per 100 mL,

§ Medians are labeled

Source: EPA 2007a

some emerging contaminants may affect aquatic life, including causing changes in sexual development (Jobling et al. 1998; White et al. 1994).

A limited number of surface water samples from the Arkansas River Basin were analyzed by USGS (2006b) for some of the emerging contaminants including disinfectants, insect repellants, nonprescription drugs, pesticides, steroids, and solvents. As described in the Water Quality Effects Analysis (MWH 2008f), some contaminants were detected at very low concentrations, 5 µg/L or less; however, there is no clear spatial pattern in the detection or concentrations of these different types of compounds. Although relatively little development or wastewater discharge occurs upstream of the Portland Gage, several emerging contaminants were found at the same concentrations as at locations farther downstream. This preliminary analysis suggests that, in the Arkansas River Basin, levels of emerging contaminants in surface waters may not be related to proximity to WWTFs. However, more research is needed to confirm this initial conclusion.

3.7.4.2 Ground Water Quality

Limited ground water quality data are available to characterize Existing Conditions for most of the analysis area. Ground water quality in the upper Arkansas River Basin meets WQS for agricultural and domestic use with a few exceptions. Localized contamination due to acid mine drainage and industrial contamination has been documented (Crouch et al. 1984; Walton-Day et al. 2000). Three ground water sites in the analysis area in the upper Arkansas River Basin are on EPA's National Priorities List (hazardous waste sites eligible for cleanup under the federal Superfund program). All three sites are either actively being remediated, or have moved into the maintenance and monitoring stages of cleanup (EPA 2007b, 2007c; HDR 2007):

- California Gulch, near Leadville – contamination from historical mining activities; contaminants include: lead, arsenic, other metals, and acid mine drainage
- Smeltertown, near Salida – contamination from lead/zinc smelting, wood treatment, and zinc-sulfate manufacturing; contaminants include: arsenic, cadmium, copper, lead, manganese, zinc, pentachlorophenol, and creosote
- Lincoln Park, near Cañon City – contamination from uranium milling; contaminants include: molybdenum and uranium

The Fountain Creek alluvial aquifer, including the Widefield Aquifer, meets WQS for domestic use with the exception of localized areas of high TDS and nitrate. Salinity levels increase in the downstream direction.

Alluvial ground water along lower Fountain Creek and the Arkansas River in the vicinity of Pueblo can have concentrations of dissolved selenium on the order of 100 to 1,000 µg/L, 20 to 200 times greater than the chronic surface WQS of 4.6 µg/L (Keller 2006a).

Lower Arkansas River alluvial ground water generally meets WQS for agricultural and domestic use (CDPHE 2006d). However, salinity is a concern for the agricultural and municipal users of alluvial ground water. Both elevated salinity and the related problem of elevated ground water tables have been shown to affect crop yield in the lower Arkansas River Basin (Gates et al. 2002). High salinity also has caused some municipalities to invest in advanced drinking water treatment technology.

The quality of ground water in the Denver Basin aquifers generally meets irrigation and domestic water supply standards (CGS 2003). TDS and sulfate concentrations vary spatially within the Denver Basin aquifers, with some ground water near the lateral boundaries exceeding the drinking water secondary MCL for TDS (Robson 1987).

3.7.5 Environmental Consequences

3.7.5.1 Direct and Indirect Effects

The water quality effects analysis is discussed in the following order:

- Western Slope water quality
- Parameters examined quantitatively (bacteria, dissolved selenium, salinity, and sulfate) in Fountain Creek and Arkansas River
- Chronic low flow analysis for WWTFs
- Effluent limits at permitted discharge locations
- Water quality parameters examined semi-quantitatively or qualitatively (metals in the upper Arkansas River, suspended sediment, total recoverable

iron in the lower Arkansas River, temperature, nutrients in stream segments, and emerging contaminants) in Fountain Creek and Arkansas River

- Reservoirs (Twin Lakes and Turquoise reservoirs, Pueblo Reservoir, Lake Henry and Lake Meredith, Holbrook Reservoir, proposed terminal storage, and proposed Williams Creek Reservoir)
- Ground water

More detailed descriptions of the analysis and results are presented in technical documents (MWH 2008f, 2008h).

Western Slope Water Quality Effects

All alternatives would cause negligible to minor changes in streamflow in the Western Slope study area. These changes would occur primarily during the annual peak flow period of May through July or August. These slight streamflow differences would have negligible effects on water quality. The moderate reduction in storage volume for Homestake Reservoir for the No Action Alternative, compared to Existing Conditions would correspond to reduced residence times and would not affect water quality. Storage volumes for all Action Alternatives would be slightly greater than those for the No Action Alternative, resulting in negligible effects on water quality.

E. coli

Effects of all alternatives on *E. coli* densities in Monument Creek, Fountain Creek, and the Arkansas River below Pueblo Reservoir would be negligible to minor beneficial. All alternatives would have about the same *E. coli* densities in Monument Creek, and would have lower densities than Existing Conditions due to dilution water from the new J.D. Phillips Water Reclamation Facility (Table 58). The statewide WQS of 126 per 100 mL as a geometric mean is not met under Existing Conditions and would not be met despite reductions associated with the SDS alternatives.

Within Fountain Creek, *E. coli* densities for the No Action Alternative would be slightly lower than Existing Conditions. *E. coli* densities for the Wetland and Arkansas River alternatives would be slightly higher than for the other alternatives because the Highway 115 Return Flow Pipeline would divert reusable return flows with low *E. coli* densities out of Fountain Creek. The remaining Action Alternatives would have densities slightly lower than the No Action Alternative.

In the lower Arkansas River, *E. coli* densities for the No Action Alternative would be similar to those for Existing Conditions. Under all alternatives, including the No Action Alternative, the WQS would be met in the Arkansas River. *E. coli* densities in the Arkansas River are low under Existing Conditions. Consequently, the small numerical differences among alternatives shown in Table 58 represent percentage differences of up to 48 percent.

Dissolved Selenium

All alternatives would result in a combination of negligible, beneficial, and adverse effects on dissolved selenium concentrations in Monument Creek, Fountain Creek, and the Arkansas River below Pueblo Reservoir. At the Monument Creek at Bijou Street and Fountain Creek at Fountain locations, dissolved selenium concentrations would be similar among all alternatives (Table 59). The chronic WQS for selenium would be met in Monument Creek at Bijou Street (WQS = 4.6 μg/L) and in Fountain Creek at Fountain (WQS = 8.0 μg/L) under all alternatives.

Table 58. Estimated Direct Effects *E. coli* Densities.

Location	Existing Conditions	Alt 1	Alt 2	Alt 3	Alt 4	Alt 5	Alt 6	Alt 7
Geometric Mean Simulated *E. coli* (number/100 mL)								
Monument Creek at Bijou Street	474	386	386	386	386	386	386	386
Fountain Creek near Fountain	142	133	131	146	146	129	139	134
Fountain Creek at Pueblo	142	133	130	151	151	134	139	135
Arkansas River at Moffat Street	26	29	37	27	20	37	32	43
Arkansas River near Avondale	48	56	56	45	40	43	55	58
Arkansas River at Catlin Dam	56	60	61	54	51	53	59	62
Effects (number/100 ml) (Alternative - Alternative 1)								
Monument Creek at Bijou Street	---	---	0	0	0	0	0	0
Fountain Creek near Fountain	---	---	-2	13	13	-4	6	1
Fountain Creek at Pueblo	---	---	-3	18	18	1	6	2
Arkansas River at Moffat Street	---	---	8	-2	-9	8	3	14
Arkansas River near Avondale	---	---	0	-11	-16	-13	-1	2
Arkansas River at Catlin Dam	---	---	1	-6	-9	-7	-1	2
Effects (%) [(Alternative - Alternative 1) / Alternative 1]								
Monument Creek at Bijou Street	---	---	0%	0%	0%	0%	0%	0%
Fountain Creek near Fountain	---	---	-2%	10%	10%	-3%	5%	1%
Fountain Creek at Pueblo	---	---	-2%	14%	14%	1%	5%	2%
Arkansas River at Moffat Street	---	---	28%	-7%	-31%	28%	10%	48%
Arkansas River near Avondale	---	---	0%	-20%	-29%	-23%	-2%	4%
Arkansas River at Catlin Dam	---	---	2%	-10%	-15%	-12%	-2%	3%

The No Action Alternative would slightly reduce dissolved selenium concentrations in Fountain Creek at Pueblo compared to Existing Conditions due to increased streamflows. Compared to the No Action Alternative, the Wetland, Arkansas River, and Fountain Creek alternatives would have moderately higher selenium concentrations in Fountain Creek at Pueblo because of the use of the Chilcotte Ditch and Eastern Return Flow Pipeline or Highway 115 Return Flow Pipeline. These alternatives would divert return flows with low selenium concentrations out of Fountain Creek, resulting in less water to dilute dissolved selenium inflows lower in the watershed. The chronic WQS for dissolved selenium would be met in Fountain Creek at Pueblo (WQS = 28.1 µg/L) under all alternatives except the Wetland, Arkansas River, and Fountain Creek alternatives. These three alternatives include a return flow pipeline to the Arkansas River and would result in moderate increases above the dissolved selenium WQS.

Under the No Action Alternative, dissolved selenium concentrations in the Arkansas River at the Moffat Street location (upstream of Fountain Creek) would increase compared to Existing Conditions. Dissolved selenium concentrations would be highest for alternatives that rely on exchanges from Fountain Creek (No Action, Participants' Proposed Action, Fountain Creek, and Highway 115 alternatives), which result in lower streamflows and greater influence of local inflows on water quality. Selenium concentrations would be lowest for the Arkansas River Alternative because of the greater streamflows through this reach to deliver water to the untreated water intake, which would dilute selenium concentrations.

Table 59. Estimated Direct Effects Dissolved Selenium Concentrations.

Location	Existing Conditions	Alt 1	Alt 2	Alt 3	Alt 4	Alt 5	Alt 6	Alt 7
85th Percentile Simulated Dissolved Selenium (µg/L)								
Monument Creek at Bijou Street	4	4	4	4	4	4	4	4
Fountain Creek near Fountain	5	4	4	5	5	5	4	4
Fountain Creek at Pueblo	28	23	24	34	34	34	21	22
Arkansas River at Moffat Street	33	49	59	43	26	54	65	70
Arkansas River near Avondale	16	18	20	19	17	18	17	19
Arkansas River at Catlin Dam	12	14	14	14	12	14	13	14
Effects (µg/L) (Alternative - Alternative 1)								
Monument Creek at Bijou Street	---	---	0	0	0	0	0	0
Fountain Creek near Fountain	---	---	0	1	1	1	0	0
Fountain Creek at Pueblo	---	---	1	11	11	11	-2	-1
Arkansas River at Moffat Street	---	---	10	-6	-23	5	16	21
Arkansas River near Avondale	---	---	2	1	-1	0	-1	1
Arkansas River at Catlin Dam	---	---	0	0	-2	0	-1	0
Effects (%) [(Alternative - Alternative 1) / Alternative 1]								
Monument Creek at Bijou Street	---	---	0%	0%	0%	0%	0%	0%
Fountain Creek near Fountain	---	---	0%	25%	25%	25%	0%	0%
Fountain Creek at Pueblo	---	---	4%	48%	48%	48%	-9%	-4%
Arkansas River at Moffat Street	---	---	20%	-12%	-47%	10%	33%	43%
Arkansas River near Avondale	---	---	11%	6%	-6%	0%	-6%	6%
Arkansas River at Catlin Dam	---	---	0%	0%	-14%	0%	-7%	0%

The Downstream Intake Alternative would have higher concentrations at the 85th percentile because of lower streamflows resulting from higher exchange rates during dry conditions. Median selenium concentrations for the Downstream Intake Alternative would be lower than for those alternatives that rely on exchanges through the reach. The chronic WQS for dissolved selenium (17.4 µg/L) is substantially exceeded for Existing Conditions and would be exceeded for all alternatives. The acute WQS (50.9 µg/L) would or may be exceeded by the Participants' Proposed Action, Fountain Creek, Downstream Intake, and Highway 115 alternatives.

Below the Fountain Creek confluence (shown in Table 59) as the Arkansas River below Avondale and the Arkansas River at Catlin Dam locations), dissolved selenium concentrations would be similar among all alternatives, and would vary primarily as upstream concentrations in the Arkansas River above Fountain Creek vary. The underlying chronic WQS (14.1 µg/L) is exceeded at Avondale under Existing Conditions and would continue to be exceeded under all alternatives. At Catlin Dam, the underlying WQS (4.6 µg/L) is substantially exceeded under Existing Conditions and would continue to be exceeded under all alternatives.

Salinity

Table 60 summarizes the direct effects simulated salinity (simulated as specific conductance) and effects on agricultural and municipal uses. Simulated salinity concentrations for the No Action Alternative would be similar to Existing Conditions at most locations. However, concentrations would be about 27 percent lower than Existing Conditions at Arkansas River at Portland Gage. Under the No Action and Highway 115 alternatives, the Highway 115 Intake would

Table 60. Specific Conductance (Salinity) Direct Effects.

Location	Existing Conditions	Alt 1	Alt 2	Alt 3	Alt 4	Alt 5	Alt 6	Alt 7	High Salinity Hazard	Second-ary MCL‡
Simulated Specific Conductance 85th Percentile (µS/cm)									**(µS/cm)**	**(µS/cm)**
Ark River at Portland	630	490	610	720	720	610	630	490	750	775
Ark River above Pueblo	650	680	660	750	750	660	680	690	750	740
Ark River Moffat Street	790	790	810	820	790	800	810	860	750	726
Fountain Crk at Janitell	850	940	930	1,000	1,000	930	920	930	750	778
Fountain Crk at Fountain	1,100	1,200	1,200	1,400	1,400	1,400	1,100	1,200	750	778
Fountain Crk at Pueblo	1,700	1,700	1,700	2,100	2,100	2,100	1,500	1,600	750	778
Ark River near Avondale	1,200	1,200	1,300	1,300	1,300	1,200	1,300	1,200	750	742
Ark River at Catlin Dam	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	750	757
L. Henry & L. Meredith	1,500	1,600	1,500	1,500	1,500	1,500	1,500	1,500	750	694
Effects (%) [(Alternative - Alternative 1) / Alternative 1]†									**High Salinity Hazard**	**Second-ary MCL‡**
Ark River at Portland	---	---	24%	47%	47%	24%	29%	0%	750	775
Ark River above Pueblo	---	---	-3%	10%	10%	-3%	0%	1%	750	740
Ark River Moffat Street	---	---	3%	4%	0%	1%	3%	9%	750	726
Fountain Crk at Janitell	---	---	-1%	6%	6%	-1%	-2%	-1%	750	778
Fountain Crk at Fountain	---	---	0%	17%	17%	17%	-8%	0%	750	778
Fountain Crk at Pueblo	---	---	0%	24%	24%	24%	-12%	-6%	750	778
Ark River near Avondale	---	---	8%	8%	8%	0%	8%	0%	750	742
Ark River at Catlin Dam	---	---	0%	0%	0%	0%	0%	0%	750	757
L. Henry & L. Meredith	---	---	-6%	-6%	-6%	-6%	-6%	-6%	750	694

† Differences of less than 10 percent are not considered meaningful due to model uncertainty and are shown in grey text.

‡ TDS secondary MCL converted from 500 mg/L to specific conductance using site-specific regression equations.

create a new municipal water diversion near the Portland Gage (a beneficial use that does not currently exist in this segment). For the Action Alternatives, salinity in the upper Arkansas River between Florence and Pueblo Reservoir would be affected by the Highway 115 Return Flow Pipeline in the Wetland and Arkansas River alternatives, resulting in higher salinity concentrations than the No Action Alternative and adverse agricultural and municipal effects. The return flow pipeline would convey water of higher salinity, relative to the upper Arkansas River, increasing salinity in this reach. Salinity concentrations at the Portland Gage for the Participants' Proposed Action, Fountain Creek, and Downstream Intake alternatives are higher than the No Action Alternative, but similar to Existing Conditions. There are no substantial municipal or agricultural water uses in this reach to result in an adverse effect. None of the alternatives would affect drinking water taste because all of the alternatives and Existing Conditions would have 85th percentile concentrations less than the secondary MCL. Below the secondary MCL, differences in taste would not likely be discernable to most consumers.

In the Fountain Creek Basin, the 85th percentile of simulated salinity would exceed the secondary MCL (about 726 µS/cm in Fountain Creek) for all alternatives and Existing Conditions. There would be adverse agricultural effects for the Wetland, Fountain Creek, and Arkansas River alternatives in Fountain Creek at Fountain and adverse agricultural effects at Pueblo for these alternatives. Beneficial agricultural effects would occur for the Downstream Intake Alternative in Fountain Creek at Pueblo. There would be adverse agricultural effects for the No Action Alternative at Janitell. Increases in salinity could slightly reduce crop yield (depending on the type of crops grown) between the cities of Colorado Springs and Pueblo, and degrade the taste of water from alluvial wells in the vicinity of Fountain and Security.

At the Janitell Gage, the 85th percentile for the No Action Alternative would have an increase of 11 percent over Existing Conditions. With concentrations above the agricultural high salinity hazard, crop yield could be slightly reduced. Changes in salinity from the Action Alternatives would be negligible at the Janitell Gage.

Farther downstream in Fountain Creek, near Fountain and Pueblo, the No Action Alternative would result in similar salinity concentrations to Existing Conditions. Alternatives that do not include the Williams Creek Return Flow Pipeline (Wetland, Arkansas River and Fountain Creek alternatives) would have minor to substantial salinity increases due to decreased flows for dilution. Therefore, agricultural uses may be adversely affected The Downstream Intake Alternative would result in a 8 to 12 percent decrease in salinity compared to the No Action Alternative, which would result in a minor beneficial effect for agricultural and municipal uses compared to the No Action Alternative. The Downstream Intake Alternative would result more diluting streamflows at times of the year when salinity tends to be high in Fountain Creek.

In the lower Arkansas River, there would be no substantial difference among the 85th percentiles of simulated salinity for the alternatives. Although the salinity model does not extend downstream of the Catlin Dam Gage, the minimal salinity effects estimated at Catlin Dam likely would continue in the downstream direction to John Martin Reservoir. Because there would be little effect on salinity in the lower Arkansas River, there would also be little effect on sulfate concentrations.

In Lake Henry and Lake Meredith the 85th percentiles of simulated salinity would be similar among Existing Conditions, the No Action Alternative, and the Action Alternatives.

Table 62 summarizes simulated irrigation season TDS and potential effects on crop yield. The No Action Alternative would result in irrigation season TDS increases between 6 and 10 percent compared to Existing Conditions. These increases may result in crop yield decreases ranging from 0.1 to 0.6 percent, depending on hydrologic conditions. None of the Action Alternatives would have irrigation season TDS more than 10 percent different from the No Action Alternative. Differences in crop yield would range from negative 0.1 percent to positive 0.4 percent.

Sulfate

Direct effects on sulfate concentrations would be negligible to minor for all alternatives. Estimated sulfate concentrations for all alternatives would be similar to those for Existing Conditions (Table 61). The 85th percentile is shown in the table because CDPHE uses this statistic to determine whether

Table 62. Direct Effects Simulated Irrigation Season TDS and Estimated Effects on Crop Yield – Catlin Dam Gage.

Year	Existing Conditions	Alt 1	Alt 2	Alt 3	Alt 4	Alt 5	Alt 6	Alt 7
Simulated April to September Average TDS (mg/L) †								
1999	610	670	680	660	660	640	670	680
2000	680	720	730	730	730	730	730	720
2001	660	700	700	680	680	680	680	690
Effects – TDS Increase (%) [(Alternative – Alternative 1) / Alternative 1] ‡								
1999	---	---	1%	-1%	-1%	-4%	0%	1%
2000	---	---	1%	1%	1%	1%	1%	0%
2001	---	---	0%	-3%	-3%	-3%	-3%	-1%
Effects – Changes to Crop Yield Relative to Alternative 1								
1999	---	---	0.0%	0.0%	0.0%	0.1%	0.0%	0.0%
2000	---	---	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%	0.0%
2001	---	---	0.0%	0.4%	0.4%	0.4%	0.4%	0.2%

† Simulated specific conductance converted to TDS using a regression equation (TDS = specific conductance in µS/cm x 0.82 – 120.6).

‡ Differences in TDS of less than 10 percent are not considered meaningful due to model uncertainty and are shown in grey text. Changes in crop yield based on differences in TDS of less than 10 percent are also shown in grey.

a waterbody is meeting its WQS for sulfate. Small calculated differences among alternatives are likely to be within the range of uncertainty for the estimation method. The underlying WQS for sulfate (250 mg/L) is substantially exceeded at Avondale under Existing Conditions and would continue to be exceeded under all alternatives.

Chronic Low Flows at Permitted WWTF Discharge Locations

Changes in streamflow or background water quality caused by operation of the SDS Project could affect effluent limits for WWTFs. These limits are set by CDPHE and included in discharge permits. Compliance with limits that are lower (more stringent) than those in a WWTF's current permit could require facility improvements. A principal concern to permittees would be a reduction in available dilution flows, which may increase the stringency of some effluent limits. Effluent limits for ammonia are a key design parameter for many WWTFs in the analysis area.

Table 61. Estimated Direct Effects Sulfate Concentrations – Arkansas River near Avondale Gage.

Statistic	Existing Conditions	Alt 1	Alt 2	Alt 3	Alt 4	Alt 5	Alt 6	Alt 7
Simulated Sulfate (mg/L)								
85th Percentile	392	399	413	416	419	409	417	408
Effects (mg/L) (Alternative - Alternative 1)								
85th Percentile	---	---	14	17	20	10	18	9
Effects (%) [(Alternative - Alternative 1) / Alternative 1]								
85th Percentile	---	---	3%	4%	5%	2%	5%	2%

Consequently, where analysis of simulated streamflow results show that dilution flows would be reduced substantially, potential effect of dilution on a WWTF's effluent limits and treatment requirements for ammonia was evaluated. Additional analyses of potential effects on effluent limits for dissolved selenium, *E. coli*, and sulfate are discussed in the next subsection.

In some cases where the low flow analysis showed that chronic low flows would decrease compared to Existing Conditions, adverse effects would not occur for the following reasons:

(1) Dilution of effluent would still be high, typically at least 90 percent. At high levels of dilution (90 percent or greater), effluent limits are typically not based on streamflow in the receiving water (CDPHE 2002b, 2006b).

(2) Historical effluent quality is good enough that even with reduced chronic flows, the WWTF may meet applicable effluent limits

(3) Regardless of dilution flows, WWTF will need to make substantial upgrades to existing treatment facilities to meet changes in WQS, such as the new ammonia standard, which was adopted in 2007 for the Arkansas River Basin (CDPHE 2008a, 2008b). Generally, the new WQS would result in more stringent criteria in warm water segments, such as Fountain Creek and the lower Arkansas River, and less stringent criteria for cold water segments such as the upper Arkansas River. However, the Colorado's antidegradation policy would likely keep discharge limits near their current levels in cold water segments.

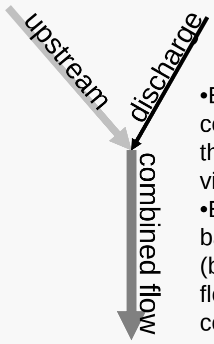
Table 64 summarizes the results of the chronic low flow analysis. The middle column discusses which, if any, alternatives would result in reductions in chronic low flow resulting in receiving water dilution of less than 90 percent. If dilution would be less than 90 percent, the right-hand column discusses whether these reductions in dilution would likely result in changes to effluent limits or treatment technologies.

Effluent Limits for Permitted Wastewater Treatment Facilities

As described above, changes in streamflow or background water quality caused by operation of the SDS Project could affect effluent limits for WWTFs. Potential effluent limits were estimated for potentially affected WWTFs in Monument Creek, Fountain Creek, and the lower Arkansas River. The WQA procedure used by CDPHE was used for this evaluation; however, future changes to WQS or differences in calculation inputs could yield different effluent limits when CDPHE issues renewal permits for these WWTFs. Additionally, because discharge permits are renewed on a five-year cycle, it is possible for effluent limits for Existing Conditions to differ from those in a current permit.

Table 63. Summary of Low Flow Direct Effects For All Alternatives.

Location	Alternatives Resulting in Reduction in Chronic Low Flow Compared to Existing Conditions and Dilution of Less than 90 Percent	Potential Effects of Chronic Low Flow on Discharge Limits or Treatment Technologies
Buena Vista Sanitation District WWTF	Some flows reduced, but dilution greater than 90 percent for all alternatives.	No.
Salida WWTF	Some flows reduced, but dilution greater than 90 percent for all alternatives.	No.
Fremont County Rainbow Park WWTF	Some flows reduced, minimum dilution of 88 percent.	No, generally high dilution rate and receiving stream classified as "cold water aquatic life," which will likely lead to slightly increased ammonia effluent limits, counteracting reduction in low flows.
Pueblo WWTF	Some flows reduced, minimum dilution of 83 percent.	No, City of Pueblo has determined that plant will require substantial upgrades to comply with future ammonia standards (Red Oak Consulting 2006; Keller 2006b). Dilution level would still be relatively high with any alternative.
Rocky Ford WWTF	Some flows reduced, minimum dilution of 52 percent.	No, treatment plant will require substantial WWTF improvements to comply with new ammonia standards regardless of reductions in low flows.
La Junta WWTF	Some flows reduced, minimum dilution of 77 percent.	No, treatment plant should be able to meet new ammonia requirements, based on historical performance, even with reductions in low flow due to any alternative.
Colorado Springs J.D. Phillips WRF	No substantial differences in low flows between alternatives and Existing Conditions.	No.
Colorado Springs LVSWWTF	No substantial differences in low flows between alternatives and Existing Conditions.	No.



Setting Effluent Limitations

- Effluent limitation is the maximum concentration allowed in discharge that does not cause WQS to be violated in combined flow.
- Effluent limitation calculation is based on (a) upstream flow, (b) upstream quality, (c) discharge flow, and (d) WQS applicable in combined flow.

Monument and Fountain Creek WWTFs
All of the facilities discharging to these creeks (i.e., Colorado Springs J.D. Phillips WRF, Colorado Springs LVSWWTF, Fort Carson, Fountain, Security, and Widefield WWTFs) would be required to undergo an Antidegradation Review (CDPHE 2008c) for future renewals of their discharge permits. The future capacities of those facilities are anticipated to increase or remain unchanged. Consequently, each of these facilities would likely receive "Non-Impact Limits" (CDPHE 2001) in its renewal permit. These limits are calculated by dividing the current permitted pollutant load by the new hydraulic design capacity for each facility. The Non-Impact Limits would be more stringent than the calculated effluent limits (per the methods described in Section 3.7.3.2) under Existing Conditions or any SDS Project alternative. Nonetheless, potential effluent limits for *E. coli*, chronic (monthly) selenium, and acute (daily) selenium were calculated for each of the Monument and Fountain Creek WWTFs. At all of these WWTFs, calculated effluent limits for *E. coli* would be equal to the WQS (126 colonies per 100 ml) for Existing Conditions and each alternative. Calculated selenium limits for each facility are described below.

J.D. Phillips WRF. Chronic and acute effluent limits for selenium would be equal to the WQS (4.6 and 18.4 µg/L for chronic and acute, respectively) under Existing Conditions and all alternatives.

LVSWWTF. Changes in streamflow and background selenium concentrations under all alternatives would have a negligible effect on effluent limits for selenium at the LVSWWTF. Calculated effluent limits for selenium would be about 9 µg/L (chronic) and 21 to 22 µg/L (acute) for Existing Conditions, the No Action Alternative, and the Action Alternatives (Table 64).

Widefield WWTF. The No Action Alternative would have moderately higher (less stringent) calculated chronic and acute selenium effluent limits by compared to Existing Conditions (Table 65). Calculated selenium effluent limits for the Participants' Proposed Action, Fountain Creek, Downstream Intake, and Highway 115 alternatives would be comparable to those for the No Action Alternative. The calculated chronic and acute selenium effluent limits for the Wetland and Arkansas River alternatives would be substantially less than those for the No Action Alternative. This is primarily due to a reduction in dilution flows by the Highway 115 Return Flow Pipeline that would convey reusable return flows to the Arkansas River. Historical effluent selenium data are not available for this WWTF (EPA 2008a). However, effluent selenium concentrations are for neighboring WWTFs are typically below 10 µg/L, substantially below the calculated effluent limits.

Table 64. Estimated Selenium Effluent Limits Direct Effects – Las Vegas Street WWTF.

Selenium (µg/L)	Existing Conditions	Alt 1	Alt 2	Alt 3	Alt 4	Alt 5	Alt 6	Alt 7
Chronic Effluent Limit (WQS = 8)	9.3	8.9	8.9	9.5	9.5	8.9	8.9	8.9
Acute Effluent Limit (WQS = 18.4)	21.2	20.5	20.5	21.7	21.7	20.5	20.5	20.5

Table 65. Estimated Selenium Effluent Limits Direct Effects – Widefield WWTF.

Selenium (µg/L)	Existing Conditions	Alt 1	Alt 2	Alt 3	Alt 4	Alt 5	Alt 6	Alt 7
Chronic Effluent Limit (WQS = 8)	57	77	78	36	36	78	77	79
Acute Effluent Limit (WQS = 18.4)	165	209	211	83	83	211	214	211

Table 66. Estimated Selenium Effluent Limits Direct Effects – Security WWTF.

Selenium (µg/L)	Existing Conditions	Alt 1	Alt 2	Alt 3	Alt 4	Alt 5	Alt 6	Alt 7
Chronic Effluent Limit (WQS = 8)	82	103	103	42	42	103	102	105
Acute Effluent Limit (WQS = 18.4)	240	274	281	91	91	281	281	281

Table 67. Estimated Selenium Effluent Limits Direct Effects – Fort Carson WWTF.

Selenium (µg/L)	Existing Conditions	Alt 1	Alt 2	Alt 3	Alt 4	Alt 5	Alt 6	Alt 7
Chronic Effluent Limit (WQS = 8)	67	94	94	42	42	94	94	95
Acute Effluent Limit (WQS = 18.4)	200	255	258	96	96	258	261	258

Table 68. Estimated Selenium Effluent Limits Direct Effects – Fountain WWTF.

Selenium (µg/L)	Existing Conditions	Alt 1	Alt 2	Alt 3	Alt 4	Alt 5	Alt 6	Alt 7
Chronic Effluent Limit (WQS = 8)	120	48	48	25	25	48	48	49
Acute Effluent Limit (WQS = 18.4)	359	119	115	49	49	92	123	121

Security WWTF. Effects on calculated effluent limits for selenium at the Security WWTF would be similar to those for the Widefield WWTF (Table 66). Historical effluent selenium data for this WWTF (EPA 2008a) indicate that concentrations are typically less than 10 µg/L, substantially below all of the calculated effluent limits.

Fort Carson WWTF. Effects on calculated effluent limits for selenium at the Fort Carson WWTF would be similar to those for the Widefield WWTF (Table 67). All of the calculated effluent limits would be substantially higher than historical effluent selenium concentrations (2 to 6 µg/L) for this WWTF (EPA 2008a).

Fountain WWTF. Effects on calculated effluent limits for selenium at the Fountain WWTF would be similar to those for the Widefield WWTF except that the No Action Alternative would have moderately lower (more stringent) limits compared to Existing Conditions (Table 68). Historical effluent selenium data for this WWTF (EPA 2008a) indicate that concentrations are typically less than 10 µg/L, substantially below all of the calculated effluent limits.

Pueblo WWTF. Effects on effluent limits for the Pueblo WWTF were evaluated for E. coli, selenium, and sulfate. The chronic effluent limit for E. coli would be about 930 colonies per 100 mL for the No Action Alternative, comparable to Existing Conditions (Table 69). The chronic E. coli limit for the Action Alternatives would range from 712 to 852 colonies per 100 mL, with the Downstream Intake Alternative being the most stringent. Historical monthly geometric mean (the statistic used to determine compliance) fecal coliform densities in effluent from the Pueblo WWTF are typically well below 100 colonies per 100 mL (EPA 2008a). E. coli is a subset of fecal coliform bacteria. Based on historical performance of this WWTF for fecal coliform, no substantial facility improvements should be required to meet E. coli effluent limits under any SDS alternative.

The SDS alternatives would have no effect on the chronic selenium limit based on the underlying chronic WQS for the Pueblo WWTF. This effluent limit would be equal to the WQS (14.1 µg/L) for Existing Conditions, the No Action Alternative, and the Action Alternatives.

The acute selenium effluent limit for the No Action Alternative would be about 24 µg/L compared to 35 µg/L for Existing Conditions. All Action Alternatives would have comparable or lower effluent limits than the No Action Alternative. The most stringent acute limit (about 19 µg/L) would occur for the Participants' Proposed Action and Wetland alternatives. Given uncertainty associated with the estimating approach used for this FEIS, these limits are considered comparable to the current acute selenium limit of 22 µg/L for the Pueblo WWTF. None of the SDS alternatives would likely change selenium treatment requirements at this WWTF.

Effects on chronic sulfate effluent limits were calculated for the Pueblo WWTF because sulfate is a parameter of concern for the Arkansas River directly downstream of Fountain Creek (Lower Arkansas River segment 1a). Using the sulfate temporary chronic WQS of 329 mg/L (estimated from recent historical data), the chronic sulfate effluent limit would be equal to the WQS for Existing Conditions and all of the SDS alternatives. Consequently, effects of the SDS alternatives on streamflow and sulfate

Table 69. Estimated Effluent Limits Direct Effects – Pueblo WWTF.

Parameter	Existing Conditions	Alt 1	Alt 2	Alt 3	Alt 4	Alt 5	Alt 6	Alt 7
***E. coli* (# / 100 ml)**								
Chronic Effluent Limit (WQS = 126)	945	933	725	837	815	852	712	749
Selenium (µg/L)								
Chronic Effluent Limit for Underlying WQS (WQS = 14.1)	14.1	14.1	14.1	14.1	14.1	14.1	14.1	14.1
Acute Effluent Limit (WQS = 19.1)	34.6	24.0	19.1	19.1	28.1	23.8	23.8	20.2
Sulfate (mg/L)								
Chronic Effluent Limit for Underlying WQS (WQS = 250)	250	250	250	250	250	250	250	250

concentrations would have no effect on the effluent limit for sulfate.

Rocky Ford WWTF

Effects on effluent limits for the Rocky Ford WWTF were evaluated for *E. coli* and selenium. The chronic effluent limit for *E. coli* would be about 340 colonies per 100 mL for the No Action Alternative compared to 470 for Existing Conditions (Table 70). The chronic *E. coli* limit for the Action Alternatives would range from 186 to 282 colonies per 100 mL. The Participants' Proposed Action, Wetland, Arkansas River, Fountain Creek, and Highway 115 alternatives would have limits close to 200 per 100 mL whereas the Downstream Intake Alternative would have a moderately higher limit. Based on historical performance of this WWTF for fecal coliform (EPA 2008a), facility improvements may be required to meet *E. coli* effluent limits under Existing Conditions. The SDS alternatives would not affect these circumstances.

The SDS alternatives would have no effect on the chronic selenium limit based on the underlying WQS or the acute selenium limit for the Rocky Ford WWTF. These effluent limits would be equal to the WQS (4.6 and

Table 70. Estimated Effluent Limits Direct Effects – Rocky Ford WWTF.

Parameter	Existing Conditions	Alt 1	Alt 2	Alt 3	Alt 4	Alt 5	Alt 6	Alt 7
***E. coli* (# / 100 ml)**								
Chronic Effluent Limit (WQS = 126)	470	340	186	193	196	195	282	214
Selenium (µg/L)								
Chronic Effluent Limit for Underlying WQS (WQS = 4.6)	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6
Acute Effluent Limit (WQS = 18.4)	18.4	18.4	18.4	18.4	18.4	18.4	18.4	18.4

18.4 µg/L for chronic and acute, respectively) under Existing Conditions and all alternatives. Historical effluent selenium data are not available for this WWTF (EPA 2008a). Consequently, the ability of this WWTF to comply with potential effluent limits cannot be determined.

Metals and Selenium in the Upper Arkansas River

Acid rock drainage and historical mining sources of metals in the upper Arkansas River would not be affected by the alternatives. Although streamflow and metals concentrations are not directly related, alternatives with higher flows would generally dilute dissolved metals concentrations from watershed contributions, and lower flows would generally increase dissolved metals concentrations.

In most months, the No Action Alternative would result in a substantial increase in streamflow at the Granite Gage compared to Existing Conditions. The Highway 115 Alternative would be similar to the No Action Alternative. The remaining Action Alternatives would result in decreased streamflow compared to the No Action Alternative (Figure 68). The No Action and Highway 115 alternatives may improve metals WQS attainment in the upper Arkansas River compared to Existing Conditions. The remaining alternatives may have adverse effects on metals WQS attainment in the upper Arkansas River compared to the No Action Alternative. However, by 2046, mine remediation and other water quality efforts in the upper watershed, such as efforts at the California Gulch Superfund site, improvements in treatment at the Leadville Mine Drainage Tunnel (EPA 2007d), and ongoing cleanup of historical tailings, may reduce metals loading to the river for all alternatives, offsetting any decreased flows.

The annual average volume of streamflow imported from the Western Slope would be within 2 percent for all alternatives (Appendix D). Because the transmountain diversions would be similar, no effects on metals concentrations would likely occur.

Water in the Highway 115 Return Flow Pipeline typically would be treated wastewater effluent. Water in the pipeline would be a combination of treated wastewater effluent and diversions from Fountain Creek. The Wetland and Arkansas River alternatives may slightly increase concentrations of dissolved selenium upstream of Pueblo Reservoir resulting in a minor adverse effect. However, as shown in Table 71, estimated concentrations of dissolved selenium in the Arkansas River upstream of Pueblo Reservoir would remain below the chronic and acute WQS; thus, no beneficial uses of the water would be affected.

Concentrations of dissolved manganese are historically near the chronic WQS in the Arkansas River upstream of Pueblo Reservoir. Estimates of dissolved manganese from the Highway 115 Return Flow Pipeline suggest that the Wetland and Arkansas River alternatives would result in equal or slightly decreased dissolved manganese concentrations in the Arkansas River through dilution. The effects on total recoverable iron would be similar. Consequently, the Wetland and Arkansas River alternatives would not affect metals concentrations in the upper Arkansas River.

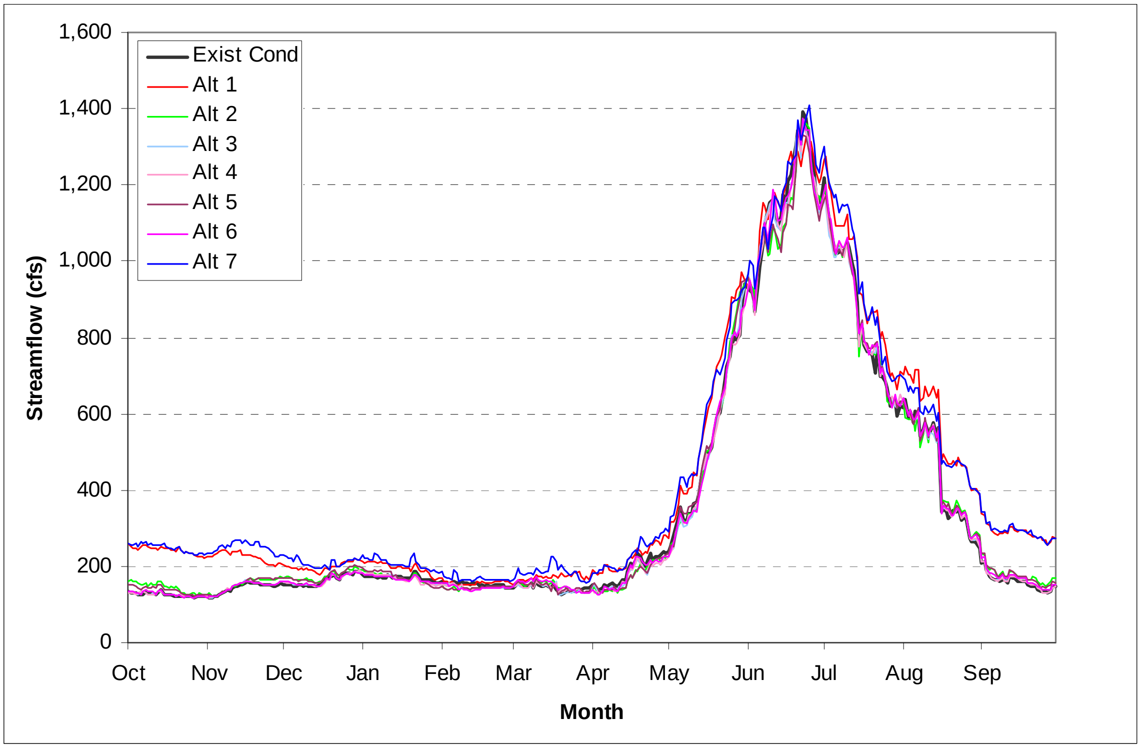


Figure 68. Granite Gage Direct Effects Daily Model Simulated Streamflows – Average Years.

Suspended Sediment

The increases and decreases in simulated streamflows depicted in Figure 69 would result in increased and decreased channel erosion and suspended sediments expected in Fountain Creek. At Colorado Springs upstream of the LVSWWTF, the streamflows would be similar among alternatives and slightly higher than Existing Conditions, indicating that the No Action Alternative suspended sediment concentrations likely would be slightly higher than Existing Conditions and the Action Alternatives would have similar concentrations to the No Action Alternative.

Figure 69 shows the general suspended sediment effects (using streamflow as a surrogate) in Fountain Creek. A numerical analysis also estimated the maximum possible differences in suspended sediment concentration at the Security Gage using simulated streamflows and a historical regression equation. The annual mean estimated concentration for Existing Conditions is 170 mg/L. The Wetland and Arkansas River alternatives would result in a maximum reduction in suspended sediment concentration of about 30 mg/L compared to Existing Conditions and up to 93 mg/L less suspended sediment than the No Action Alternative. The remaining alternatives would result a maximum of 65 mg/L more suspended sediment than Existing Conditions and similar suspended sediment concentrations to the No Action Alternative (MWH 2008g, 2008h).

There are no numerical WQS for suspended sediment. However, the increase in suspended sediment concentration for the No Action Alternative would be considered an adverse effect. The Participants' Proposed Action, Fountain Creek, Downstream Intake, and Highway 115 alternatives would have the same effect as the No Action Alternative. The

Table 71. Summary of Highway 115 Return Flow Pipeline Effects on Upper Arkansas River Metals.

Metal	Applicable Percentile	Estimated Return Flow Concentration (µg/L)[†]	Historical Upper Arkansas River Concentration (µg/L)[‡]	Applicable WQS (µg/L)
Dissolved Selenium	85th	3.1	0	4.6
Total Recoverable Iron	50th (median)	70	168	1,000
Dissolved Manganese	85th	31	50	Least restrictive of 50 µg/L or existing quality

[†] Values are based on historical LVSWWTF effluent concentrations.

[‡] Values less than the minimum detection limit are set to 0.

Source: Dahlberg 2006a, 2006b, 2006c; MWH 2008f, 2008h.

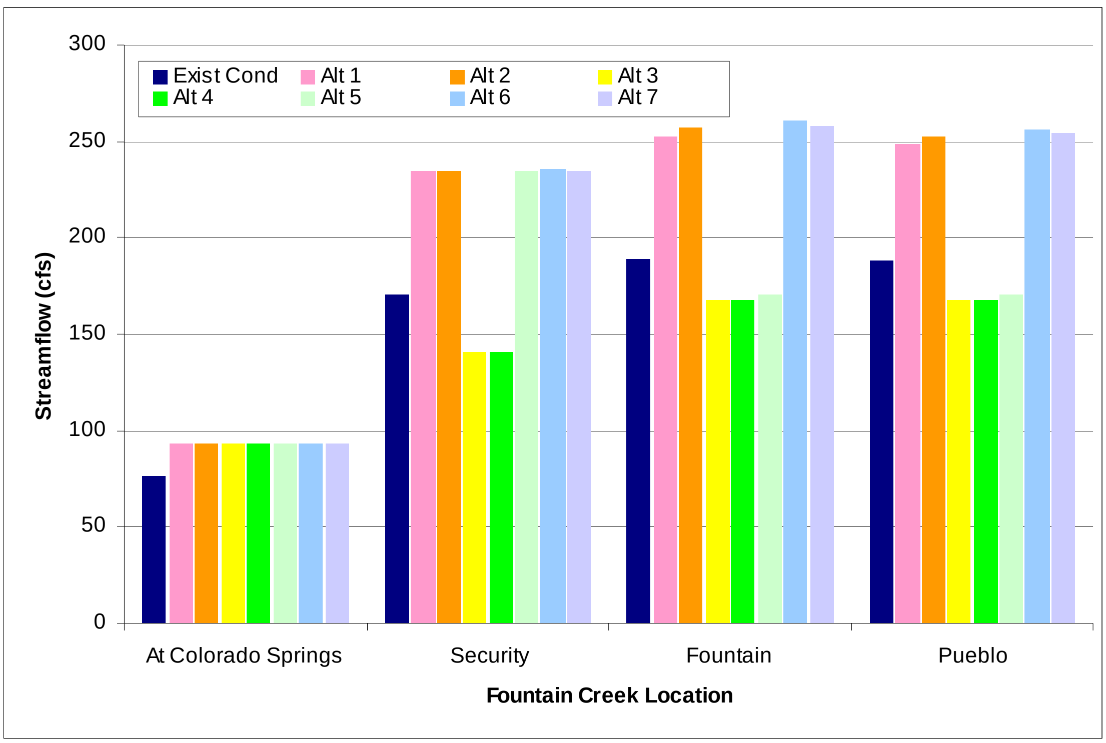


Figure 69. Average Annual Simulated Streamflow in Fountain Creek – Direct Effects.

Streamflow is indicative of general suspended sediment effects. Higher streamflow generally results in higher suspended sediment.

Source: MWH 2008h.

Wetland and Arkansas River alternatives would have a minor beneficial effect on suspended sediment concentrations compared to the No Action Alternative and Existing Conditions. Effects of changes in sediment transport on erosion and sedimentation in Fountain Creek are discussed in Section 3.9.

As shown in Figure 69, at Security, the Wetland and Arkansas River alternatives would have substantially lower streamflows and thus lower suspended sediment concentrations due to diversions into the Highway 115 Return Flow Pipeline. At Fountain and Pueblo, the No Action Alternative likely would have higher suspended sediment concentrations than Existing Conditions. The Wetland, Arkansas River, and Fountain Creek alternatives would have lower suspended sediment concentrations than the No Action Alternative. The remaining Action Alternatives would have similar flows and similar suspended sediment concentrations to the No Action Alternative.

For the Wetland and Arkansas River alternatives, the return flow pipeline would not likely result in increased suspended sediment in the upper Arkansas River because Fountain Creek flows would typically only comprise about 3 percent of the pipeline flow and because a presedimentation basin would remove some of the sediment before diversion into the pipeline. Similarly, the return flow pipeline in the Fountain Creek Alternative would not likely increase suspended sediment in the lower Arkansas River because sediment would be removed through settling during storage in Williams Creek Reservoir.

Lower Arkansas River Total Recoverable Iron

The amount of streamflow from Fountain Creek comprising streamflow in the lower Arkansas River under the No Action Alternative would slightly increase (by about 7 percent relative to Existing Conditions (Table 33)), indicating a potential slight increase in total recoverable iron. The proportion of Fountain Creek flows in the lower Arkansas River would be less than the No Action Alternative for the Wetland, Arkansas River, and Fountain Creek alternatives, suggesting a potential reduction in total recoverable iron compared to the No Action Alternative. The Participants' Proposed Action, Downstream Intake, and Highway 115 alternatives would result in streamflow and total recoverable iron contributions from Fountain Creek similar to the No Action Alternative. Because WQS for total recoverable iron are set at ambient concentrations in both Fountain Creek and the lower Arkansas River (CDPHE 2008a), changes in concentrations due to the alternatives would not likely result in impairment.

Temperature

No adverse effects to stream temperature would be likely for any of the alternatives. Figure 70 depicts historical temperatures in the upper Arkansas River at the Portland Gage and estimated temperatures for the Wetland and Arkansas River alternatives considering mixing of return flows in the Highway 115 Return Flow Pipeline with streamflows. During the summer, pipeline water generally would be cooler than stream temperature; in the winter, pipeline water would be warmer than stream temperature. The pipeline releases would cool summer water temperatures to be closer to the cold water WQS of 20°C.

Water from Williams Creek Reservoir would be released to Fountain Creek under the No Action, Participants' Proposed Action, Downstream Intake, and Highway 115 alternatives. Estimated Williams Creek Reservoir temperatures would be within a few

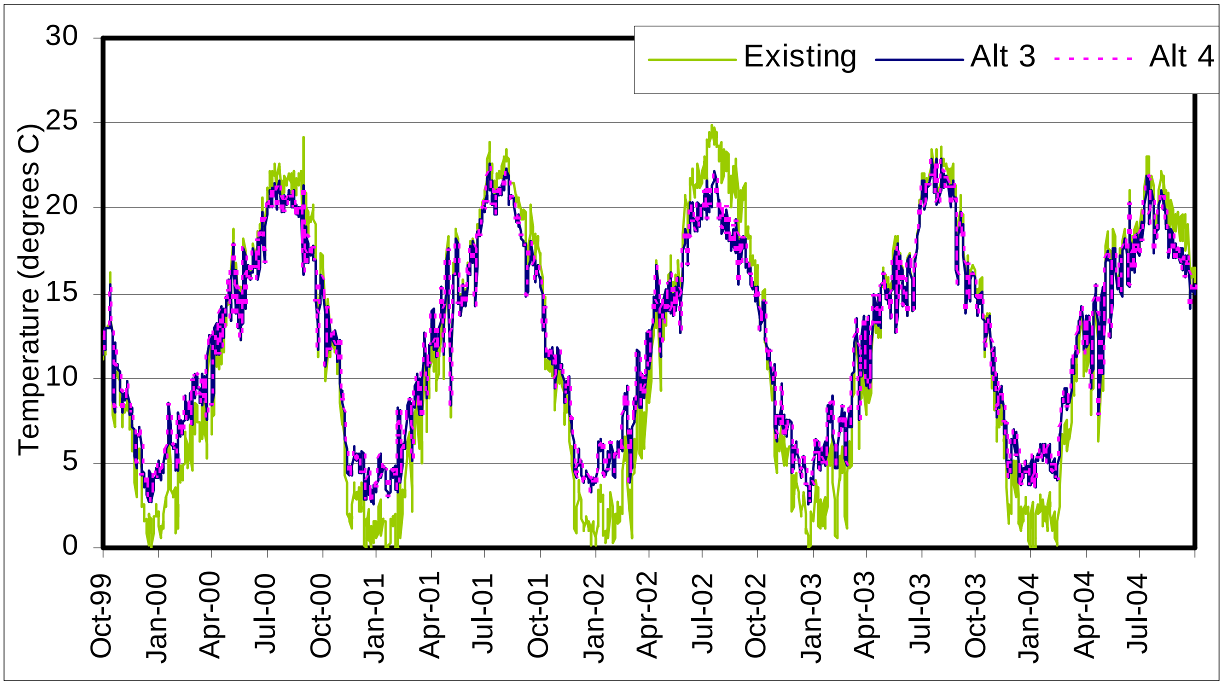


Figure 70. Arkansas River at Portland Estimated Temperature for Direct Effects.

degrees of temperatures measured historically in Fountain Creek and would not cause stream temperatures in Fountain Creek to exceed the warm water aquatic life WQS of 30°C.

Nutrients in Stream Segments

Mixing calculations indicate that the Highway 115 Return Flow Pipeline (Wetland and Arkansas River alternatives) would typically result in a three- to four-fold increase in nutrient concentrations in the Arkansas River upstream of Pueblo Reservoir. After complete mixing, the median concentration of total ammonia would be about 0.11 mg/L as nitrogen. Total nitrate plus nitrite would be about 0.6 mg/L, and total phosphorus would be about 0.2 mg/L. Nutrient concentrations would still meet WQS for ammonia and nitrate (CDPHE 2008a, 2008c) and phosphorus concentrations would be within the range reported for reference streams for the region (EPA 2000). However, more algae growth may occur in the reach between Colorado 115 and Pueblo Reservoir due to the additional nutrients.

The CE-QUAL-W2 model of Pueblo Reservoir shows that the Wetland and Arkansas River alternatives would result in substantially higher nutrient concentrations near the dam (see Pueblo Reservoir subsection below). Releases of these waters to the stream segment between Pueblo Reservoir and Fountain Creek may result in increased attached algae growth in the middle Arkansas River.

Nutrient concentrations in Fountain Creek and the lower Arkansas River would likely increase under all alternatives due to increased wastewater return flows from the Project Participants. The Wetland and Arkansas River alternatives would result in the lowest nutrient concentrations in Fountain Creek and the lower Arkansas River due to diversion of return flows into the Highway 115 Return Flow

Pipeline. Regardless of the alternative, increased nutrient concentrations would not likely adversely affect Fountain Creek and the lower Arkansas River. Physical conditions in these stream reaches are not favorable for algae growth. The dominant streambed material of these streams is sand (MWH 2007a), which is subject to frequent scour and does not support high populations of plants and algae attached to the stream bottom (EPA 2000). Additionally, these streams are relatively turbid (MWH 2008g) and would not support a high biomass of floating aquatic plants and algae (EPA 2000), which require light for photosynthesis. These characteristics limit the sensitivity of Fountain Creek and the lower Arkansas River to increased nutrient concentrations.

WWTF effluent limitations for regulated nutrients are set so that dischargers will not cause exceedances of WQS. Therefore, increased return flows would not likely result in exceedances of WQS in the analysis area because effluent limits would be adjusted according to future flow conditions.

Emerging Contaminants

Although the potential effects of emerging contaminants on human health are generally unknown, the increased amounts of treated wastewater, runoff, and other inflows that may contain emerging contaminants discharged to streams in the future may cause concern over the adequacy of drinking water treatment in different parts of the analysis area, depending on the alternative. However, because these contaminants, for the most part, are not likely to be regulated in the near future, the potential effect of the alternatives on the cost of drinking water treatment or attainment of WQS cannot be determined.

Bank filtration, the process where surface water moves through soil into ground water to alluvial wells, and conventional water treatment, can effectively remove some emerging contaminants from drinking water. In addition, emerging contaminants are completely removed from those portions of water treated with reverse osmosis, which is proposed for some of the water supply in the Downstream Intake Alternative and is already used by some municipalities along the lower Arkansas River.

Under all alternatives, a substantial amount of the baseflow in Fountain Creek would be treated wastewater. Although limited data for the study area (USGS 2006b) do not indicate higher levels of emerging contaminants in segments receiving a greater volume of treated wastewater, there remains concern about the potential occurrence of these compounds in treated wastewater. Concerns about emerging contaminants in Fountain Creek would be minimized in the Wetland and Arkansas River alternatives because return flows would be diverted to the Arkansas River near Florence via the Highway 115 Return Flow Pipeline.

The Wetland and Arkansas River alternatives may cause concern for municipalities using Pueblo Reservoir for water supply. For the other alternatives, nearly all streamflow originates as snowmelt runoff. For the Wetland and Arkansas River alternatives, about 12 to 24 percent of the average streamflow would be from the Highway 115 Return Flow Pipeline (MWH 2008h).

Twin Lakes and Turquoise Lakes

It is unlikely that Twin Lakes and Turquoise Lake water quality would be affected by any of the alternatives. Both reservoirs are oligotrophic with, other than metals loading from abandoned mine tailings, relatively pristine water sources from both sides of the Continental Divide. The quality of the water sources to these reservoirs would not be affected by any of the alternatives. Operational changes due to the alternatives, such as changes to depth and residence time, a measure of the time water remains in a water body, would be minimal. Average residence time for the No Action Alternative would be reduced by 2 percent compared to Existing Conditions in Turquoise Lake and reduced by 13 percent in Twin Lakes. Average residence time would be further reduced for the Action Alternatives by up to 7 percent compared to the No Action Alternative in Turquoise Lake. Average residence time would increase by up to 7 percent compared to the No Action Alternative in Twin Lakes, but still have less residence time than compared to Existing Conditions. Reductions in residence time are typically beneficial to water quality.

Pueblo Reservoir

Simulated hydrologic data show that storage volume and depth in Pueblo Reservoir would not differ substantially among the alternatives (MWH 2008d). Average water depth would typically be within 8 feet of Existing Conditions and the No Action Alternative (Table 72). Residence time would vary by a greater degree. The No Action Alternative would result in a 2 percent decrease in residence time compared to Existing Conditions (Table 73). The Action Alternatives would result in changes in average residence times from a 1 percent increase to a 20 percent decrease compared to the No Action Alternative. Shorter residence times are generally beneficial to water quality in Pueblo Reservoir (Lewis and Edelmann 1994).

For all but the Wetland and Arkansas River alternatives, the quality of inflows into Pueblo Reservoir would be similar to historical inflow quality. Therefore, inflow quality would not affect reservoir water quality under the No Action, Participants' Proposed Action, Fountain Creek, Downstream Intake, and Highway 115 alternatives.

USGS modeling results (Ortiz et al. 2008, in press) showed some general similarities among the modeled parameters, particularly nutrients. Generally, modeling results for the Existing Conditions, No Action, Upstream Diversion (Highway 115 Alternative), and Downstream Diversion (Participants' Proposed Action, Fountain Creek, and Downstream Intake alternatives) scenarios were similar. These scenarios had the lowest concentrations. By comparison, concentrations associated with the Upstream Return Flow scenario (Wetland and Arkansas River alternatives) showed the highest overall concentrations.

For all scenarios, concentrations of selected parameters generally increased with time as modeling proceeded from a wet year (water year 2000) to a dry year (water year 2002). The increases are likely related to decreased inflow into the reservoir and a subsequent decrease in reservoir storage.

High concentrations of ammonia can be toxic to aquatic life, can lead to low dissolved-oxygen concentrations through nitrification, and generally are not desirable in lakes and reservoirs. Simulated concentrations of ammonia in the epilimnion were low compared to WQS for all the modeled scenarios (Figure 71). Comparisons of ammonia concentrations between Existing Conditions, No Action, Upstream Diversion scenario (Highway 115 Alternative), and the Downstream Diversion scenarios (Participants' Proposed Action, Fountain Creek, and Downstream Intake alternatives) indicated that, in general, the results were similar. Annual median concentrations for these four scenarios ranged from 0.003 to 0.005 mg/L as nitrogen for the three years that were simulated. The largest difference in concentrations was associated with results from the Upstream Return Flow scenario (Wetland and Arkansas River alternatives). Although the annual median values did not differ substantially from the other scenarios (range 0.003 to 0.007 mg/L), a comparison of the 85th percentile values indicated that concentrations associated with the Upstream Return Flow scenario were as much as 3 to 5 times higher than any of the other scenario results, but still below WQS.

Reservoir nutrient concentrations were shown to affect the simulated productivity of algae in the reservoir. Figure 72 depicts simulated chlorophyll *a* concentrations for the scenarios.

The additional algae that would grow and die each year under the Upstream Return Flow scenario could have adverse water quality effects over time, compared to the other alternatives, including the No Action Alternative. The Wetland and Arkansas River alternatives would result in peak chlorophyll *a* concentrations in the epilimnion from about 20 to 40 µg/L, indicating slightly eutrophic conditions. The remaining scenarios would result in peak chlorophyll *a* concentrations of less than 10 µg/L. The additional organic matter deposited in the reservoir sediments would decompose, reducing dissolved oxygen and potentially acting as a source of phosphorus, feeding the cycle of algae growth and death. Over time, this additional algae growth could increase the rate of eutrophication of Pueblo Reservoir and its accompanying adverse water quality effects.

Table 72. Average Water Depth Direct Effects – Pueblo Reservoir.

Existing Conditions	Alt 1	Alt 2	Alt 3	Alt 4	Alt 5	Alt 6	Alt 7
Simulated Depth (feet)							
103	99	96	98	99	98	95	97
Effects (feet) (Alternative - Alternative 1)							
---	---	-2.5	-0.6	0.2	-1.3	-4.1	-1.5
Effects (%) [(Alternative - Alternative 1) / Alternative 1]							
---	---	-3%	-1%	0%	2%	-4%	-1%

Table 73. Average Residence Time Direct Effects – Pueblo Reservoir.

Existing Conditions	Alt 1	Alt 2	Alt 3	Alt 4	Alt 5	Alt 6	Alt 7
Average Residence Time (days)							
117	115	100	90	92	102	98	116
Effects (days) (Alternative - Alternative 1)							
---	---	-15	-25	-23	-13	-17	1
Effects (%) [(Alternative - Alternative 1) / Alternative 1]							
---	---	-13%	-2%	-20%	-1%	-15%	1%

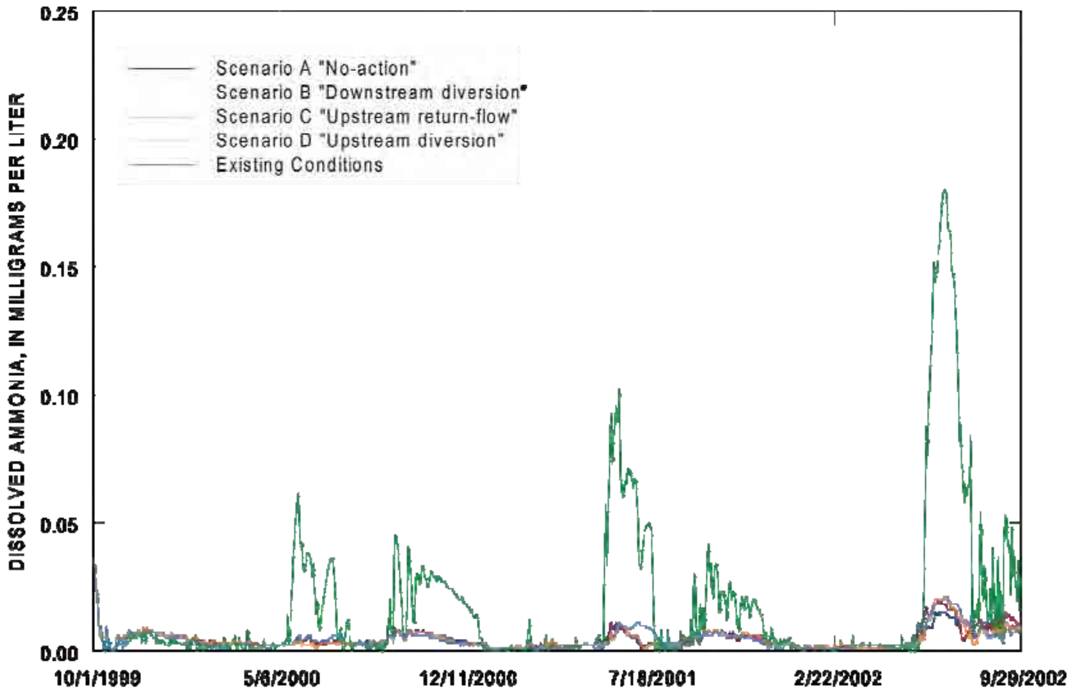


Figure 71. Simulated Direct Effects Dissolved Ammonia in Pueblo Reservoir Epilimnion near Dam.

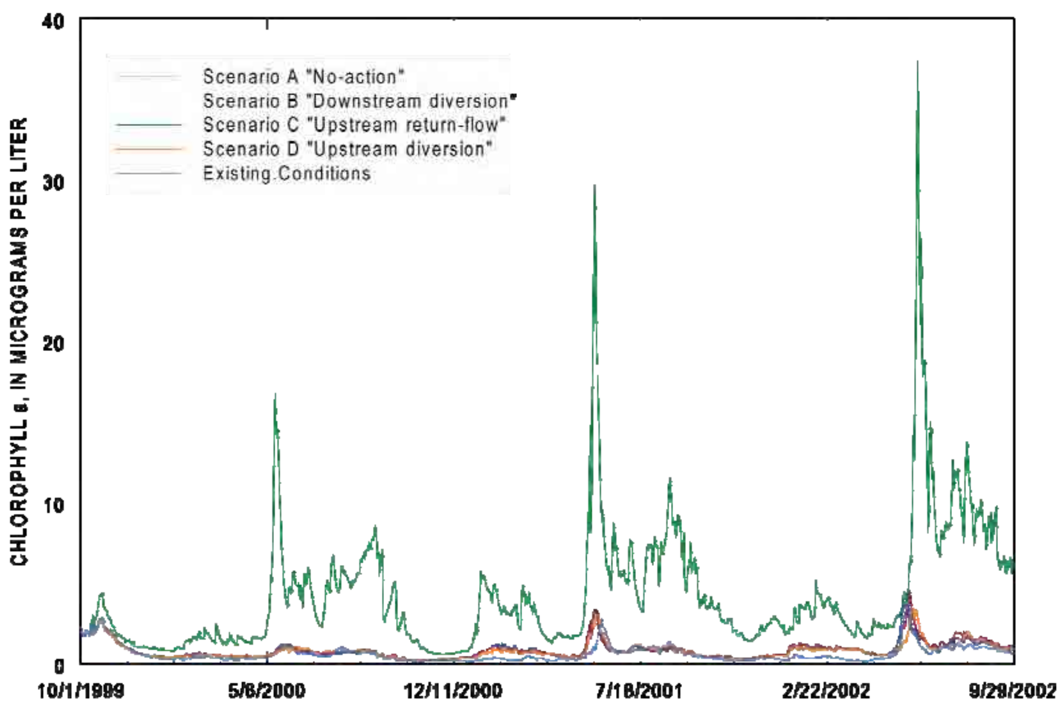


Figure 72. Simulated Direct Effects Chlorophyll *a* in Pueblo Reservoir Epilimnion near Dam.

Scenario A represents the No Action Alternative

Scenario B represents the Participants' Proposed Action, Fountain Creek, and Downstream Intake alternatives

Scenario C represents the Wetland and Arkansas River alternatives

Scenario D represents the Highway 115 Alternative

Source: Ortiz et al. (2008, in press).

Dissolved oxygen concentrations in the hypolimnion, which can be affected by excessive algae growth, were relatively similar for all the modeled scenarios (Figure 73). The model generally showed anoxic conditions of similar durations for all scenarios. In Colorado, during periods of stratification, the hypolimnion is not subject to dissolved oxygen WQS.

Lake Henry and Lake Meredith

For Lake Henry and Lake Meredith, reservoir residence time (Table 74) would be similar for all alternatives. Storage for the Action Alternatives would be almost completely depleted each fall. With higher nutrient concentrations in the inflow, there may be more algae growth, although shorter residence times may cause water to be removed before nutrients have been completely used. With the shallow conditions, the water would likely be completely mixed and near oxygen saturation. Refer to Figure 54 and Figure 55 in Section 3.5 for additional information on reservoir storage in Lake Henry and Lake Meredith.

Salinity would increase slightly for the No Action Alternative only, but by less than 10 percent (Table 60). Salinity levels for Existing

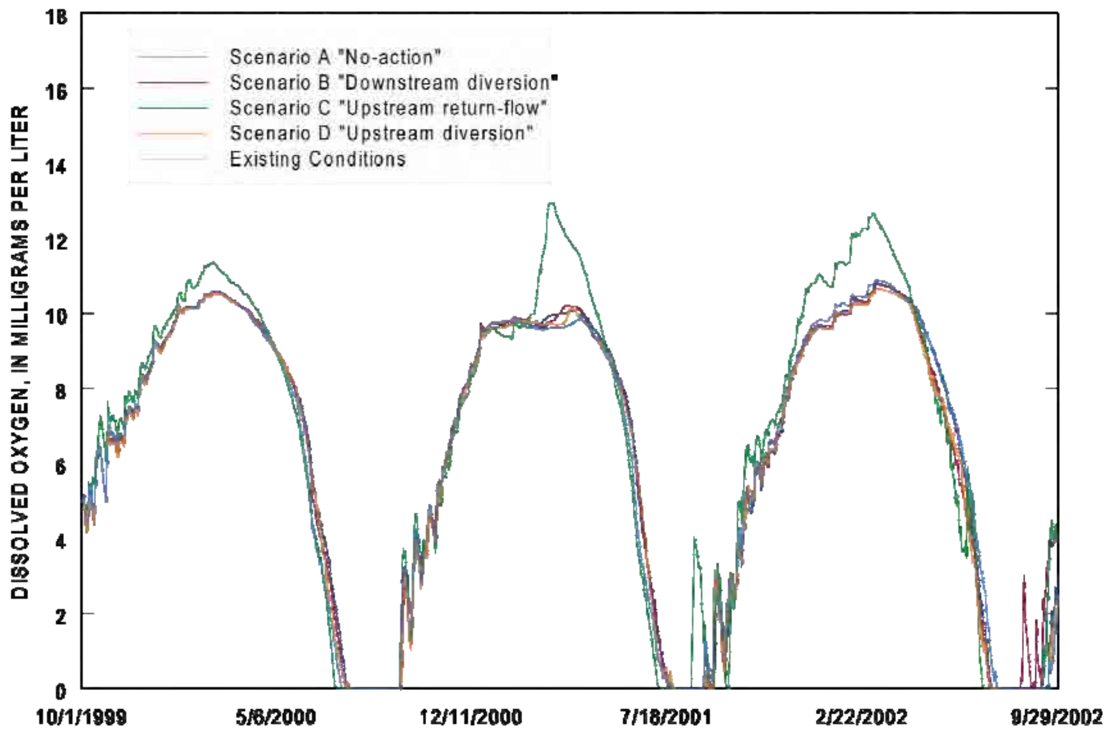


Figure 73. Simulated Direct Effect Dissolved Oxygen Concentrations in Pueblo Reservoir Hypolimnion near Dam.

Scenario A represents the No Action Alternative

Scenario B represents the Participants' Proposed Action, Fountain Creek, and Downstream Intake alternatives

Scenario C represents the Wetland and Arkansas River alternatives

Scenario D represents the Highway 115 Alternative

Source: Ortiz et al. (2008, in press).

Table 74. Simulated Average Depth and Average Residence Time in Lake Meredith and Lake Henry – Direct Effects.

Parameter/Location	Existing Conditions	Alt 1	Alt 2	Alt 3	Alt 4	Alt 5	Alt 6	Alt 7
Simulated Mean Depth (ft)								
Lake Meredith	9.3	9.4	8.8	8.3	8.3	9.0	9.0	9.7
Lake Henry	6.7	6.7	5.0	5.2	5.2	5.4	5.6	6.4
Average Residence Time (days)								
Lake Meredith & Lake Henry Combined	114	120	109	102	101	111	116	119

Conditions, the No Action Alternative, and the Action Alternatives would exceed the agricultural high salinity hazard threshold by about two-fold. Consequently, agricultural uses of the water would not be affected by the alternatives. With similar dissolved selenium concentrations in the Arkansas River near the Colorado Canal headgate, which diverts water to the reservoirs, there would no difference in effects among the alternatives in Lake Henry and Lake Meredith selenium concentrations.

Holbrook Reservoir

Return flows that may not be stored in Williams Creek Reservoir or exchanged to the upper basin would be stored in lower basin reservoirs, including Holbrook Reservoir. For the No Action Alternative, this would result in increased storage in Holbrook Reservoir when compared with Existing Conditions. The Action Alternatives show lower simulated reservoir storage than the No Action Alternative and Existing Conditions. There would be only minor differences in reservoir storage contents among the Action Alternatives. It is unlikely that the negligible to minor changes in water quality of the lower Arkansas River, described in preceding subsections, or the changes in storage would have substantial effects on water quality in Holbrook Reservoir.

Terminal Storage Reservoirs

Based on the Osgood Index (Osgood 1988), calculated from simulated Upper Williams Creek Reservoir and Jimmy Camp Creek Reservoir depths and storage volumes, the reservoirs would likely stratify in all alternatives. For all alternatives except the Downstream Intake Alternative, the terminal storage reservoirs would be low in nutrient loading because their source water would be from either the upper or middle Arkansas River. The untreated water pipeline in the Downstream Intake Alternative would convey water from the Arkansas River downstream of Fountain Creek, which would result in higher nutrient loading. The higher turbidity of water conveyed from the Arkansas River downstream of Fountain Creek may reduce the ability of algae to grow and offset the additional nutrient loading. With moderate levels of algae growth, the terminal storage reservoirs would likely remain oxygenated throughout most of the water column. The Downstream Intake Alternative already includes advanced water treatment (due to higher salinity levels) so higher algae and turbidity levels should not substantially affect treatment costs or processes.

Williams Creek Reservoir

Operations of Williams Creek Reservoir would vary substantially among the alternatives that would include the reservoir for return flow storage (all but the Wetland and Arkansas River alternatives). Figure 74 shows the simulated storage in Williams Creek Reservoir under direct effects. Storage for the Downstream Intake Alternative would be low compared to the other alternatives because return flows would usually be delivered directly to the diversion location downstream of Fountain Creek and would rarely require storage in a reservoir. Under the Highway 115 Alternative, it would be easier to exchange reusable return flows directly into Pueblo Reservoir because Colorado Springs would not participate in the Pueblo Flow Management Program and, therefore, return flows would not need to be stored as often in Williams Creek Reservoir as the No Action Alternative due to increased exchanges. The No Action Alternative configuration is similar to the Highway 115 Alternative, but Williams Creek Reservoir would have more frequent drawdowns for the No Action Alternative because there would not be long-term contracts for storage in Pueblo Reservoir. Although storage would be similar for the Participants' Proposed Action and Fountain Creek alternatives, there would be substantially more flow through the reservoir for the Fountain Creek Alternative. The higher inflows from Fountain Creek for the Fountain Creek Alternative would result in higher loading of suspended sediments, causing higher turbidity in the reservoir for this alternative.

Because of the high suspended solids loading from Fountain Creek, algae growth would be low for most of the alternatives. The Downstream Intake Alternative would typically divert less water to Williams Creek Reservoir than the other alternatives, resulting in a reservoir that is shallower and clearer than the other alternatives, allowing algae growth. Substantial algae growth would be expected for the Downstream Intake Alternative, and

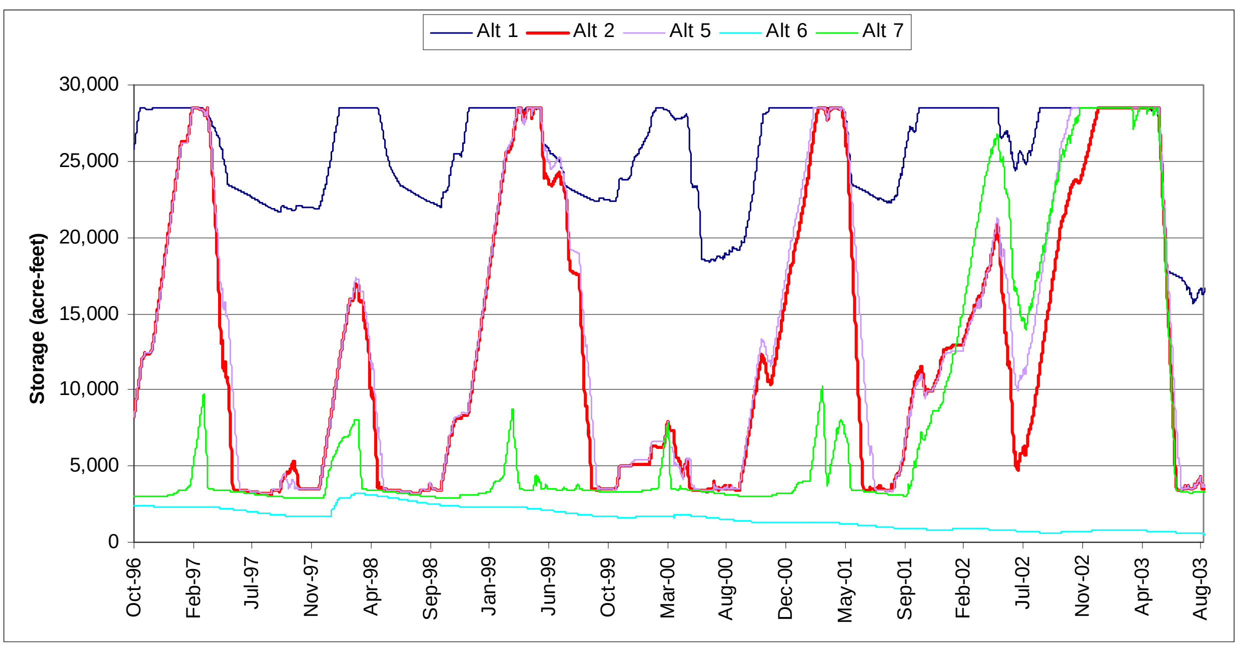


Figure 74. Daily Model-Simulated Storage in Williams Creek Reservoir – Direct Effects.

Williams Creek Reservoir would be considered eutrophic based on simulated peak chlorophyll *a* concentrations of about 90 to 160 µg/L (Figure 75).

In all alternatives using Williams Creek Reservoir, algae growth would be limited primarily by the high turbidity of water diverted from Fountain Creek, and reduced light for photosynthesis. Figure 76 summarizes the simulated TSI in Williams Creek Reservoir based on simulated summertime average chlorophyll *a* concentrations. The Downstream Intake Alternative would tend to result in a eutrophic reservoir throughout the summer. The No Action, Proposed Action, Fountain Creek, and Highway 115 alternatives would have very low algae growth (represented by a single line near a TSI of 0 in Figure 76) and may generally be considered oligotrophic.

For each alternative, simulated dissolved oxygen concentrations would attain warm water aquatic life WQS.

Surficial geology at the Williams Creek Reservoir and Upper Williams Creek Reservoir sites includes Cretaceous marine shale and may be a source of dissolved selenium to surface and ground waters under those alternatives including the reservoirs. A relatively small volume of water is expected to seep under the dams. This water could contact the underlying seleniferous (selenium rich) geology, and result in ground water with high selenium concentrations. Additional information on the particular geology underlying the reservoir sites or ground water concentrations currently underlying the reservoir sites is not available and would be needed to quantify likely concentrations of that seepage water. To affect aquatic life, the seepage water would need to travel downstream to Fountain Creek (distances of about 5 miles and 15 miles, respectively) and be of high enough concentration to raise concentrations in Fountain Creek.

A sensitivity analysis showed that relatively high concentrations of selenium in seepage water from Williams Creek Reservoir would be needed to substantially affect dissolved selenium concentrations in Fountain Creek. Considering that the chronic selenium WQS is 8 µg/L, an increase of 0.5 to 1.0 µg/L could be considered substantial. The annual seepage under Williams Creek Reservoir was estimated to be 40 ac-ft/yr, or 0.05 cfs (GEI 2005b). If seepage from the reservoir reached Fountain Creek, a seepage selenium concentration of 800 µg/L would raise the average stream selenium concentration by 0.5 µg/L and a seepage concentration of 1,600 µg/L would raise the stream concentration by 1.0 µg/L. Ground water concentrations in the range of 800 µg/L and higher are uncommon, but have been measured in ground water near Pueblo (MWH 2008g).

No adverse effects on water quality downstream of Williams Creek Reservoir would likely occur in those alternatives that include it as a component. Nutrient concentrations would be within the range of historical nutrient concentrations in Fountain Creek (Table 75), indicating that releases from Williams Creek Reservoir would not affect the productivity of downstream waters.

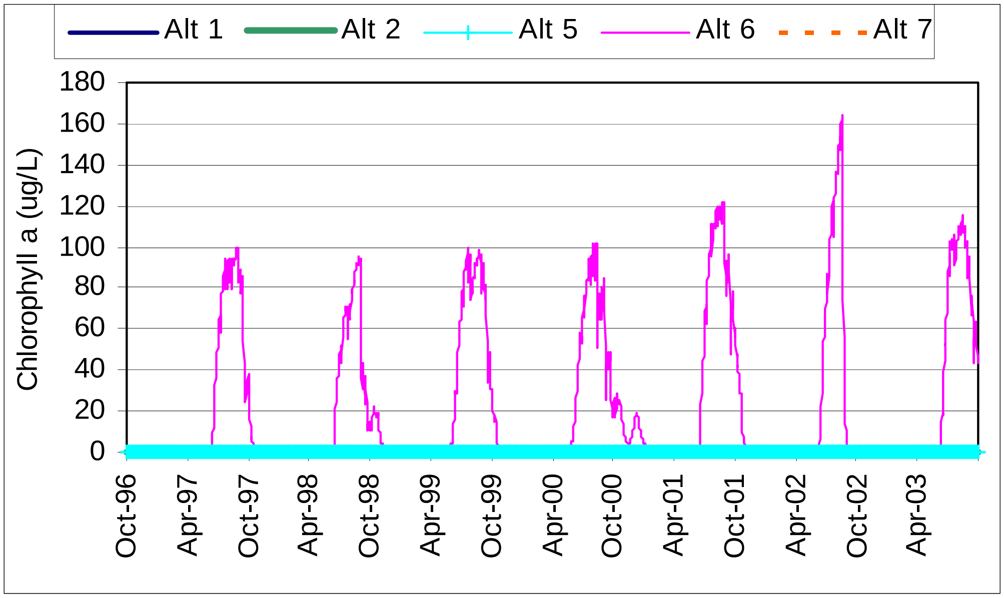


Figure 75 Simulated Direct Effects Chlorophyll *a* Concentrations in Williams Creek Reservoir.

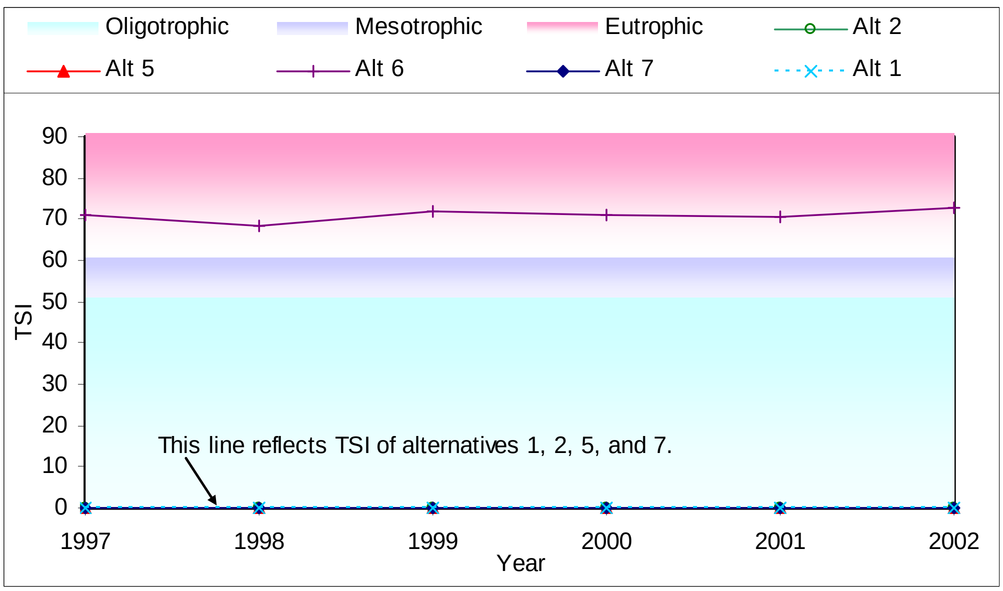


Figure 76. Simulated Direct Effects Chlorophyll *a* TSI in Williams Creek Reservoir.

Ground Water Quality

The differences in stream water quality discussed above may result in changes to alluvial ground water quality. Changes in surface water quality would have the most effect on alluvial ground water in Fountain Creek and the lower Arkansas River where pumping of alluvial ground water and irrigation diversions cause more extensive mixing of surface and ground water than at other locations. As described in the Ground Water Hydrology section (Section 3.6), the No Action Alternative would drawdown the

Table 75. Predicted Median Nutrient Concentrations in Fountain Creek and Williams Creek Reservoir – Direct Effects.

Parameter	Fountain Creek (historical)†	Williams Creek Reservoir				
		Alt 1	Alt 2	Alt 5	Alt 6	Alt 7
Phosphorus as P (mg/L)	0.7 (0.2 to 8.2)	0.6	0.6	0.6	1.8	0.8
Ammonia as N (mg/L)	0.03 (0 to 0.6)	0.2	0.2	0.4	0.4	0.2
Nitrate plus nitrite as N (mg/L)	3.8 (1.8 to 5.2)	1.7	3.3	3.3	6.7	3.6

† Fountain Creek median and range. Phosphorus data from USGS 2006b, Fountain Creek at Security (07105800) between 1998 and 2004. Ammonia and nitrate data from MWH 2008g, segment FO2a.

alluvial aquifer near Fountain and Security. Drawdown would not occur under the Action Alternatives. This suggests that mixing of surface and ground water would likely continue at the same rate for the Action Alternatives, and increase for the No Action Alternative relative to Existing Conditions.

Surface water salinity in the lower Arkansas River would be similar among Existing Conditions and all alternatives (Table 60); therefore, little change in alluvial ground water salinity would occur under all alternatives. Nutrient concentrations in lower Arkansas River alluvial ground water would likely increase similarly for all alternatives.

In Fountain Creek, depending on the location, the No Action, Wetland, Arkansas River, and Fountain Creek alternatives may result in increased surface water salinity (Table 60) and consequently increased ground water salinity. Nutrient concentrations in the alluvial ground water may increase, with the least increase for the Wetland and Arkansas River alternatives.

Ground water quality in the Denver Basin aquifers may be affected by pumping toward the end of the study period (2046) for the No Action Alternative. Concentrations of TDS and sulfate are not uniform throughout the Denver Basin aquifers (Robson 1987) and pumping may cause water of higher TDS and sulfate concentrations located at the edges of the aquifer to migrate toward the wells and result in pumping of higher concentrations than historically pumped near Colorado Springs; however, most Denver Basin water has TDS concentrations below the secondary MCL, such that treatment costs would not be affected.

3.7.5.2 *Cumulative Effects*

A description of reasonably foreseeable actions considered in this FEIS is presented in Section 3.1.3.1. Reasonably foreseeable actions with potential cumulative water quality effects include the Colorado Springs Stormwater Enterprise, alluvial ground water development by Fountain, urban development in El Paso, Pueblo, and Fremont counties, and climate change.

Most of the cumulative water quality effects would be similar to direct and indirect effects. Differences between the direct and indirect effects and cumulative effects are summarized below:

- Cumulative effects for dissolved selenium are summarized in Table 76. Except for the Arkansas River at Moffat Street, cumulative effects would be similar to direct effects. Due to increased exchanges by non-SDS municipal entities and decreased delivery of agricultural Fry-Ark water, resulting in lower streamflows, dissolved selenium concentrations at Moffat Street would be 2 to 15 µg/L higher for cumulative effects.
- Cumulative effects for salinity are shown in Table 77. At the Portland Gage, the No Action Alternative would result salinity similar to direct effects, but still lower than Existing Conditions. At the Arkansas River above Pueblo Gage and the Arkansas River at the Moffat Street Gage, the No Action Alternative and all Action Alternatives would result in slightly higher salinity than direct effects. The No Action Alternative would have salinity similar to direct effects at all other gages. At the Fountain Creek at Pueblo Gage, the Downstream Intake Alternative would have an 85th percentile salinity that is less than 10 percent different from the No Action Alternative. Consequently, the minor beneficial effect for agricultural uses that would occur for direct effects would not occur for cumulative effects. The Arkansas River Alternative would result in a 13 percent increase in salinity in Lake Henry and Lake Meredith, compared to the No Action Alternative, resulting in potentially minor adverse effects on agricultural uses.
- Chronic low flows at several WWTF locations would be marginally less than for direct effects; however, with the new ammonia regulations and other considerations discussed in the direct effects low flow analysis, treatment plants would not likely be affected.

Table 76. Estimated Cumulative Effects Dissolved Selenium Concentrations.

Location	Existing Conditions	Alt 1	Alt 2	Alt 3	Alt 4	Alt 5	Alt 6	Alt 7
Simulated Dissolved Selenium 85th Percentile (µg/L)								
Monument Creek at Bijou Street	4	4	4	4	4	4	4	4
Fountain Creek near Fountain	5	5	5	6	6	5	4	4
Fountain Creek at Pueblo	28	23	23	35	35	35	21	22
Arkansas River at Moffat Street	33	58	66	58	28	67	67	74
Arkansas River near Avondale	16	18	19	19	17	18	17	18
Arkansas River at Catlin Dam	12	14	14	14	13	14	14	14
Effects (%) [(Alternative - Alternative 1) / Alternative 1]								
Monument Creek at Bijou Street	---	---	0%	0%	0%	0%	0%	0%
Fountain Creek near Fountain	---	---	0%	20%	20%	0%	0%	1%
Fountain Creek at Pueblo	---	---	0%	52%	52%	52%	-9%	-4%
Arkansas River at Moffat Street	---	---	14%	0%	-52%	16%	16%	28%
Arkansas River near Avondale	---	---	6%	6%	-6%	0%	-6%	0%
Arkansas River at Catlin Dam	---	---	0%	0%	-7%	0%	0%	0%

- Effluent limits for most WWTFs would be similar to direct effects for most WWTFs. The chronic *E. coli* limit would be lower under cumulative effects at the Pueblo WWTF; however, it would be about 500 colonies per 100 mL or higher for all alternatives. The effluent limit for *E. coli* would be moderately different under cumulative effects at the Rocky Ford WWTF (Table 78). This effluent limit would be lower for the No Action Alternative under cumulative effects than under direct effects. Conversely, the effluent limit would increase for the Action Alternatives under cumulative effects. The potential need for facility improvements to meet the *E. coli* effluent limit, independent of the SDS Project, would remain under cumulative effects.
- Similar to direct effects, the No Action Alternative would result in greater storage in Williams Creek Reservoir than the Action Alternatives for direct or cumulative effects. The higher inflows from Fountain Creek would result in higher turbidity in Williams Creek Reservoir, reducing algae growth, compared to direct effects. Nutrient concentrations would be within the range historically measured in Fountain Creek. Dissolved oxygen concentrations would remain above the WQS of 5 mg/L.
- Residence times in Twin and Turquoise Lakes would be shorter than direct effects. For the No Action Alternative, residence time would be reduced by 11 percent in Turquoise Lake and reduced by 18 percent in Twin Lakes compared to Existing Conditions. Average residence time would be further reduced for the Action Alternatives by up to 6 percent compared to the No Action Alternative in Turquoise and Twin Lakes.
- Based on differences in streamflow, cumulative effects suspended sediment concentrations are likely to be similar to direct effects concentrations (MWH 2008g, 2008h). Urban development typically increases levels of suspended sediment and other water quality parameters in adjacent surface waters. However, most municipalities in the watershed have MS4 permits from CDPHE requiring water quality best management practices for construction and permanent stormwater quality controls for new development. These controls should reduce the amount of sediment entering waterways for all alternatives compared to development that occurred before the mid-1990s. More discussion of Colorado Springs' MS4 permit is included in Section 3.1.3.1.

Table 77. Specific Conductance Cumulative Effects.

Location	Existing Condition	Alt 1	Alt 2	Alt 3	Alt 4	Alt 5	Alt 6	Alt 7	High Salinity Hazard	Second-ary MCL
Simulated Specific Conductance 85th Percentile (µS/cm)									**(µS/cm)**	**(µS/cm)**
Ark River at Portland	630	490	610	720	730	620	630	500	750	775
Ark River above Pueblo	650	700	680	770	770	680	720	720	750	740
Ark River Moffat Street	790	810	840	830	810	840	830	890	750	726
Fountain Crk at Janitell	850	940	940	1,000	1,000	940	930	930	750	778
Fountain Crk at Fountain	1,100	1,200	1,200	1,400	1,400	1,400	1,100	1,200	750	778
Fountain Crk at Pueblo	1,700	1,700	1,700	2,200	2,200	2,200	1,600	1,600	750	778
Ark River near Avondale	1,200	1,200	1,300	1,300	1,300	1,200	1,300	1,200	750	742
Ark River at Catlin Dam	1,500	1,500	1,500	1,500	1,500	1,800	1,500	1,500	750	757
L. Henry & L. Meredith	1,500	1,600	1,500	1,600	1,800	1,500	1,500	1,600	750	694
Effects (%) [(Alternative - Alternative 1) / Alternative 1]†									**High Salinity Hazard**	**Second-ary MCL**
Ark River at Portland	---	---	24%	47%	49%	27%	29%	2%	750	775
Ark River above Pueblo	---	---	-3%	10%	10%	-3%	3%	3%	750	740
Ark River Moffat Street	---	---	4%	2%	0%	4%	2%	10%	750	726
Fountain Crk at Janitell	---	---	0%	6%	6%	0%	-1%	-1%	750	778
Fountain Crk at Fountain	---	---	0%	17%	17%	17%	-8%	0%	750	778
Fountain Crk at Pueblo	---	---	0%	29%	29%	29%	-6%	-6%	750	778
Ark River near Avondale	---	---	8%	8%	8%	0%	8%	0%	750	742
Ark River at Catlin Dam	---	---	0%	0%	0%	20%	0%	0%	750	757
L. Henry & L. Meredith	---	---	-6%	0%	13%	-6%	-6%	0%	750	694

† Differences of less than 10 percent are not considered meaningful and are shown in grey text.
‡ TDS secondary MCL converted from 500 mg/L to specific conductance using site-specific regression equations.

Table 78. Estimated Effluent Limits for *E. coli* Cumulative Effects – Rocky Ford WWTF.

Parameter	Existing Conditions	Alt 1	Alt 2	Alt 3	Alt 4	Alt 5	Alt 6	Alt 7
***E. coli* (# / 100 mL)**								
Chronic Effluent Limit (WQS = 126)	470	250	546	497	301	609	376	506

- The Colorado Springs Stormwater Enterprise's top priority projects are likely to reduce stream channel erosion and thus suspended sediment concentrations through the addition of drop structures, bank protection, and other channel improvements in Fountain Creek and its tributaries. New and/or improved detention ponds could also reduce watershed contributions of sediments (Colorado Springs 2007b). The Colorado Springs Stormwater Enterprise will place "increased emphasis on detention and water quality control" (Baker 2006). Typically, stormwater management systems with water quality components reduce sediments and pollutants associated with sediments through settling (Minton 2002). More information on the Colorado Springs Stormwater Enterprise is in Section 3.1.3.1.

- Bacteria densities will not necessarily increase with the reasonably foreseeable urban growth in the Fountain Creek watershed because rural areas currently contribute substantially to the bacteria load in Fountain Creek (Mau et al. 2007).
- Fountain would pump an additional 7,500 ac-ft/yr of Fountain Creek alluvial well water, greatly increasing the proportion of its municipal supply that is from alluvial water for all alternatives. Fountain plans to treat a portion of its source water by reverse osmosis so that the taste of its water should not be affected.
- Some of the reasonably foreseeable actions identified in Section 3.1.3.1 would likely improve water quality in the Fountain Creek Basin, regardless of the SDS Project. The City of Colorado Springs Stormwater Enterprise and Sanitary Sewer Evaluation and Rehabilitation Program by Colorado Springs Utilities could potentially improve levels of parameters that are currently of concern. The sanitary sewer improvements in particular should reduce future occurrences of sewer breaks that have historically affected surface water quality in Fountain Creek.
- Climate change is expected to cause runoff to occur earlier in the spring, which would change the typical temporal patterns of water quality parameters. With an earlier peak runoff, salinity levels would be diluted earlier in the spring. The peak concentration of heavy metals in the upper Arkansas River, which generally occurs during early runoff or peak snowmelt runoff (Ortiz et al. 1998), would occur earlier. Warmer temperatures could increase rates of evaporation and evapotranspiration, slightly increasing surface water concentrations, particularly in reservoirs. Cumulative effects to surface water quality are likely to result in similar effects in alluvial ground water quality over time. In general, however, climate change is not expected to result in substantial changes in concentration of parameters, nor the attainment of WQS by the year 2046.

3.7.5.3 Resource Commitments

None of the alternatives would result in any irreversible resource commitments in terms of surface and alluvial ground water quality because changes at one point in time are not necessarily permanent. However, the surface and ground water effects described above would be irretrievable. Changes to Denver Basin ground water quality due to pumping in the No Action Alternative likely would result in an irreversible commitment of resources.

3.7.5.4 Mitigation

Proposed Measures

Because most of the water quality effects would be small and because there is some uncertainty regarding future conditions, the most effective mitigation measure is implementation of a water quality monitoring program commensurate with the potential effects of the Preferred Alternative combined with adaptive management. These measures would apply to operation of the SDS Project, rather than construction, which is not likely to have substantial water quality effects. The Participants would implement the following measures to minimize water quality impacts:

- Develop a water quality monitoring and adaptive management plan and submit it to Reclamation
- Begin implementing monitoring, upon acceptance by Reclamation, at least 2 years prior to beginning operation of the SDS Project
- Submit water quality monitoring data, including trend analyses, to Reclamation annually
- If operation of the SDS Project is determined to cause or contribute to an exceedence of applicable water quality standards, coordinate with Reclamation, CDPHE, and other interested parties to evaluate and select measures to mitigate adverse effects

An adaptive management program would consider the results of water quality monitoring and determine whether an exceedence of applicable water quality standards is occurring as a result of implementing the SDS Project. The program would then respond by mitigating the adverse effects (Figure 77). The adaptive management program would be developed by Project Participants in cooperation with CDPHE and/or other regional stakeholders and implemented as a condition of long-term contracts with Reclamation or another binding agreement. The Participants' adaptive management program concept is described in more detail in Appendix F. The final plan will be prepared in general accordance with Department of the Interior Policy guidance

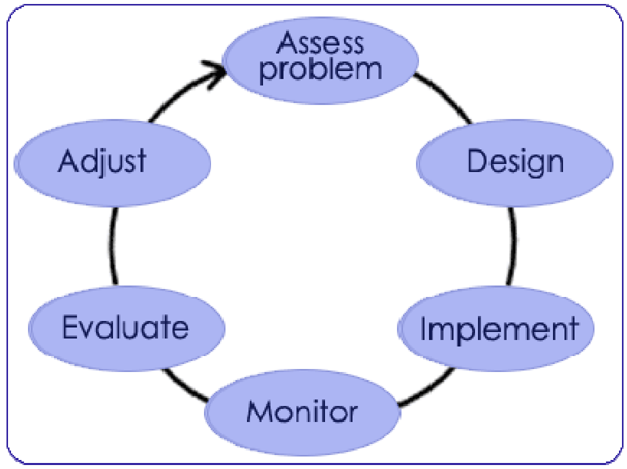


Figure 77. Diagram of the Adaptive Management Process.

Source: DOI 2007.

(Order 3270) and the report Adaptive Management, The U.S. Department of the Interior Technical Guide (Williams et al. 2007).

The geomorphology mitigation measures described in Section 3.9.5.4 include stream stabilization. Implementation of these measures also would serve to reduce stream channel erosion consequently reducing suspended sediment and total recoverable iron concentrations in Fountain Creek and the lower Arkansas River.

Potential locations for water quality monitoring during operation of the Preferred Alternative would be:

- Arkansas River at Portland Gage (Wetland or Arkansas River alternatives only)
- Pueblo Reservoir (Wetland or Arkansas River alternatives only)
- Arkansas River at Moffat Street Gage (all alternatives)
- Fountain Creek at Security Gage (all alternatives)

- Fountain Creek at Pueblo Gage (all alternatives)
- Arkansas River near Avondale Gage (all alternatives)

Although some water quality parameters are already monitored at these locations with varying regularity, depending on which alternative is implemented, those water quality parameters with a reasonable potential for effects should be tracked to determine actual effects that may be associated with the project. Potential parameters to be monitored include:

- Salinity (as Specific Conductance)
- Dissolved selenium
- Suspended sediment
- Total recoverable iron
- *E. coli*
- Reservoir water quality including nutrients and algae

The monitoring suggestions are only conceptual and are meant to be inclusive of all of the alternatives evaluated. The Participants' water quality monitoring and adaptive management plan should be oriented toward only those parameters and locations likely to be affected by the Preferred Alternative as disclosed in this FEIS.

Mitigated Effects

Development and implementation of a water quality monitoring and adaptive management plan will provide a means of detecting changes in water quality, judging whether they are likely caused by operation of the SDS Project, and addressing actual effects in a systematic manner. Additionally, implementation of the geomorphology mitigation measures (Section 3.9.5.4) will reduce suspended sediment and total recoverable iron concentrations in Fountain Creek and the lower Arkansas River.

3.8 Flood Hydrology and Floodplains

Flood hydrology and floodplains are being analyzed because construction of new reservoirs and movement of water from one location to another may affect the magnitude and depth (also referred to as stage) of peak flows, and the width of floodplains associated with peak flows. Flood-related indicators evaluated are:

- Peak flows recurring at 2-year, 10-year, and 100-year intervals
- Floodplain stage and width at 100-year peak flows
- Acres and existing structures inundated by new reservoirs under probable maximum flood conditions

3.8.1 Summary of Effects

Direct and indirect effects of all alternatives would be beneficial (i.e., peak flows and floodplain stages and widths would be reduced) as a result of construction of the proposed reservoirs. Although none of the reservoirs would have dedicated flood control space, some incidental attenuation of flood flows would occur. The most substantial direct and indirect effects would occur for alternatives with Williams Creek Reservoir (No Action, Participants' Proposed Action, Fountain Creek, Downstream Intake, and Highway 115 alternatives). For these alternatives, peak flows and floodplain stage and width would be reduced relative to Existing Conditions. The incidental flood control benefit of Williams Creek Reservoir would carry downstream in Fountain Creek and the Arkansas River. Although the direct and indirect effects would be primarily beneficial, there may also be minor channel encroachment (e.g., growth of riparian vegetation along the streambank) that may reduce channel capacity over time as reduced flood flows increase the ability for vegetation to establish.

> Some tables and figures in this section use the following numbers to identify the alternatives:
>
> - Alternative 1 (No Action Alternative)
> - Alternative 2 (Participants' Proposed Action)
> - Alternative 3 (Wetland Alternative)
> - Alternative 4 (Arkansas River Alternative)
> - Alternative 5 (Fountain Creek Alternative)
> - Alternative 6 (Downstream Intake Alternative)
> - Alternative 7 (Highway 115 Alternative)

Inundation associated with the proposed reservoirs also would be a direct effect of the SDS Project. Inundation at the reservoir sites would affect floodplains by increasing the width and stage of the floodplain area at the reservoir sites. Jimmy Camp Creek Reservoir would inundate about 700 acres under maximum flood conditions for the No Action, Arkansas River, Fountain Creek, Downstream Intake, and Highway 115 alternatives. Upper Williams Creek Reservoir would inundate about 870 acres for the Participants' Proposed Action and Wetland alternatives. Williams Creek Reservoir would inundate about 1,340 acres for No Action, Participants' Proposed Action, Fountain Creek, Downstream Intake, and Highway 115 alternatives.

Direct and indirect effects of a potential dam failure at any of the proposed SDS reservoirs would include major flood inundation and potentially substantial loss of life and property damage. However, there would be a low probability of an actual dam failure because the proposed reservoirs would be designed and constructed according to the Colorado State

Engineer's Office dam safety criteria. Under the unlikely event of a dam failure, there would be substantial flood inundation downstream of the failure, including flooding within the Colorado Centre Metropolitan District, the city of Fountain, and the city of Pueblo. The maximum peak discharge rates failure (CH2M HILL 2008c) would be about:

- 460,000 cfs for Jimmy Camp Creek Reservoir
- 450,000 cfs for Upper Williams Creek Reservoir
- 340,000 cfs for Williams Creek Reservoir
- 550,000 cfs for a sequential Upper Williams Creek and Williams Creek reservoirs dam failure

Time to maximum peak discharge in the metropolitan areas downstream of the dams would range from about 3 to 6 hours after the dam breach.

3.8.2 Regulatory Framework

The U.S. Federal Emergency Management Agency (FEMA) maps 100-year floodplains and sets regulations for construction within these areas or alterations of the 100-year floodplains. Two regional building departments—Pikes Peak Regional Building Department (PPRBD) and Pueblo County Planning and Development—enforce FEMA regulations and complete reviews of proposed construction within floodplains or alteration of floodplains within the Fountain Creek Basin. The Regional Floodplain Management division of PPRBD is the floodplain management authority for El Paso County. PPRBD requires a Floodplain Development Permit in order to alter the floodplains or to construct within the floodplains. Similar to PPRBD, Pueblo County Planning and Development enforces FEMA regulations and provides permits for construction within or modifications to floodplains within Pueblo County. The Otero County Building Department reviews applications to build in or modify floodplains in Otero County, and enforces FEMA regulations. Applications to build in or modify floodplains in Otero County are reviewed by the County Commissioners, and referred to FEMA if approved by the commissioners (Shultz 2007). There is no county oversight for modifications to floodplains in Crowley County, where floodplain-related issues are directed to FEMA (Grant 2007). Regulatory authorities for floodplains in Fremont County are not described because of the negligible flood-related effects of the alternatives in this county (Section 3.8.5).

Construction of proposed SDS Project reservoirs would increase the floodplain area immediately upstream of the proposed dams, where the reservoir flood inundation pool would be located. At each of the three proposed reservoir sites, 100-year floodplains are currently mapped. A Conditional Letter of Map Revision (CLOMR) and a Letter of Map Revision (LOMR) would be necessary to provide FEMA with revised floodplain mapping for any locations where floodplain width or stage would increase. Additionally, procedures for obtaining approval for development within a floodplain would need to be followed, as outlined in Executive Order 11988 (42 FR 26971, 3 CFR). This executive order requires the agency responsible for approving the development to determine whether the development would occur within a floodplain, consider alternatives to development within the floodplain, facilitate public comments by notifying potentially affected landowners, and provide updated information on the extent and height of the resulting floodplain.

Additionally, municipal stormwater regulations throughout the analysis area would specify restrictions on the potential effects of development within the analysis area. For example, the recently approved Colorado Springs Stormwater Enterprise (discussed in section 3.1.3.1) would require future peak flows (up to the 100-year recurrence interval) to remain at current peak flow levels following future development (Colorado Springs 2007a; Baker 2006). Stormwater regulations adopted by other entities (e.g., El Paso County, Pueblo County, and the City of Pueblo) also would regulate potential effects on peak flows and floodplains. Although development is not a direct or indirect effect of the SDS Project, the effect of development on peak flows and floodplains is considered in the cumulative effects analysis.

The Colorado Division of Water Resources, SEO, adopts regulations regarding the construction and maintenance of dams in the state of Colorado. In its Rules and Regulations for Dam Safety and Dam Construction (CDWR 2007), hazard classifications, permit requirements, design requirements, water diversion requirements, and safety regulations are described. Dams are classified from "no public hazard" type, where there would only be damage to the dam owner's property, to "high hazard" dams, where loss of human life would be expected in the event of a dam failure. Several permit and design specifications requirements are required for SEO approval of construction of dams. Requirements for an Emergency Action Plan also are provided in the SEO rules. The proposed dams would be considered "high hazard" dams until the SEO permit is applied for and flood modeling to determine flood conditions associated with a dam failure is evaluated.

3.8.3 Analysis Area and Methods

3.8.3.1 Analysis Area

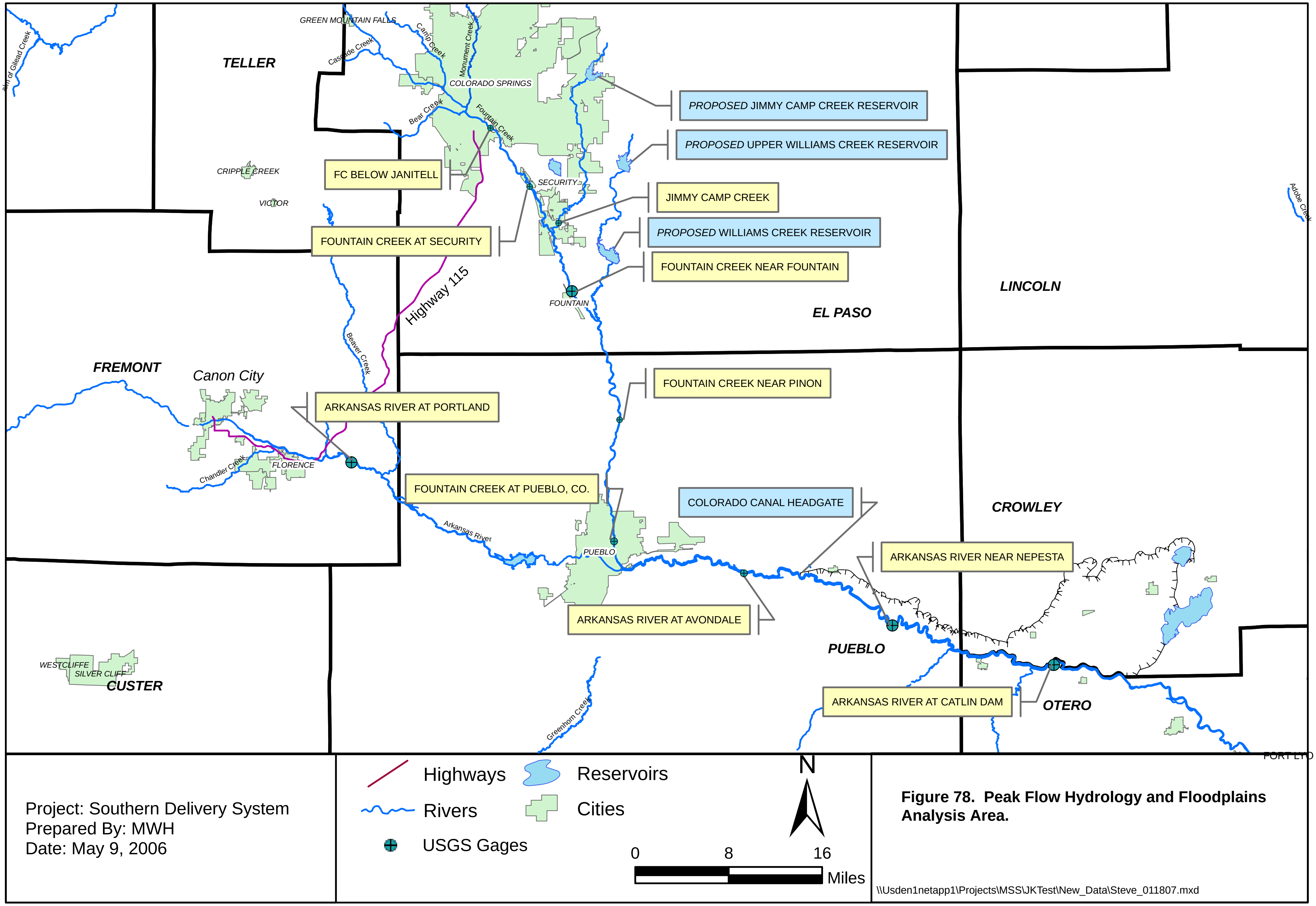
The analysis area for flood hydrology and floodplains is the Fountain Creek Basin and the Arkansas River near Florence downstream to the Catlin Dam Gage near Fowler (Figure 78). These areas could be directly or indirectly affected by the SDS Project components (e.g., proposed dams) or cumulatively by the alternatives in conjunction with reasonably foreseeable actions. Potential effects are described for the following stream reaches (shown in Figure 78):

- Arkansas River from Portland to the Fountain Creek confluence
- Fountain Creek from Colorado Springs to the confluence with Jimmy Camp Creek
- Jimmy Camp Creek from the Jimmy Camp Creek Reservoir site to the confluence with Fountain Creek
- Williams Creek from the Upper Williams Creek Reservoir site to the confluence with Fountain Creek
- Fountain Creek from Jimmy Camp Creek to the Arkansas River
- Arkansas River from Fountain Creek to the Catlin Dam Gage

There would be no effects on flood hydrology or floodplains at locations farther upstream on Fountain Creek or the Arkansas River. Effects on the Arkansas River downstream of the Catlin Dam Gage would be similar to those at the Catlin Dam Gage. The existing flood control storage in Pueblo Reservoir would not be affected in any way by the alternatives, and was not analyzed.

3.8.3.2 Methods

A quantitative analysis was completed to determine direct and indirect effects of the



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Prepared By: MWH
Date: May 9, 2006

Figure 78. Peak Flow Hydrology and Floodplains Analysis Area.

\\Usden1netapp1\Projects\MSS\JKTest\New_Data\Steve_011807.mxd alternatives on peak flows. Direct and indirect effects on floodplain stage and width were analyzed qualitatively. The only SDS Project components that may affect peak flows and floodplains would be construction of the proposed Jimmy Camp Creek, Upper Williams Creek, or Williams Creek reservoirs. The reservoirs would have primarily a beneficial effect on peak flows and floodplains (i.e., peak flows, floodplain width, and floodplain stage would be reduced following construction of the reservoirs). The SEO would ensure that water rights are not affected by incidental flood attenuation. The only adverse direct and indirect effects on floodplains would be inundation at the reservoir sites, and potential reduction in channel capacity as a result of riparian vegetation encroachment into the floodplain that could follow reduced floodplains. Adverse effects associated with inundation at the reservoir sites were quantified and are described in Section 3.8.5.1. Adverse effects from the encroachment of riparian vegetation that could reduce channel capacity were qualitatively discussed because of the inability to precisely determine the extent of riparian vegetation encroachment. Although the proposed dams would incidentally reduce peak flows downstream of the dams, the reservoirs would not have reserved flood control space and would not be operated specifically for flood control purposes.

A quantitative cumulative effects analysis was completed to determine the effects of the alternatives and reasonably foreseeable actions on peak flows and floodplains. The primary reasonably foreseeable action analyzed was development within the Fountain Creek Basin. Development within the basin, independent of the SDS Project, would increase peak flows and floodplain stage and width.

In the cumulative effects analysis, it was assumed that the City of Colorado Springs would implement the Colorado Springs Stormwater Enterprise that was approved by the City Council in 2005 and is beginning implementation. The Stormwater Enterprise generates funding to construct regional flood control facilities in the Colorado Springs service area. Additionally, for new development, it implements regulations that require peak flows under future conditions to be maintained at current peak flow values, for peak flows with recurrence intervals of 100 years or less. This is achieved by requiring developments to construct flow control structures (e.g., stormwater detention basins) to compensate for the increased runoff associated with future development (Colorado Springs 2007a; Baker 2006). The Colorado Springs Stormwater Enterprise was assumed to be in effect for the area within the city limits of the City of Colorado Springs for the cumulative effects analysis.

Methods specific to peak flow hydrology and floodplains are discussed in the following two sections.

Flood Hydrology

Throughout this section, peak flow hydrology values are discussed for flows with various recurrence intervals. A recurrence interval is the long-term average time between peak flows of a specific magnitude. For example, a 100-year recurrence interval peak flow would occur on average once every 100 years over a long period. However, peak flows do not occur regularly at their respective recurrence intervals. In any given year, the probability of a peak flow occurring is estimated using the following equation:

$$P = (1/T)*100$$

Where P is the probability of a flood value being equaled or exceeded in a given year (given as a percentage) and T is the recurrence interval. For example, a peak flow with a recurrence interval of 2 years has a 50 percent chance of occurring in any given year. The peak flow data in this section are instantaneous peak flows. The instantaneous peak flow is the highest flow during a flood event that occurs at any instant (e.g., a flood can occur over a 4-hour period with an average flow of 200 cfs; however, the instantaneous peak flow would be the maximum flow, for example 3,000 cfs, at any instant during the 4-hour period). Peak flows for storm events with 2-, 5-, 10-, 25-, 50- 100-, and 500-year recurrence intervals were evaluated in this analysis (MWH 2008i, 2008j). Peak flows for the 2-, 10-, and 100-year recurrence interval events are discussed in detail because of their relative importance in channel stability (Section 3.9) and floodplain depth and width.

Arkansas River Basin

Flood hydrology for Existing Conditions in the Arkansas River Basin analysis area was based primarily on previous flood studies (MWH 2007a) and hydrologic modeling completed for this FEIS (URS 2006). The best available peak flow data for each location were used in this analysis. Data from the Corps' Fountain Creek Watershed Study hydrologic modeling (Corps 2006a) were considered the best available data for the Fountain Creek Watershed. The most recently published values of peak flows were considered the best available data for the Arkansas River.

Hydrologic modeling was performed for the Fountain Creek watershed to analyze potential effects and to estimate peak flows under Existing Conditions for locations that lacked published data. The existing Fountain Creek Watershed Study (Corps 2006a) flood hydrology model of the Fountain Creek Basin was modified for use in the effects analysis. The model was constructed using the Corps Hydrologic Engineering Center - Hydrologic Modeling System Version 2.2.2 software. The model incorporates watershed properties including land use, topography, and river properties to estimate peak flows from precipitation events. The hydrologic model was modified to fit the alternatives, as described in the SDS Project Water Resources Effects Analysis (MWH 2008i). Separate hydrologic models were also developed for the Fountain Creek, Jimmy Camp Creek, and Williams Creek sub-basins. Model development details are described in a technical memorandum (URS 2006). The following land use conditions were assumed for the direct and cumulative effects analyses:

- Direct effects analysis land use assumptions – existing conditions land use (2005) was assumed throughout the Fountain Creek Basin
- Cumulative effects analysis land use assumptions – future conditions land use (best available data approximating 2046) for basins with greater than 50 percent area outside of Colorado Springs city limits, and existing conditions land use for basins with greater than 50 percent area within Colorado Springs city limits (i.e., Colorado Springs Stormwater Enterprise holds future peak flows constant at existing conditions peak flows levels as described in Section 3.8.2)

Hydrologic models were not developed for the Arkansas River stream segments. Future peak flow hydrology for the Arkansas River upstream of the confluence with Fountain Creek was assumed to be equal to Existing Conditions peak flows (i.e., the alternatives would not affect Arkansas River peak flows upstream of the Fountain Creek confluence). The only SDS Project facility that could affect peak flows upstream of the Fountain Creek confluence would be the Highway 115 Return Flow Pipeline (Wetland and Arkansas River alternatives). Return flows from the pipeline (up to 130 cfs) would be much smaller than Arkansas River peak flow values.

Future peak flow hydrology for the Arkansas River below the Fountain Creek confluence is at least partially dictated by Fountain Creek peak flows (i.e., the magnitude of peak flows from Fountain Creek have a higher magnitude than peak flows from the Arkansas River below Pueblo Reservoir because of Pueblo Reservoir's control of peak flows). Therefore, effects on Arkansas River peak flows downstream of Fountain Creek for each alternative were based on effects at the Fountain Creek at Pueblo Gage. Future peak flows for the Arkansas River downstream of Fountain Creek were estimated by adding the Existing Conditions peak flows for the Arkansas River stream segments plus the difference between Existing Conditions and future peak flows for the Fountain Creek at Pueblo Gage.

Western Slope Streams

Historical instantaneous peak flow values were obtained from the USGS (2008a) for key stream gage locations on the Western Slope streams. A flood frequency analysis was completed for each of the key streamgage locations using the Pearson Type III distribution and the methods suggested by the USGS (1981). Proposed diversions from these streams associated with the SDS Project were compared to the results of the flood frequency analysis to analyze potential effects on the Western Slope locations.

Floodplains

A quantitative analysis was performed to determine the direct and indirect effects on flood inundation associated with the proposed reservoirs. The direct effect of the proposed reservoirs on acreage of flood inundation was calculated. The area upstream of the proposed terminal and return flow reservoir dams would be flooded following filling of the reservoirs. Reservoir surface areas provided by CH2M HILL (2006c) for the normal operating pool and the Probable Maximum Flood pool were used to determine effects on flood inundation. The extent of the reservoirs associated with the normal operating pool and Probable Maximum Flood were also evaluated using aerial photographs to determine whether any existing structures would be affected by the flood inundation. There would be no additional indirect or cumulative effects on the acreage of flood inundation at the reservoir sites.

The potential for any alternatives to increase the elevation (stage) and extent (width) of 100-year floods was evaluated throughout the analysis area using the flood hydrology information. Figure 79 depicts flow width and flow stage, which were calculated in the floodplain effects analysis. The 100-year flood was used because it is the standard regulatory flood adopted for nationwide floodplain management purposes by FEMA (e.g., FEMA Flood Insurance Studies). Floodplain width, one of the indicators used to determine effects described in this section, would be equal to the "Flow Width" shown in Figure 79 for flow conditions at the 100-year peak flow value.

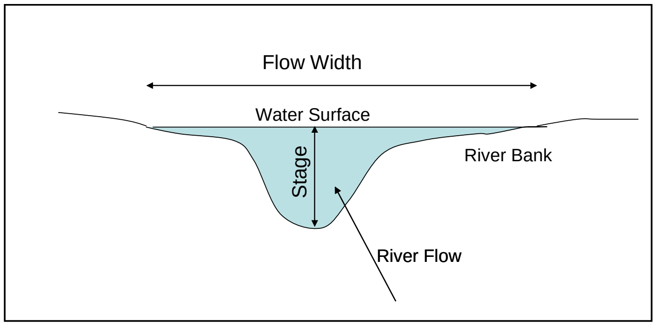


Figure 79. Floodplain Effects Parameters Diagram.

Direct and indirect effects were evaluated qualitatively as described previously. For the cumulative effects analysis, floodplain stage was determined for the 100-year peak flows by translating the 100-year peak flows into floodplain stage using stage-discharge rating curves obtained from the Colorado Division of Water Resources (Ley 2004) and USGS (Payne 2004), and extending the stage discharge curves using USGS topographic maps and normal depth calculations (the depth of flow in a channel for a given flow rate at which the flow is uniform and the depth remains constant). Effects on floodplain stage were determined for locations throughout the analysis area for each of the alternatives, and effects on floodplain width were determined for locations and alternatives with floodplain stage effects of at least 0.2 feet. Floodplain stage effects less than 0.2 feet would result in minimal effects on floodplain width. Floodplain width was determined using the Fountain Creek Watershed Study hydraulic model (Corps 2006b).

Effects on floodplain stage and width are summarized by stream segment. Effects were classified into the following four categories using professional judgment to determine the severity of effects on the environment and property along the floodplains:

- Negligible – stage increases of less than 0.2 feet and width increases of less than 50 feet for the 100-year flood flow at USGS gages. Beneficial effects (i.e., decreases in floodplain stage and width) were classified as negligible.
- Minor – stage increases of 0.2 to 0.5 feet for the 100-year flood flow at USGS gages, or increase in stage would result in an increase in floodplain width of 50 to 200 feet.
- Moderate – stage increases of 0.51 to 1.0 feet for the 100-year flood flow at USGS gages, or increase in stage would result in increase in floodplain width of 200 to 1,000 feet.
- Major – stage increases of over 1.0 foot for the 100-year flood flow at USGS gages, or increase in stage would result in increase in floodplain width of greater than 1,000 feet; or if an increase in floodplain width would inundate an existing structure (regardless of the change in width).

Floodplain effects are presented relative to the No Action Alternative throughout this section. However, the inundation of existing structures that would trigger classification of floodplains effects as major was only used in the comparison of effects to Existing Conditions. Evaluation of the inundation effects for existing structures was done because existing structures are the only structures that could be affected by changes in peak flows and floodplains. Additionally, floodplain effects for the Action Alternatives relative to Existing Conditions are discussed for alternatives that would have effects relative to the No Action Alternative but not relative to Existing Conditions. Final effects classifications were made relative to the No Action Alternative to be consistent with the methods used throughout the FEIS.

Dam Failures

Dam failure analyses were conducted to disclose the extent of potential flooding resulting from the following four potential dam failure scenarios: Jimmy Camp Creek Reservoir (No Action, Arkansas River, Fountain Creek, Downstream Intake, and Highway115 alternatives), Williams Creek Reservoir (No Action, Participants' Proposed Action, Fountain Creek, Downstream Intake, and Highway 115 alternatives), Upper Williams Creek Reservoir (Participants' Proposed Action and Wetland alternatives), and a sequential dam failure of Upper Williams Creek and Williams Creek reservoirs (Participants' Proposed Action).

Assumptions and methods used to complete the dam failure analyses are summarized by CH2M HILL (2008c). These analyses were completed with a combination of flood routing and peak flow rate modeling of conceptual dam failures. A dam failure would occur as a result of a breach in the dam and subsequent release of stored water without additional peak flows from storm events. The designs of the proposed SDS dams were taken into account, and hypothetical breaches were modeled. Breach parameters (e.g., size and shape) were estimated, downstream channel cross-sections were determined based on best available topography, and hydraulic parameters such as resistance to flow were estimated for the modeled streams. The HEC-1 hydrologic model, created by the Corps Hydrologic Engineering Center, was used to estimate discharge, downstream flow rates, and time to maximum stage. The HEC-RAS hydraulic model, also created by the Corps Hydrologic Engineering Center, was used to estimate streamflow depths, velocities, and flood inundation areas downstream of the hypothetical dam breaches.

3.8.3.3 Limitations

There are potential inaccuracies in the hydrology models (Corps 2006a; URS 2006) and hydraulics model (Corps 2006b) used to calculate peak flows and floodplain width, respectively. Results from the peak flow modeling should be considered an estimate of peak flows. However, any peak flow modeling has inherent inaccuracies because of inexact land use and topographic conditions. Additional inaccuracies may exist in the flow-discharge rating curves from Payne (2004) and Colorado Division of Water Resources (Ley 2004).

3.8.4 Affected Environment

Existing flood-related conditions at representative locations are summarized in this section. More detailed information on existing peak flow and floodplain characteristics is provided in the Water Resources Technical Report (MWH 2007a).

3.8.4.1 Peak Flows

Peak flow information for locations within the analysis area was compiled from FEMA (2002) and Corps (2001a, 2001b, 2003, 2006a), calculated from flood frequency curves, or simulated for this FEIS (URS 2006). Flood hydrology data for various recurrence intervals and the associated sources of data are summarized in Table 79. Peak flows generally increase with distance downstream due to increasing drainage area; however, there are some exceptions. Pueblo Reservoir attenuates peak flows in the Arkansas River near Pueblo (Section 3.8.4.3). Peak flows at some Fountain Creek locations are comparable to or slightly lower than at those locations with smaller drainage areas. For example, peak flows are generally less for Fountain Creek at Pueblo than for Fountain Creek near Piñon. The reduction in peak flows from Piñon to Pueblo is a result of channel storage near Piñon (i.e., the channel increases in width, providing additional storage in the channel to attenuate peak flows).

The simulated peak flow values shown in Table 79 can be compared to historical peak flows recorded by the USGS in order to put the theoretical simulated values in context. For example, the four largest peak flows on record for the Fountain Creek at Pueblo Gage (USGS record from 1921 to 2005) are: 34,000 cfs for 1921; 35,000 cfs for 1935; 47,000 cfs for 1965; and 18,900 cfs for 1999. These actual peak flows can be compared to the 100-year theoretical peak flows of 44,000 cfs and 500-year theoretical peak flows of 74,000 cfs. The Fountain Creek at Pueblo Gage was used in this example because it is the gage with the most contributing drainage and its peak flow values are representative of the Fountain Creek Basin.

Historical peak flows for Western Slope study area streams are provided in Table 80.

3.8.4.2 Floodplains

Figure 80 shows the Existing Conditions 100-year floodplain for streams within or near the analysis area. Within the analysis area, floodplain widths generally increase with distance downstream and tend to be substantially wider in the Arkansas River downstream of Pueblo. Existing Conditions floodplains were not determined for Western Slope streams because no previous studies have been completed by state or federal agencies for the Western Slope streams within the study area. Floodplain studies are typically only completed for streams and rivers that may be affected by development within the floodplains, but the remote location of the Western Slope streams within the study area has prevented the need for floodplain studies for these streams.

3.8.4.3 Flood Control Storage

Flood control storage within the analysis area exists in Pueblo Reservoir, which has dedicated flood control space of 26,991 ac-ft and a joint use pool of 66,000 ac-ft (Section 3.2.10). The joint use pool is used for flood control storage between April 15 and November 1 and can be used for other storage throughout the remainder of the year. Any storage in Pueblo Reservoir associated with the alternatives would not affect flood control operations of Pueblo Reservoir.

Table 79. Existing Instantaneous Peak Flows.

Gage (Gage Number) or Monitoring Location	Drainage Area (sq. mi.)	Peak Flow (in cfs) by Recurrence Interval					Reference
		2-year	10-year	50-year	100-year	500-year	
Arkansas River at Minnequa Dam (located about 10 miles upstream of Portland)‡	3,546	Φ	11,000	21,000	28,000	71,000	FEMA (2002)
Arkansas River Above Pueblo (0709940)	4,670	4,220	6,070	7,050	7,350	7,880	Corps (2001a)
Arkansas River at Moffat Street (07099970)	4,778	4,830	7,990	11,100	20,000	40,000	Corps (2001a)
Fountain Creek near Colorado Springs (07103700)	103.4	340	2,100	9,200	14,000	24,000	Corps (2006a)
Fountain Creek at Colorado Springs (07105500)	366	2,400	12,000	29,000	36,000	51,000	Corps (2006a)
Fountain Creek below Janitell Road below Colorado Springs (07105530)	402	2,700	12,000	29,000	35,000	51,000	Corps (2006a)
Fountain Creek at Security (07105800)	485	3,900	12,000	28,000	34,000	49,000	Corps (2006a)
Fountain Creek near Fountain (07106000)	672	6,100	15,000	35,000	45,000	68,000	Corps (2006a)
Fountain Creek near Piñon (07106300)	849	4,500	17,000	42,000	56,000	89,000	Corps (2006a)
Fountain Creek at Pueblo (07106500)	925	4,700	16,000	33,000	44,000	74,000	Corps (2006a)
Jimmy Camp Creek at Proposed Jimmy Camp Creek Reservoir ‡	6.6	6.7	260	1,300	1,900	3,600	URS (2006)
Jimmy Camp Creek at Fountain Creek Confluence (07105900)	68.3	300	4,100	16,000	22,000	35,000	Corps (2006a)
Williams Creek at Proposed Upper Williams Creek Reservoir ‡	2.0	170	390	710	830	1,100	URS (2006)
Williams Creek at Proposed Williams Creek Reservoir ‡	31.1	2,000	5,500	11,000	13,000	18,000	URS (2006)
Williams Creek at Fountain Creek Confluence ‡	52.5	3,000	8,000	16,000	19,000	26,000	URS (2006)
Arkansas River near Avondale (07109500)	6,327	Φ	16,500	33,600	44,400	81,900	Corps (2001b)
Arkansas River near Nepesta (07117000)	9,291	Φ	19,700	39,000	50,600	88,500	Corps (2001b)
Arkansas River at Catlin Dam at Fowler (07119700)	10,901	Φ	18,400	39,700	53,500	102,000	Corps (2001b)

‡ Monitoring location is not a USGS gage location. Location is a FEMA flood study location, a cross-section used in Corps (2006a) modeling, or an SDS Project specific location for URS modeling (URS 2006).

Φ No data available

Table 80. Historical Peak Flows for Western Slope Streams.

Stream Gage	Drain-age Area (mi^2)	Peak Flow (cfs) by Recurrence Interval		
		2-Year	100-Year	500-Year
Roaring Fork above Difficult Creek	76	630	4,100	6,200
Homestake Creek at Gold Park	36	410	1,500	1,900
Ivanhoe Creek near Nast	9.4	47	300	560

3.8.5 Environmental Consequences

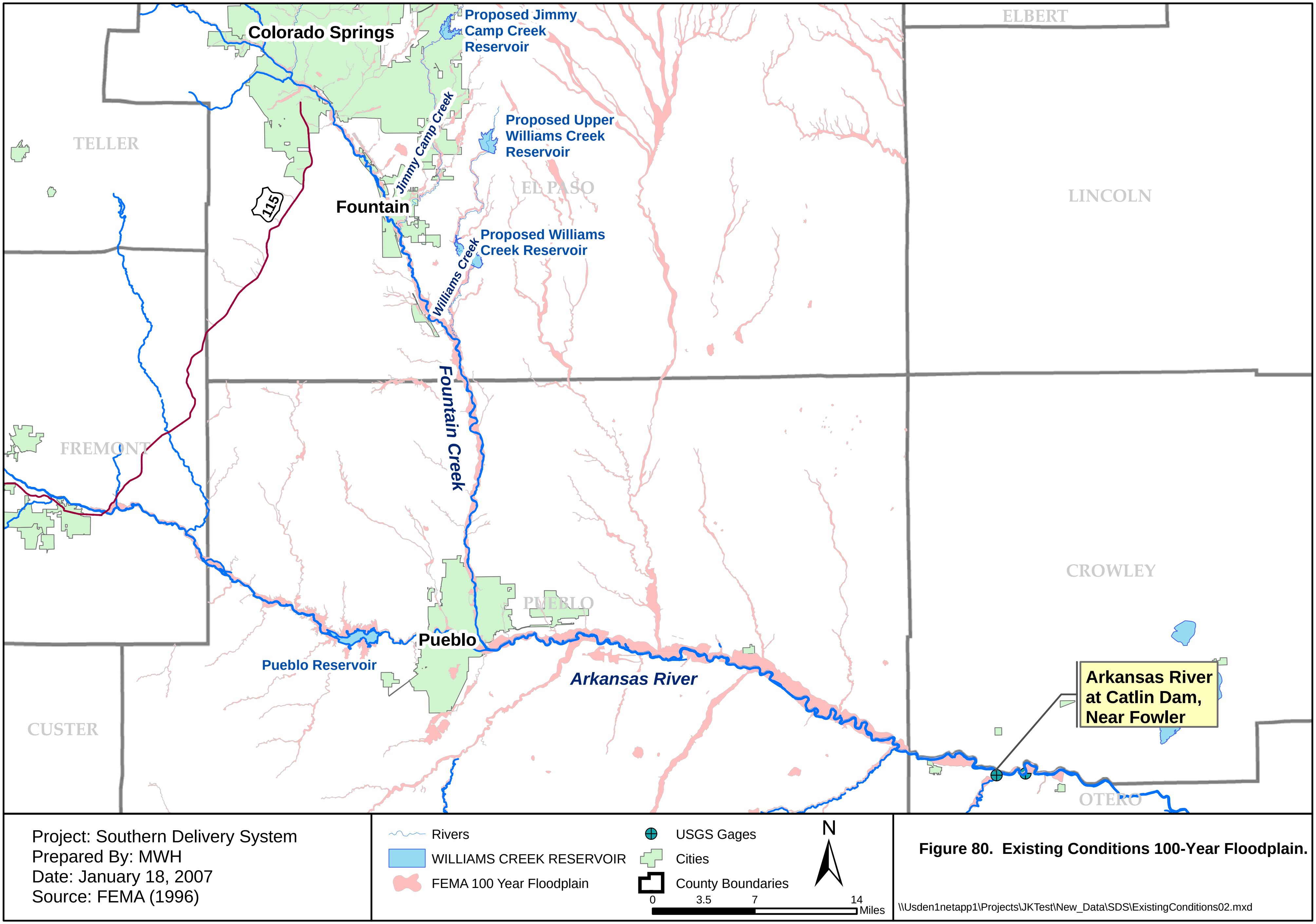
3.8.5.1 Direct and Indirect Effects

Three types of environmental consequences are presented: effects that would occur as a result of changes to peak flows, effects of flood inundation and proposed reservoir sites, and effects associated with potential dam breaches at proposed SDS reservoirs.

Effects on Peak Flows and Floodplains

There would be negligible adverse direct and indirect effects on peak flows and floodplain stage and width, except for inundation at the proposed reservoir sites and potential reduction in channel capacity following reductions in floodplains and the associated encroachment of riparian vegetation. Inundation at the proposed reservoir sites was quantified and is described below. The reduction in channel capacity following encroachment of riparian vegetation was assumed to have a minimal effect on floodplain stage and width, but was not quantified because of the inability to precisely determine the potential extent of riparian vegetation encroachment. There would be some beneficial effects on peak flows and floodplains directly related to the alternatives (e.g., incidental flood control storage for storm flows, and the resulting reduction in floodplain width and depth downstream of the proposed reservoirs). As a result of these beneficial effects, the magnitude of direct and indirect effects on peak flows and floodplains is not provided in this section. Direct and indirect effects on peak flows were quantified, but are not described in detail in this section because they would be limited to beneficial effects on flooding (reductions in peaks flows and floodplains from incidental flood control storage in proposed SDS reservoirs). Although reduced peak flows would provide beneficial effect for flooding conditions, detrimental effects could occur for other resource areas as a result of reduced peak flows. These associated direct and indirect effects are described in the resource-specific sections (e.g., Geomorphology, Section 3.9.5). The proposed Jimmy Camp Creek, Upper Williams Creek, and Williams Creek reservoirs would reduce peak flows and floodplains downstream of the proposed reservoirs. A portion of stormwater runoff that would flow into the reservoirs would be incidentally captured by the reservoirs, and peak flows would be reduced downstream of the reservoirs. Potential effects on peak flows and floodplains could occur downstream of SDS Project construction sites. However, a stormwater management plan, including a description of best management practices, would be implemented to minimize effects from construction.

Effects on peak flows and floodplains for the Western Slope streams (i.e., Homestake Creek, the Roaring Fork River, and Ivanhoe Creek) would be negligible. Proposed diversions from these streams associated with the SDS Project are summarized in Table 81. Effects on peak flows and floodplains were assumed to be negligible because the proposed diversions



Project: Southern Delivery System
Prepared By: MWH
Date: January 18, 2007
Source: FEMA (1996)

Figure 80. Existing Conditions 100-Year Floodplain.

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Table 81. Western Slope Peak Flows and Diversions.

Stream Gage	Maximum Effect of Proposed Diversion† (cfs)	100-year Recurrence Interval Peak Flow (cfs)
Homestake Creek at Gold Park	4 cfs reduction (Alt 2, May)	1,900
Roaring Fork above Difficult Creek	47 cfs reduction (Alt 1, June)	6,200
Ivanhoe Creek near Nast	6 cfs reduction (Alt 1, June)	560

† Effects for Alternative 1 calculated as Alternative 1 minus Existing Conditions. Effects for Alternatives 2-7 calculated as Alternatives 2-7 minus Alternative 1.

would be a minimum of two orders of magnitude (100 times) less than the 100-year recurrence interval peak flows. Effects on floodplains were not quantified, but are expected to be negligible because of the negligible effect on peak flows that would occur. Although effects would be negligible, minor channel encroachment (such as growth of riparian vegetation along the streambank) may reduce channel capacity over time as reduced streamflow increases the ability for vegetation to establish.

Flood Inundation at Proposed Reservoir Sites

Table 82 summarizes inundation areas of the normal operating and the probable maximum flood pools for the proposed reservoir sites. Total flood inundation acreage for each alternative (i.e., sum of probable maximum flood pools for all reservoirs in an alternative) would be as follows:

- No Action Alternative – 2,040 ac.
- Participants' Proposed Action – 2,210 ac.
- Wetland Alternative – 870 ac.
- Arkansas River Alternative – 700 ac.
- Fountain Creek Alternative – 2,040 ac.
- Downstream Intake Alternative – 2,040 ac.
- Highway 115 Alternative – 2,040 ac.

Table 82. Inundation Area for Proposed Reservoirs.

Reservoir	Surface Area (acres)	
	Normal Pool	Probable Maximum Flood Pool
Jimmy Camp Creek	610	700
Upper Williams Creek	760	870
Williams Creek	980	1,340

Currently, residential structures are located nearby or within the flood inundation areas of the reservoir site and electrical transmission lines at the Upper Williams Creek Reservoir site. However, Colorado Springs would acquire any properties it does not already own within the inundation area, and all homes would be removed and the transmission lines relocated prior to filling the reservoir (Robler 2006; CH2M HILL 2005b). Consequently, there would be negligible additional reservoir inundation effects.

Potential Dam Failure

Proposed SDS reservoirs would be designed and constructed according to the dam safety criteria specified by the Colorado State Engineer's Office, resulting in a low probability of actual dam failures. In an event of an unlikely dam breach at any of the proposed SDS reservoirs, flood inundation would occur downstream of the breach.

Maximum peak discharge rates (CH2M HILL 2008c) are as follows:

- 460,000 cfs for Jimmy Camp Creek Reservoir
- 450,000 for Upper Williams Creek Reservoir
- 340,000 cfs for Williams Creek Reservoir
- 550,000 cfs for sequential Upper Williams Creek and Williams Creek reservoirs dam failure

These maximum peak discharge rates would occur directly downstream of the proposed dams, and flow rates would diminish as the flood spread out and progressed downstream.

The flood inundation area would be substantial under all of the four dam failure scenarios. Flood inundation areas within metropolitan areas downstream of the hypothetical dam breaches are summarized in Table 83, and flood inundation maps of metropolitan areas are provided in Appendix G. The flood inundation area would be greatest within the Colorado Centre Metropolitan District, the city of Fountain, and the city of Pueblo. The sequential dam failure of Upper Williams Creek and Williams Creek reservoirs would result in the highest flood stage and greatest flood inundation area, followed by the Upper Williams Creek breach scenario, the Williams Creek Reservoir breach scenario, and the Jimmy Camp Creek Reservoir breach scenario. The potential for loss of life and damage to property was not quantified for this analysis, but would be substantial in the event of a dam breach based on large flood inundation areas within Colorado Centre Metropolitan District, the city of Fountain, and the city of Pueblo. Flooding downstream of the town of Avondale would be within the 100-year floodplain, and as a result, flood inundation within developed areas would not occur downstream of Avondale.

3.8.5.2 Cumulative Effects

Cumulative effects would be the combined effects of a decrease in peak flows and floodplain width as a result of the proposed dams, and an increase in peak flows and floodplain width as a result of reasonably foreseeable development. Two reasonably foreseeable actions would affect peak flows and floodplains in the cumulative effects analysis: increased urban and suburban development in the analysis area and the Colorado Springs Stormwater Enterprise. Increased development results in higher runoff and peak flows because of an increase in paved surfaces (Colorado Springs 1994). The hydrologic models described in Section 3.8.3 were used to simulate the cumulative effects of increased development and the City of Colorado Springs Stormwater Enterprise. Because of the Stormwater Enterprise, cumulative effects future peak flows would be equal to Existing Conditions peak flows for areas within the City of Colorado Springs service area or directly downstream of the city's service area. Similar regulations were not assumed to apply to portions of the Fountain Creek watershed outside of the Colorado Springs service area. Consequently, any increases in peak flows and floodplain stage and width would result from growth outside the City of Colorado Springs. Likewise, any reduction in peak flows and floodplain stage and width would result from incidental storage by the proposed reservoirs.

Cumulative effects for potential dam breaches would be the same as those described for direct and indirect effects. Neither of the reasonably foreseeable actions described above would affect the potential dam breaches.

Table 83. Dam Failure Effects Summary.

Metropolitan Area	Dam Failure†	Effects Description
Colorado Centre Metropolitan District	JCC Reservoir (Alts 1, 4, 5, 6, and 7)	Maximum flow about 3 hours after breach. Maximum flood stage of about 5,828 feet amsl‡. Flood inundation across District, from about Marksheffel Road on the west to areas east of JCC.
City of Fountain	JCC Reservoir (Alts 1, 4, 5, 6, and 7)	Maximum flow about 5 hours after breach. Maximum flood stage of about 5,560 feet amsl. Flood inundation east and south side of City, including Aragon Middle School and a mobile home park.
Town of Piñon	JCC, UWC, WC, and UWC + WC Reservoirs (All Alts.)	Time to maximum flow varies by dam breach scenario. Maximum flood stage about 5,027 feet amsl for UWC + WC breach scenario. No flood inundation within town.
City of Pueblo	JCC, UWC, WC, and UWC + WC Reservoirs (All Alts.)	Time to maximum flow varies by dam breach scenario; minimum time of about 6 hours for WC breach scenario. Maximum flood stage of 4,678 feet amsl for UWC + WC breach scenario. Substantial flood inundation along Fountain Creek and near the mouth of Fountain Creek for all breach scenarios.
Town of Avondale	JCC, UWC, WC, and UWC + WC Reservoirs (All Alts.)	No flood inundation within town.

† JCC = Jimmy Camp Creek; UWC = Upper Williams Creek; WC= Williams Creek

‡ amsl = above mean sea level

Source: CH2M HILL (2008c)

Arkansas River from Portland to the Fountain Creek Confluence

Peak flows and floodplain stage and width in the Arkansas River upstream of Fountain Creek for all alternatives would be the same as those for Existing Conditions. Cumulative effects of all alternatives would be negligible in this reach.

Fountain Creek from Colorado Springs to the Jimmy Camp Creek Confluence

Peak flows would be higher for the No Action Alternative than for Existing Conditions. The increase in peak flows when comparing the No Action Alternative to Existing Conditions would be:

- An increase from 100 to 600 cfs (increasing from the Colorado Springs Gage to the Security Gage) for the 2-year peak flow
- An increase of 2,000 cfs for the 10-year peak flow
- An increase of 1,000 cfs for the 100-year peak flows

The Action Alternatives would have the same effect on peak flows as the No Action Alternative.

Floodplain stage would be up to 0.1 feet higher for the No Action Alternative relative to Existing Conditions, resulting in a negligible effect. Floodplain stage and width for all Action Alternatives would the same as those for the No Action Alternative. Cumulative effects are not summarized in tabular format for this reach, because there would be negligible cumulative effects for all alternatives.

Jimmy Camp Creek

Cumulative effects on Jimmy Camp Creek peak flows are summarized in Table 84, and cumulative effects on floodplain stage and width are provided in Table 85. The 2-year peak flow would increase by 200 cfs, the 10-year peak flow would increase by 1,100 cfs, and the 100-year peak flows would increase by 2,000 cfs for the No Action Alternative relative to Existing Conditions. The 100-year floodplain stage would increase by 0.4 feet and width for the No Action Alternative would increase 30 feet, relative to Existing Conditions.

Floodplain stage and width for the Arkansas River, Fountain Creek, Downstream Intake, and Highway 115 alternatives would be the same as those for the No Action Alternative, resulting in a negligible effect. The Participants' Proposed Action and the Wetland alternatives would not have the incidental flood control benefit from Jimmy Camp Creek Reservoir. Consequently the 100-year peak flow would be 1,000 cfs greater for Jimmy Camp Creek at the mouth for these alternatives, resulting in minor cumulative effects (i.e., an increase in floodplain stage of 0.2 feet and an increase in width of 10 feet) relative to the No Action Alternative.

Williams Creek from Proposed Williams Creek Reservoir to Fountain Creek

There would be negligible cumulative effects on peak flows and floodplains for Williams Creek between the Upper Williams Creek Reservoir site and the Williams Creek Reservoir site because Upper Williams Reservoir would be located too far upstream in the basin to have a beneficial effect on peak flows. As a result, cumulative effects are discussed for the reach between the Williams Creek Reservoir site and Fountain Creek. Cumulative effects on peak flows representative of Williams Creek are summarized in Table 86. Because of Williams Creek Reservoir, the 2-year peak flow would decrease by 1,500 cfs, the 10-year peak flow would decrease by 4,400 cfs, and the 100-year peak flow would decrease by 11,000 cfs for the No Action Alternative relative to Existing Conditions. Cumulative effects for Williams Creek would be the same as direct and indirect effects, and there would be no reasonably foreseeable actions that would add any additional cumulative effects.

Peak flows for all Action Alternatives that include Williams Creek Reservoir (Participants' Proposed Action, Fountain Creek, Downstream Intake, and Highway 115 alternatives) would be the same as those for the No Action Alternative. Relative to the No Action Alternative, peak flows in Williams Creek for the Wetland and Arkansas River alternatives, which would not have the incidental flood control benefit from Williams Creek Reservoir, would be higher. Peak flows for both the Wetland and Arkansas River alternatives, however, would be similar to those for Existing Conditions.

Table 84. Peak Flows Cumulative Effects – Jimmy Camp Creek at Fountain.

Peak Flow Recurrence Interval	Alt 1†	Cumulative Effects (cfs) Relative to Alternative 1					
		Alt 2	Alt 3	Alt 4	Alt 5	Alt 6	Alt 7
2-Year	200	-- Φ	--	--	--	--	--
10-Year	1,100	--	--	--	--	--	--
100-Year	2,000	1,000	1,000	--	--	--	--

† Cumulative effects for Alternative 1 are calculated relative to Existing Conditions, e.g., the 2-year peak flow would be 200 cfs more than Existing Conditions.

Φ Cumulative effects of 0 cfs indicated with "--"

Table 85. 100-Year Floodplain Cumulative Effects – Jimmy Camp Creek at Fountain.

Floodplain Characteristic	Alt 1†	Cumulative Effects (feet) Relative to Alternative 1					
		Alt 2	Alt 3	Alt 4	Alt 5	Alt 6	Alt 7
Stage	0.4	0.2	0.2	-- Φ	--	--	--
Width	30	10	10	--	--	--	--

† Cumulative effects for Alternative 1 are calculated relative to Existing Conditions.

Φ Cumulative effects of 0 feet indicated with "--"

Table 86. Peak Flows Cumulative Effects – Williams Creek at the Mouth.

Peak Flow Recurrence Interval	Alt 1†	Cumulative Effects (cfs) Relative to Alternative 1					
		Alt 2	Alt 3	Alt 4	Alt 5	Alt 6	Alt 7
2-Year	-1,500	-- Φ	1,600	1,600	--	--	--
10-Year	-4,400	--	4,500	4,500	--	--	--
100-Year	-11,000	--	11,000	11,000	--	--	--

† Cumulative effects for Alternative 1 are calculated relative to Existing Conditions.

Φ Cumulative effects of 0 cfs indicated with "--"

Cumulative effects on Williams Creek 100-year floodplain stage and width are summarized in Table 87. The 100-year floodplain stage and width would decrease relative to Existing Conditions for the No Action Alternative. Reduction in floodplain stage and width could lead to minimal adverse effects associated with encroachment of riparian vegetation (e.g., reduction in channel capacity). However, adverse effects of riparian vegetation were assumed to be minimal relative to the increased channel capacity associated with the proposed reservoirs and as a result were not quantitatively determined. Floodplain stage and width for the Participants' Proposed Action, Fountain Creek, Downstream Intake, and Highway 115 alternatives would be the same as those for the No Action Alternative. Because the Wetland and Arkansas River Alternatives would lack the incidental flood control benefit from Williams Creek Reservoir, floodplain stage would be higher by 3.1 feet and width would increase by 220 feet relative to the No Action Alternative. These increases would be considered major relative to the No Action Alternative; however, the floodplain stage and width for the Wetland and Arkansas River

Table 87. 100-Year Floodplain Cumulative Effects – Williams Creek at Mouth.

Floodplain Characteristic	Alt 1†	Cumulative Effects (feet) Relative to Alternative 1					
		Alt 2	Alt 3	Alt 4	Alt 5	Alt 6	Alt 7
Stage	-3.1	-- Φ	3.1	3.1	--	--	--
Width	-220	--	220	220	--	--	--

† Cumulative effects for Alternative 1 are calculated relative to Existing Conditions.

Φ Cumulative effects of 0 feet indicated with "--"

alternatives would be the same as those for Existing Conditions.

Fountain Creek from the Jimmy Camp Creek Confluence to the Arkansas River Confluence

Cumulative effects on peak flows for Fountain Creek between the Jimmy Camp Creek confluence and the Arkansas River confluence are summarized in Table 88. Peak flows for the No Action Alternative would be higher than for Existing Conditions because of reasonably foreseeable development within the watershed. Although the Colorado Springs Stormwater Enterprise would limit future peak flows to existing peak flows, development outside of Colorado Springs would lead to increased peak flows. Peak flows for all Action Alternatives that include Williams Creek Reservoir (Participants' Proposed Action, Fountain Creek, Downstream Intake, and Highway 115 alternatives) would be the same as those for the No Action Alternative. Peak flows for the Wetland and Arkansas River alternatives, which would not have the incidental flood control benefit from Williams Creek Reservoir, would be higher than the No Action Alternative except the 10-year peak flows for Fountain Creek at Pueblo which would be equal to those for the No Action Alternative.

Cumulative effects on floodplain stage and width for the 100-year flood are summarized in Table 89. The 100-year floodplain stage would increase by up to 0.3 feet and the 100-year floodplain width would increase by up to 70 feet relative to Existing Conditions for the No Action Alternative. The increase in floodplain stage and width would result in minor cumulative effects. Floodplain stage and width for the Participants' Proposed Action, Fountain Creek, Downstream Intake, and Highway 115 alternatives would be the same as those for the No Action Alternative. Because the Wetland and Arkansas River alternatives would lack the incidental flood control benefit from Williams Creek Reservoir, stage would increase by 0.2 feet and width would increase by 30 feet. These increases would be considered minor relative to the No Action Alternative; however, the floodplain stage and width for the Wetland and Arkansas River alternatives would be similar to those for Existing Conditions except for the increase in peak flows and floodplain width due to increased development in the Fountain Creek Basin. Although there would be minor effects for the Wetland and Arkansas River alternatives, these effects would be a result of non-SDS Project-related cumulative effects such as development in Fountain Creek Basin.

Table 88. Peak Flows Cumulative Effects – Fountain Creek from Jimmy Camp Creek to the Arkansas River.

Location and Peak Flow Recurrence Interval	Alt 1†	Cumulative Effects (cfs) Relative to Alternative 1					
		Alt 2	Alt 3	Alt 4	Alt 5	Alt 6	Alt 7
Fountain Creek near Piñon							
2-Year	400	-- Φ	200	300	--	--	--
10-Year	1,000	--	1,000	1,000	--	--	--
100-Year	5,000	--	3,000	3,000	--	--	--
Fountain Creek at Pueblo							
2-Year	400	--	300	300	--	--	--
10-Year	2,000	--	--	--	--	--	--
100-Year	4,000	--	3,000	3,000	--	--	--

Table 89. 100-Year Floodplain Cumulative Effects – Fountain Creek from Jimmy Camp Creek to the Arkansas River.

Location and Floodplain Characteristic	Alt 1†	Cumulative Effects (feet) Relative to Alternative 1					
		Alt 2	Alt 3	Alt 4	Alt 5	Alt 6	Alt 7
Fountain Creek near Piñon							
Stage	0.2	-- Φ	0.1	0.1	--	--	--
Width	70	--	--	--	--	--	--
Fountain Creek at Pueblo							
Stage	0.3	--	0.2	0.2	--	--	--
Width	30	--	30	30	--	--	--

Arkansas River from the Fountain Creek Confluence to the Catlin Dam near Fowler

Cumulative effects on peak flows and floodplains for the Arkansas River between the Fountain Creek confluence and the Arkansas River at Catlin Dam Gage are summarized in Table 90 and Table 91, respectively. Cumulative effects of all alternatives on peak flows and floodplain stage in this stream reach would be nearly the same as those at the Fountain Creek at Pueblo Gage. Cumulative effects on floodplain width for the Arkansas River Alternative would be similar to those at the Fountain Creek at Pueblo Gage for the Arkansas River at Catlin Dam Gage. These would be considered minor effects relative to the No Action Alternative. The increase in floodplain stage and width would be a result of reasonably foreseeable development in the Fountain Creek Basin, and there would be no SDS Project-related cumulative effects for the Wetland and Arkansas River alternatives relative to Existing Conditions.

3.8.5.3 Resource Commitments

There would be no irreversible commitments of resources associated with peak flows, floodplain stage, or floodplain width. Flood inundation of the area at the proposed reservoir sites would be an irretrievable commitment of resources.

Table 90. Peak Flows Cumulative Effects – Arkansas River from Fountain Creek to the Catlin Dam Gage.

Location and Peak Flow Recurrence Interval	Alt 1†	Cumulative Effects (cfs) Relative to Alternative 1					
		Alt 2	Alt 3	Alt 4	Alt 5	Alt 6	Alt 7
Arkansas River near Avondale							
2-Year	400	-- Φ	300	300	--	--	--
10-Year	1,000	--	--	--	--	--	--
100-Year	4,000	--	3,000	3,000	--	--	--
Arkansas River at Catlin Dam							
2-Year	400	--	300	300	--	--	--
10-Year	2,000	--	--	--	--	--	--
100-Year	3,000	--	3,000	3,000	--	--	--

† Cumulative effects for Alternative 1 are calculated relative to Existing Conditions.

Φ Cumulative effects of 0 feet indicated with "--"

Table 91. 100-Year Floodplain Cumulative Effects – Arkansas River from Fountain Creek Confluence to Catlin Dam Gage.

Location and Floodplain Characteristic	Alt 1†	Cumulative Effects (feet) Relative to Alternative 1					
		Alt 2	Alt 3	Alt 4	Alt 5	Alt 6	Alt 7
Arkansas River Near Avondale							
Stage	0.2	-- Φ	--	--	--	--	--
Width	130	--	--	--	--	--	--
Arkansas River Near Catlin Dam							
Stage	0.3	--	0.3	0.3	--	--	--
Width	20	--	20	20	--	--	--

† Cumulative effects for Alternative 1 are calculated relative to Existing Conditions.

Φ Cumulative effects of 0 feet indicated with "--"

3.8.5.4 Mitigation

Proposed Measures

There would be minor increases in peak flows and floodplains for Fountain Creek for the Wetland and Arkansas River alternatives relative to Existing Conditions. However, this increase would be a result of development in the Fountain Creek Basin and would not be a direct or indirect effect of the SDS Project. Directly related to the alternatives, there would be negligible or beneficial effects on peak flows and floodplains relative to Existing Conditions. As a result, no mitigation measures are proposed for the effects on peak flows or floodplains.

Mitigated Effects

Mitigated effects would be the same as direct and indirect effects because no mitigation measures are proposed.

3.9 Geomorphology

Geomorphology is the study of landforms and the processes that shape them. Changes in streamflow from the alternatives may affect sediment transport, erosion, sedimentation, and other processes that affect stream channel characteristics and stability. Geomorphology is a relevant topic associated with the effects of the proposed SDS Project because of potential changes in channel stability that could occur with changes in streamflow and sediment transport capacity. Reductions in channel stability could result in erosion of stream channels or banks, which could cause collapse of banks or changes in stream meander patterns. Land owners and water users downstream of these changes could be affected (e.g., sedimentation could lead to reduced water quality or reduced diversion capacity in diversion structures, and erosion could cause loss of property). Geomorphic indicators used in this analysis are:

- Sediment transport capacity at peak flows
- Mobile grain size at baseflow
- Average annual sediment transport capacity
- Sediment transport capacity during exchange releases
- Streamflow changes (although changes in streamflow were indirectly used to calculate all of the other geomorphic indicators listed above, changes in streamflow were directly used for Lake Creek because of the unique methods used for these two reaches as described in Section 3.9.3.2).

3.9.1 Summary of Effects

The differences in hydrology among the alternatives generally would result in effects on geomorphology (i.e., processes affecting stream channel stability) when compared to the No Action Alternative. Moderate or major effects are described in this summary section, with details of the effects provided in Section 3.9.5. This summary of direct and indirect effects is organized by location within the analysis area. Streams and rivers are divided into segments where geomorphic properties and effects would be similar.

Geomorphic effects on Western Slope streams, Lake Creek, and the Arkansas River would be negligible to minor.

For Fountain Creek from Colorado Springs to Williams Creek, moderate to major erosion for the No Action Alternative compared to Existing Conditions would occur as a result of higher baseflows associated with increased return flows from Colorado Springs. There would be no effects for the Action Alternatives relative to the No Action Alternative for this reach.

For Fountain Creek from Williams Creek to the Arkansas River, moderate sedimentation would occur for the No Action Alternative relative to Existing Conditions because of a decrease in peak flow associated with Williams Creek Reservoir. Major sedimentation would occur for the Wetland, Arkansas River, and Fountain Creek alternatives relative to the No Action Alternative because of a decrease in streamflow for Fountain Creek downstream of Fountain associated with diversion of Colorado Springs' return flows to return flow pipelines. There would be no effects for the other Action Alternatives relative to the No Action Alternative for this reach.

Major erosion would occur in Jimmy Camp Creek for the No Action Alternative relative to

Existing Conditions because of an increase in baseflow associated with non-sewered return flows from future development within the watershed. This growth-related effect is a result of an increase in the Participants' return flows relative to Existing Conditions. Relative to the No Action Alternative, geomorphic effects would be negligible for the Action Alternatives.

Major erosion would occur for Williams Creek for the Wetland and Arkansas River alternatives relative to the No Action Alternative because of increased peak flows associated with the lack of Williams Creek Reservoir for the Wetland and Arkansas River alternatives. However, this major increase would not occur relative to Existing Conditions, and peak flow sediment transport capacity for the Wetland and Arkansas River alternatives would be the same as Existing Conditions.

Minor sedimentation would occur for the No Action Alternative relative to Existing Conditions because of a decreased peak flow sediment transport capacity.

Figure 81 depicts a summary of the geomorphic direct effects.

3.9.2 Regulatory Framework

No regulatory requirements affect this resource. Although there are no specific geomorphic related regulatory requirements, related regulatory requirements discussed in other sections of this chapter may indirectly apply to geomorphology; e.g., changes in sediment concentrations or channel stability could affect water quality regulated under the Clean Water Act or habitat for species regulated under the Endangered Species Act.

3.9.3 Analysis Area and Methods

3.9.3.1 Analysis Area

The geomorphology analysis area is the same as that for Surface Water Hydrology (Section 3.5). The geomorphic sensitivity of each stream segment in the analysis area was evaluated. Various stream characteristics and the Rosgen stream classification system (Rosgen 1996) were used to identify stream segments that may be geomorphically sensitive to the types of hydrologic effects associated with the alternatives. The geomorphology analysis area is limited to sensitive segments. Geomorphic sensitivity was determined using two primary characteristics: entrenchment (the ratio of flood prone area width divided by the bankfull flow width, where the flood prone area is equal to the flow conditions with a water surface at a depth of twice the bankfull depth) and streambed material (the sediment makeup of the material in the streambed). In general, geomorphically sensitive segments have low to moderate entrenchment and/or sand or gravel bed material. These segments have the capability of being eroded and changing their meander pattern as a result of changes in hydrology. Geomorphic characteristics and sensitivity of each segment within the study area are detailed in the Water Resources Technical Report (MWH 2007a). Geomorphically sensitive segments comprising the analysis area (Figure 82) are:

- Lake Creek from Twin Lakes to the confluence with the Arkansas River
- Arkansas River from the Portland Gage to the Pueblo Reservoir inlet
- Fountain Creek from Colorado Springs to the confluence with the Arkansas River
- Jimmy Camp Creek from the Jimmy Camp Creek Reservoir site to the confluence with Fountain Creek

- Williams Creek from the Upper Williams Creek Reservoir site to the confluence with Fountain Creek
- Arkansas River from the Fountain Creek mouth to the Avondale Gage

The Arkansas River between Pueblo Reservoir and Fountain Creek was not analyzed because the channel is predominantly lined or otherwise stabilized and would not be affected by changes in streamflow from the alternatives (Section 3.5). The Arkansas River downstream of the Avondale Gage was not analyzed for two reasons. First, there would be no SDS Project facilities downstream of the Avondale Gage for any alternative. Second, geomorphic effects caused by changes in hydrology at the Avondale Gage would be indicative of effects that would occur farther downstream on the Arkansas River.

The geomorphology analysis area also included streams on the Western Slope that could be affected by proposed Western Slope diversions. These streams included Homestake Creek and its tributaries, the Fryingpan River and its tributaries, and the Roaring Fork River and its tributaries. Portions of these streams included in the geomorphology analysis area are the downstream segments of the streams near the existing diversion structures, and are the same as those used for the surface water effects analysis.

3.9.3.2 Methods

Fluvial geomorphology is a complex science based on the complicated interaction between streamflow and sediment transport. Detailed geomorphic analyses typically involve comprehensive sediment transport modeling that can be data and time intensive. Nonetheless, even when these detailed methods are applied there is uncertainty in the results. Because the extensive data required for detailed sediment transport analysis were not available to for this FEIS, indirect methods were selected to evaluate potential geomorphic effects (i.e., approximate differences in geomorphic properties were estimated among alternatives).

Geomorphology Terms

Bankfull discharge is the maximum streamflow that fills the stream channel but does not overflow to the floodplain, and is representative of the streamflow that has the most effect on channel form.

Entrenchment is the ratio of the stream width at flood conditions to the width at bankfull flow.

Channel form is the shape and pattern of the path of the stream channel and its cross section.

Stream power is a measure of the energy of the flow of water in a stream, and is commonly used to estimate the magnitude of sediment transport capacity of flowing water.

Channel storage is the temporary storage of streamflow within the channel that results in the reduction of the velocity of stream flow, which typically occurs as a result of a widening of the stream channel.

Sediment transport capacity is the amount of potential sediment that can be transported by flowing water given adequate sediment supply.

Mobile grain size is the largest grain size of streambed material that can be carried by a given streamflow.

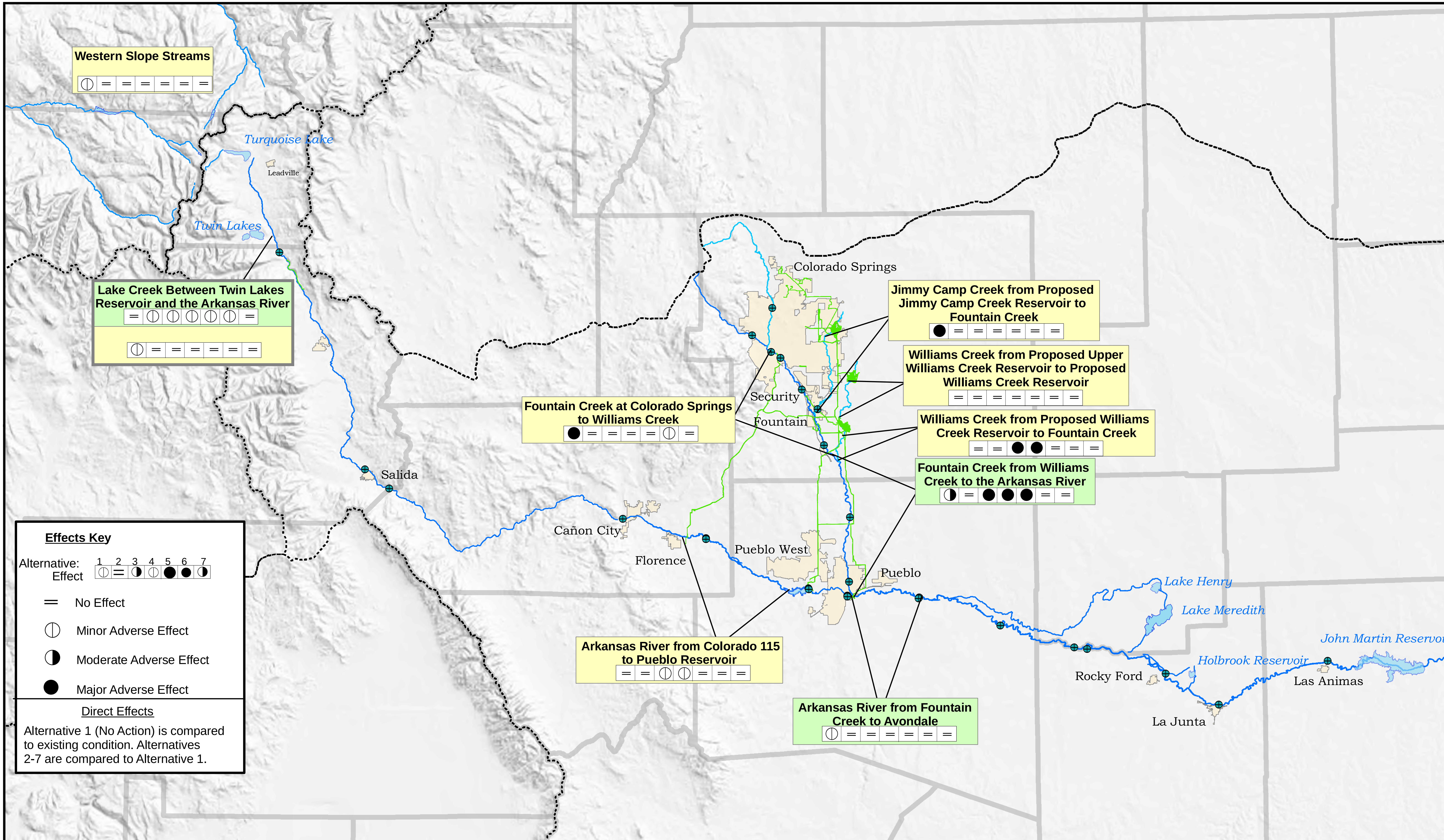
Meander width is the width of the river flow pattern measured from one bank to the other at its widest point.

Stream sinuosity is the length of a stream segment (following the path of water through stream meanders) divided by the length of the valley that the stream flows through. Higher sinuosity indicates a twisted or curvy channel form.

Aggradation is the accumulation of sediment in a stream channel resulting in reduced channel capacity.

Load is the type and amount of sediment carried by streamflow in a stream channel.

Discharge is the streamflow in a stream channel.



Project:Southern Delivery System
Source: MWH
Date: November, 2008

Project Feature
Stream Gages
River
Lake
Watershed Division
County
City
Erosion Effects
Sedimentation Effects

0 5 10 20 30 40 Miles

N

Figure 81. Summary of Geomorphology Direct Effects.

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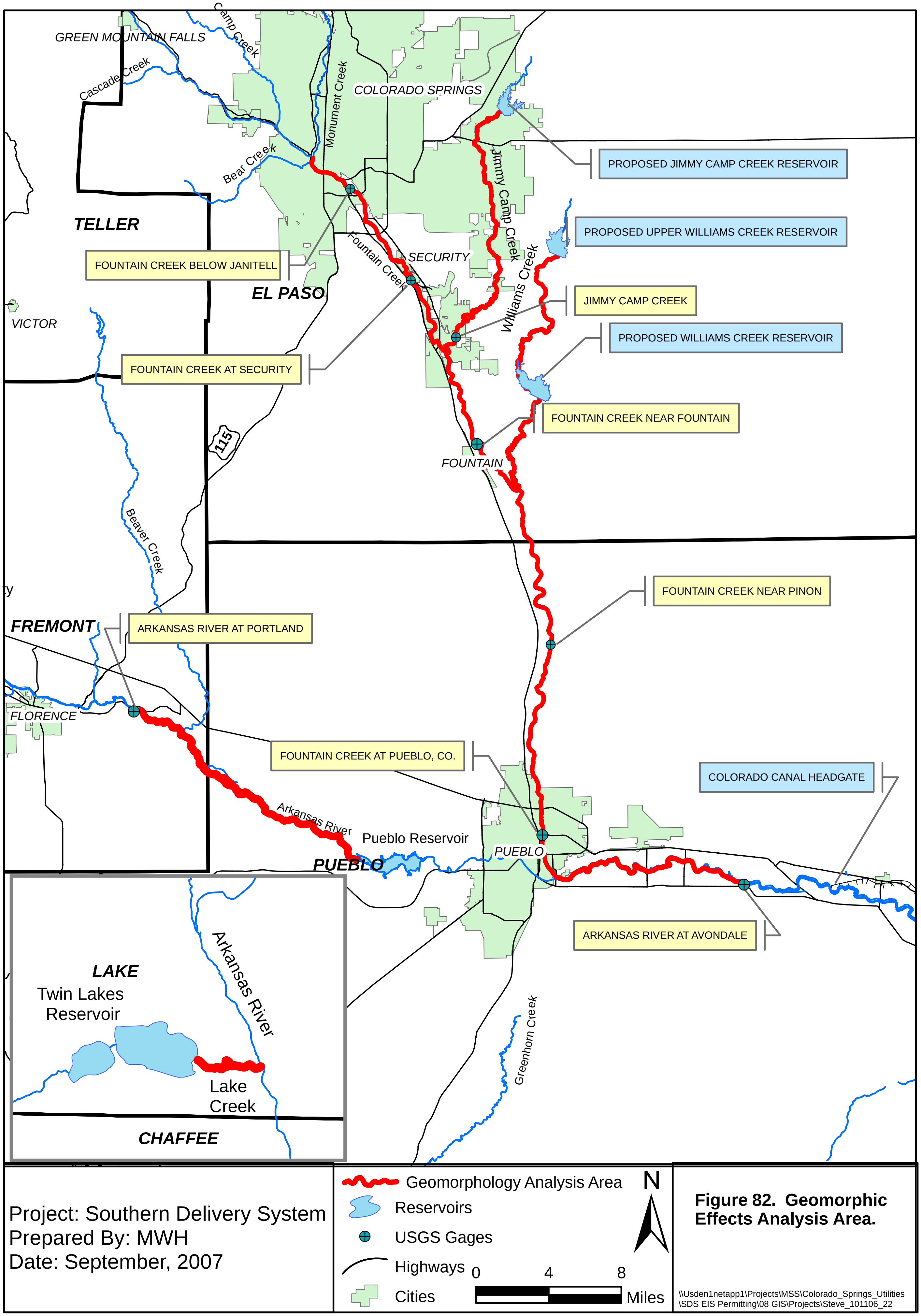


Figure 82. Geomorphic Effects Analysis Area.

This section summarizes data collection and methods used for the geomorphic analysis; detailed information is provided in the Water Resources Technical Report, (MWH 2007a) Water Resources Effects Analysis, (MWH 2008i), and Water Resources Effects Administrative Record Documentation (MWH 2008j). Data collected for the geomorphic analysis included stream channel cross-section topography collected by professional surveyors using standard methods (LDC 2006), existing streambed material pebble count data (i.e., data that describe the sizes of streambed materials) (MWH 2002), and new streambed material pebble count data (E&H 2007). Three different methods were used to assess potential geomorphic effects: one for Lake Creek, one for Western Slope streams, and one for all other segments in the analysis area. Different methods were used for Lake Creek and the Western Slope streams because these segments are short and are not affected by the geomorphic characteristics of any upstream segments (i.e., these streams are high enough in their respective watersheds that there are no potential upstream effects that could influence geomorphic properties within the streams).

Several uncertainties are associated with the geomorphic effects analysis completed for this analysis. The effects described for this FEIS are large-scale effects averaged for a stream segment. It is not possible to determine effects at an exact location using the methods for this analysis. Determination of effects for a given location would require a calibrated sediment transport model and a large amount of actual sediment transport data that were not available for this analysis. Additionally, long-term dynamic changes that would occur as streams attempt to adjust to a new geomorphic equilibrium were estimated with the conceptual model described below. These long-term effects should be considered as approximations of gross-scale effects that would occur, and specific long-term effects may vary from segment to segment.

A calibrated sediment transport model would provide more detailed predictions of long-term effects, but was not completed for this analysis because adequate sediment transport data were not available to construct and calibrate such a model and because uncertainty with the model results would still exist due to the complex nature of geomorphic interactions. Use of a conceptual geomorphic model to predict long-term effects was considered appropriate to estimate large-scale (reach averaged) effects.

Geomorphology Conceptual Model

Methods described below focus on determining the short-term effects on geomorphology following changes in streamflow. However, long-term effects also would occur as streams adjust to these short-term changes and attempt to reach a new geomorphic equilibrium. Primary geomorphic controls that would affect long-term changes to geomorphology and geomorphic equilibrium include the following:

- Hydrology (increased streamflow results in increased capacity for sediment transport capacity and potentially increased erosion)
- Composition of streambed material (cohesive material such as bedrock is more resistive to erosion than fine grained non-cohesive soil such as sand and gravel)
- Stream slope (stream slope adjusts to changes in sediment load or streamflow in order to achieve equilibrium, e.g., change in sinuosity is one way channel slope is modified)
- Stream sinuosity (streams can become more meandering in plan form in an

attempt to balance an increase in discharge or decrease in sediment supply)

- Riparian vegetation (streambank stability increases with establishment of riparian vegetation because vegetation roots increase the ability of streambank material to resist erosion)

A conceptual model of the interaction of the primary geomorphic controls for geomorphically sensitive channels is shown in Figure 83. Geomorphic equilibrium is achieved when the energy associated with stream discharge and stream slope is balanced with the energy associated with sediment size and load. In order to keep the scale balanced (i.e., achieve geomorphic equilibrium) in Figure 83, one or more of the parameters need to change in response to a change in any one of the parameters. For example, an increase in discharge would result in the scale shown in Figure 83 tipping to the right, which would result in erosion of the stream channel or banks if none of the other parameters adjusted in response to the increase in discharge. On the other hand, a decrease in discharge would result in an increase in stream slope to balance the decrease in discharge. Braiding of the stream channel throughout the floodplain may also occur with decreased discharge as the stream tends toward a new geomorphic equilibrium. The conceptual model shown in Figure 83 was used to predict the long-term effects associated with the interrelationships between the primary geomorphic controls. Additional geomorphic controls that influence geomorphic equilibrium are stream sinuosity, which can increase to offset an increased discharge, and riparian vegetation, which tends to stabilize streambanks and minimize erosion associated with increased discharge. Results of the short-term geomorphic analyses (i.e., predictions of erosion or sedimentation) were considered in the context of the conceptual model to predict long-term geomorphic adjustments.

Lake Creek Geomorphic Effects Analysis

The bankfull discharge was estimated for Lake Creek using field observations (MWH 2008i). The bankfull discharge is generally a good approximation of the channel-forming discharge (i.e., the discharge that is most responsible for the development of the channel shape and form). Geomorphic effects for Lake Creek were determined by examining changes in simulated streamflows for the alternatives and Existing Conditions and the bankfull discharge. Simulated daily streamflows for 1982 through 2004 and the bankfull discharge were plotted using flow exceedance curves. An increase in the frequency of streamflows at or above the bankfull discharge would indicate the potential for an abrupt, large scale geomorphic change to occur. Additionally, any substantial differences in streamflow below the bankfull discharge were identified. Changes in the lower streamflows would

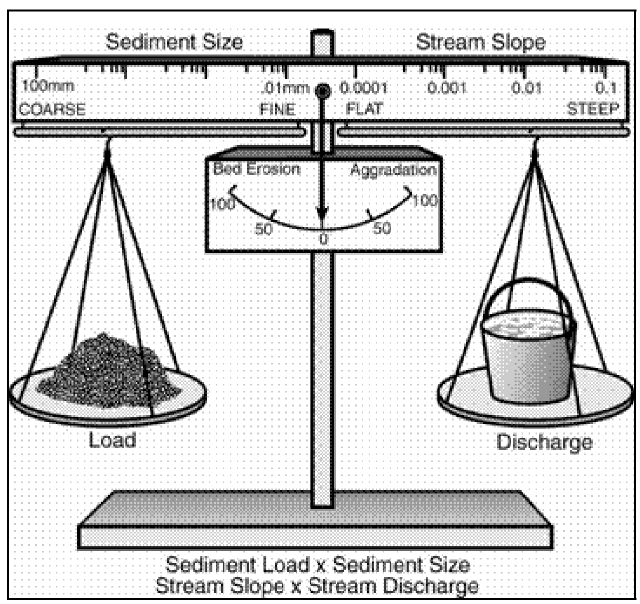


Figure 83. Geomorphic Conceptual Model.

Source: Rosgen 1996.

indicate the potential for gradual, long-term geomorphic change.

The magnitude of geomorphic effects for Lake Creek was classified using the following criteria:

- Negligible – no change in the frequency of any streamflow
- Minor – changes in the frequencies of streamflows below the bankfull discharge
- Moderate – 0 to 10 percent change in the frequency of streamflows at or above the bankfull discharge
- Major – greater than 10 percent change in the frequency of streamflows at or above the bankfull discharge

Exceedance Analysis Terms

Flow exceedance curve is a plot showing the range of streamflow values that occur at a location versus the frequency of each of the streamflows. The frequency of the streamflow values is expressed in "percent exceedance."

Percent exceedance is the percent of time that a given streamflow value is equaled or exceeded in a simulated or historical record of streamflow values.

Western Slope Geomorphic Effects Analysis

A qualitative analysis was completed to determine potential effects on the geomorphology of Western Slope streams within the study area. Diversions from Western Slope streams would result in a reduction in streamflow in these streams. The range of potential geomorphic effects that could occur as a result of the reduced streamflow was determined. Additionally, potential localized effects near the Western Slope diversion structures were determined based on knowledge of the geomorphic properties of the streams at the diversion structures. The magnitude of geomorphic effects for Western Slope streams was classified using the following criteria:

- Negligible – reduction in streamflow (i.e., would reduce erosion)
- Minor – localized erosion that would occur downstream of proposed diversion structures
- Moderate – up to 10 percent increase in streamflow (i.e., would increase erosion)
- Major – greater than 10 percent increase in streamflow (i.e., increased erosion)

Effects Analysis for all Other Streams

Effects on Fountain Creek, Jimmy Camp Creek, Williams Creek, and the Arkansas River were determined for peak flows, annual average streamflows, and baseflows as well as exchange release flows from Williams Creek Reservoir. Changes in sediment transport capacity could be caused by several factors (e.g., changes in sediment inflows from tributaries, SDS Project facilities, wastewater treatment plant discharge, and stormflow detention basins). However, changes in sediment transport capacity were explicitly estimated only for effects associated with SDS Project facilities, wastewater treatment plant discharge, and changes in land use. Inflows from tributaries other than those specifically discussed were assumed to be the same for simulated alternatives as for Existing Conditions. This assumption was made because there would be no SDS Project facilities that would affect streamflow in other tributaries. The only exception to this is that changes in land use for cumulative effects, and the associated effects on peak flows, were accounted for using appropriate assumptions for future land use in the cumulative effects peak flow modeling (Section 3.8). The results of each effects analysis method were considered in making a segment-level determination of potential geomorphic effects.

Peak Flow Hydrology Analysis

Changes in sediment transport capacity at peak flows could cause an abrupt, large scale geomorphic change. The capacity for peak flows to transport sediment was calculated using an equation developed by Yang (1996). Peak flow hydrology data (Section 3.8) were used to calculate the mass of sediment that could be transported for each stream segment at flows ranging from the 2-year to 100-year recurrence interval peak flow. Sediment transport capacity assumes an unlimited sediment supply or is the maximum sediment load that could be transported at a given peak flow. Differences in sediment transport capacity (i.e., the ability of a peak flow event to carry sediment) between adjacent stream segments were calculated based on the differences in peak flows. As peak flows increase, peak flow sediment transport capacity also increases and vice versa. Table 92 summarizes potential geomorphic effects associated with differences in sediment transport capacity between adjacent segments.

The calculations used in this analysis only compared differences in sediment transport capacity and allowed inferences about potential erosion and sedimentation effects. This approach allowed comparison of the relative effects of the alternatives. However, the actual amount of erosion or sedimentation that may occur would not necessarily be equal to the actual sediment load being transported. Actual sediment transport is dependent on both the transport capacity and the incoming sediment from upstream segments, and was not quantified for this analysis because of a lack of available sediment transport data.

Table 92. Peak Flow Sediment Transport Capacity Potential Effects.

Potential Geomorphic Effect	Sediment Transport Capacity	Basis
Erosion	Upstream less than Downstream	Shortfall in upstream supply can result in stream bank and bed erosion downstream
No Effect	Upstream equal to Downstream	Upstream and downstream supplies are balanced
Sedimentation	Upstream greater than Downstream	Excess of upstream supply can result in deposition downstream

Average Annual Sediment Transport Capacity

Changes in sediment transport capacity associated with average annual streamflows could cause a gradual, long-term geomorphic change. Although sediment transport during peak flow events is responsible for short-term, rapid geomorphic change, average annual flows contribute to gradual, long-term geomorphic change that occurs for Fountain Creek. The capacity for average annual flows to transport sediment was calculated using a sediment transport model developed for the Fountain Creek Watershed Study (Corps 2006c). This model uses the Yang (1996) equation within the Corps' Hydrologic Engineering Center River Analysis System (HEC-RAS) platform. Average daily simulated streamflows (collectively representing the average annual flow) (MWH 2008d) were used to calculate the mass of sediment that could be transported for each stream segment.

Differences in annual sediment transport capacity (i.e., the ability of average daily flows throughout the year to carry sediment) between adjacent stream segments were calculated for Fountain Creek. A negative sediment transport capacity (tons per day) indicates that there is less transport capacity in lower Fountain Creek than upper Fountain Creek (Williams Creek was used as the break point between upper and lower Fountain Creek). Less transport capacity in lower Fountain Creek is indicative of the potential for sediment to be eroded in the upstream reach and deposited in the downstream reach, because the stream would not have the capacity to transport the eroded sediment through the downstream reach. Effects were than calculated, with a negative number in tons per day (and positive number in percent) meaning there would be more potential for erosion in the upstream reach with subsequent deposition in the downstream reach relative to the baseline used (the No Action Alternative was used as the baseline for the Action Alternatives, and Existing Conditions was used as the baseline for the No Action Alternative). For example, assuming that the reach average sediment transport capacity is 1,000 tons per day for Fountain Creek upstream of Williams Creek and 500 tons per day for Fountain Creek downstream of Williams Creek, there would be a reduction of 500 tons in transport capacity. This would indicate a potential for deposition of 500 tons per day of sediment in the downstream reach (assuming that sediment transport from the upstream reach was equal to the transport capacity). If this deficit increased to -750 tons per day for a hypothetical alternative, there would be an increase in the sediment transport capacity deficit of -250 tons per day (500 – 750 tons per day), which would be a +50 percent increase in the transport capacity deficit. This number is given as the "upstream to downstream difference in sediment transport capacity" in the effects tables for Fountain Creek in Section 3.9.5.

Like the peak flow sediment transport analysis, the calculations used in this analysis only compared differences in sediment transport capacity and allowed inferences about potential erosion and sedimentation effects (Table 92). This approach allowed comparison of the relative effects of the alternatives; however, the actual amount of erosion or sedimentation that may occur was not quantified.

Baseflow Geomorphic Analysis

Changes in the sizes of sediment particles that can be transported at baseflows (i.e., the ability of baseflows to carry sediment) could cause a gradual, long-term geomorphic change. Baseflow is streamflow that occurs at low flow conditions as a result of soil moisture, ground water inflow, and wastewater effluent. Baseflow was estimated as the average flow from December through February for calculations of baseflow mobile grain size. Baseflow is considered to be one of the primary influences on long-term gradual transport of sediment on Fountain Creek, especially the finer portion of the sediment (e.g., suspended load and the finer material in the bed load) (Stogner 2000). Mobile grain size was determined using the concept of the critical Shields Parameter (Meyer-Peter and Muller 1948; Gessler 1965), which uses an equation to determine the largest sediment particle that would move at any given streamflow. Average daily simulated streamflows (MWH 2008d) for December through February (the winter period represents baseflows not associated with storm water runoff) were used to calculate the mobile grain size for each stream segment. Table 93 summarizes potential geomorphic effects associated with changes in mobile grain size between two adjacent segments.

As mobile grain size increases, more bed material will generally be moved and consequently more erosion will occur. However, this is only true if the increase in mobile grain size would result in mobilization of sediment (i.e., sediment gradation includes grain sizes at least the size of the increased mobile grain size). This limitation would be most relevant for Fountain Creek, which is primarily a sand bed stream. The validity of increased erosion potential as a result of increased mobile grain size was verified by reviewing pebble count data (i.e., minimum to maximum mobile grain sizes were within the range of existing grain sizes for all locations in the analysis area).

Riparian Vegetation Qualitative Analysis

Effects on geomorphic stability associated with changes to riparian vegetation (Section 3.11) were qualitatively considered. Stream segments where riparian vegetation plays a role in the stabilization of stream banks and where loss of riparian vegetation would be expected were identified. Erosion of channel banks can occur as a result of reduced riparian vegetation, especially in streams with sand and gravel bed material (e.g., Fountain Creek, Jimmy Camp Creek, Williams Creek, and the Arkansas River downstream of Fountain Creek). Riparian vegetation would not have a substantial effect on geomorphic stability in stream segments with more cohesive bed material such as bedrock (e.g., Lake Creek and the Arkansas River upstream of Pueblo Reservoir).

Table 93. Baseflow Mobile Grain Size Potential Effects.

Potential Geomorphic Effect	Change in Mobile Grain Size	Basis
Erosion	Increase	More bed material can be transported downstream resulting in erosion
Sedimentation	Decrease	Less bed material can be transported downstream resulting in deposition (or less erosion)

Localized Erosion/Sedimentation Qualitative Analysis

Diversions to untreated water intakes or discharges from return flow pipelines could cause localized geomorphic effects at the point of diversion or discharge. These geomorphic effects were qualitatively assessed by comparing streamflow directly upstream and directly downstream of the diversion or discharge point. Localized erosion was predicted for locations where streamflow would be substantially greater below the diversion or discharge point, and localized sedimentation was predicted where streamflow would be substantially reduced.

Effects Classification for Fountain Creek, Jimmy Camp Creek, Williams Creek, and the Arkansas River

Table 94 summarizes the criteria used for determining the magnitude of geomorphic effects for Fountain Creek, Jimmy Camp Creek, Williams Creek, and the Arkansas River. A single geomorphic effect determination for each stream segment was made based on the worst case of the individual parameter classifications for that segment. The worst case of the individual parameter classifications would be the dominant driver in geomorphic effects, because any less severe classifications would result in fewer effects. Linear relationships between the percent change in geomorphic parameters and the classification of geomorphic effects were assumed in developing the effects classification shown in Table 94 . The degree of geomorphic effects (e.g., minor versus major) were based on professional judgment using knowledge of the streams within the study area. The degree of geomorphic effects would be influenced by geomorphic thresholds, which refer to levels of changes in physical properties such as discharge or sediment supply that lead to geomorphic changes. Thresholds that were used to verify the results presented in this FEIS are described in more detail in the Secondary Effects Analysis section of the Water Resources Effects Analysis (MWH 2008i). The assessment described herein focuses on large-scale geomorphic processes for stream reaches, but does not predict effects at point locations where local controls would play an important part in determining thresholds for estimating the degree of geomorphic effects.

3.9.4 Affected Environment

3.9.4.1 Arkansas River Basin

Lake Creek between Twin Lakes and the confluence with the Arkansas River varies from a sand bed, slightly entrenched stream for the upstream portion, to a gravel to boulder, moderately entrenched stream in the lower portion (Table 95). The transition from a sand bed stream in the upstream portion of Lake Creek to a gravel and boulder stream in the downstream portion is likely a result of an increase in stream slope from upstream to downstream. The Arkansas River downstream of Colorado 115 is generally composed of sand and gravel, and is moderately entrenched. Fountain Creek is generally a sand bed stream with slight to moderate entrenchment. Jimmy Camp Creek and Williams Creek are sand bed

Table 94. Criteria Used to Establish Intensity of Geomorphology Effects.

Indicator	Percent Change† ‡ §			
	Negligible	Minor	Moderate	Major
Peak Flow Sediment Transport Capacity	0-3%	4-8%	9-15%	>15%
Average Annual Sediment Transport Capacity^ϕ	0-25%	26-50%	51-75%	>75%
Baseflow Mobile Grain Size	0-5%	6-12%	13-16%	>16%

† Percent change relative to the No Action Alternative, with the exception of the percent change for the No Action Alternative, which is relative to Existing Conditions.

‡ Increases in baseflow mobile grain size or peak flow sediment transport capacity would result in the effects shown in the table for reaches where erosion occurs under existing conditions. Conversely, decreases in these properties would result in the effects shown in the table for reaches where sedimentation occurs under Existing Conditions, but would result in negligible effects in reaches where erosion occurs under existing conditions.

§ Decreases in peak flow sediment transport capacity or baseflow mobile grain size for Jimmy Camp Creek and Williams Creek would result in negligible effects regardless of the percent reduction, because there is no sufficient supply of sediment to lead to deposition in these streams.

ϕ Positive percent changes in average annual sediment transport capacity are indicative of potential effects, while negative percent changes would result in negligible effects regardless of the percent change

Table 95. Existing Geomorphic Characteristics of Arkansas River Basin Analysis Area Streams.

Stream Segment	Geomorphic Parameter			
	Channel Material	Entrenchment	Historical Change in Channel Form	Riparian Vegetation Affects Stability
Lake Creek from Twin Lakes to Arkansas River	Sand to Boulders	Slight to Moderate	Not Evaluated	No
Arkansas River from Colorado 115 to Pueblo Reservoir	Gravel	Moderate	Not Evaluated	No
Fountain Creek from Colorado Springs to Arkansas River	Sand	Moderate	Yes	Yes
Jimmy Camp Creek from Jimmy Camp Creek Reservoir to Fountain Creek	Sand	Slight	Yes	Yes
Williams Creek from Upper Williams Creek Reservoir to Fountain Creek	Sand	Slight to Moderate	Yes	Yes
Arkansas River from Fountain Creek to Avondale	Sand	Slight	Yes	Yes

streams with slight to moderate entrenchment. The Arkansas River downstream of Fountain Creek is a sand bed stream with slight entrenchment. Riparian vegetation plays a significant role in geomorphic stability for sand bed streams within the analysis area (i.e., Fountain Creek, Jimmy Camp Creek, Williams Creek, and the Arkansas River downstream of Fountain Creek). Historical changes in channel form were observed for Fountain Creek, Jimmy Camp Creek, Williams Creek, and the Arkansas River downstream of Fountain Creek. The changes in channel form are likely a result of channel migration over time, indicating the susceptibility of these reaches for geomorphic change as a result of changes in streamflow.

There are several ongoing geomorphology-related studies for the Fountain Creek Basin, some of which generated information that was used for these analyses. Three of the most relevant ongoing studies are:

- The Fountain Creek Watershed Study (http://www.fountain-crk.org/) is a watershed study being conducted by the Corps. The goals of the plan are to document characteristics and general conditions of the Fountain Creek watershed and to identify locations where restoration areas are necessary and feasible. The City of Colorado Springs is the lead sponsor for this study, and the City of Fountain is on the Pikes Peak Area Council of Governments Board of Directors, which is helping to coordinate stakeholders for the study.
- Fountain Creek Vision Task Force (http://www.fountain-crk.org/) has a mission to create a comprehensive strategic plan for the Fountain Creek Watershed to incorporate and address all the studies that have been completed regarding the watershed, and to create a shared vision for specific action that could be taken to improve the health of

the watershed. The cities of Colorado Springs and Fountain are participating members of the Consensus Committee for the task force.

- Fountain Creek Technical Advisory Committee (http://www.fountain-crk.org/) is a group of local stakeholders with the mission of providing technical input for the Fountain Creek Watershed Study being conducted by the Corps. The cities of Colorado Springs and Fountain are participating members of the advisory committee.

The primary geomorphic instability issue in the analysis area is Fountain Creek erosion and sedimentation downstream of Colorado Springs and the Arkansas River downstream of Fountain Creek. Erosion is occurring in the upstream portion of Fountain Creek near Colorado Springs, and sedimentation is occurring in Fountain Creek downstream near Piñon and Pueblo as well as in the Arkansas River downstream of Fountain Creek (E&H 2007; Corps 2006c). The upstream portion of Fountain Creek is the largest contributor of sediment to lower Fountain Creek. Although large amounts of sediment are being transported from upstream during peak flow discharges, the stream cannot transport this same amount at downstream locations because of decreasing peak flow stream power from upstream to downstream on Fountain Creek. Stream power decreases because of reduced peak flows for lower Fountain Creek associated with channel storage near the Fountain Creek near Piñon Gage. As stream power decreases (i.e., 60 percent decrease in the 100-year peak flow stream power between the Fountain Creek near Fountain Gage and the Fountain Creek at Pueblo Gage), there is not enough stream power to transport sediment downstream. As a result, sedimentation occurs on Fountain Creek between Piñon and Pueblo. Sedimentation also occurs in the Arkansas River downstream of Fountain Creek as a result of this process.

Fountain Creek historically has been a geomorphically unstable stream, with erosion and sedimentation leading to changes in channel form as a result of natural changes in streamflow from year-to-year. However, the changes in channel form have increased in the recent past (about 25 years) as a result of changes in peak flow and baseflow hydrology that have become more frequent and higher in magnitude. The changes in hydrology that have increased geomorphic instability are likely a result of development in the Fountain Creek Basin and increases in urban land use (Stogner 2000). Over the past 25 years, Fountain Creek streamflow has increased, with land use changes from rangeland to urban and suburban use being the primary factor in the increase. Increased streamflow has exacerbated erosion in the upper portions of Fountain Creek and deposition in the lower portions of the creek. The Corps has completed portions of its Fountain Creek Watershed Study (Corps 2006a, 2006c) as a way to assess current geomorphic concerns and begin to conceive approaches to address the current geomorphic trend of erosion and sedimentation.

3.9.4.2 Western Slope Streams

Potentially affected Western Slope streams are Homestake Creek and its tributaries, the Fryingpan River and its tributaries, and the Roaring Fork River and its tributaries. These Western Slope streams are generally single-thread, high gradient, cobble and boulder-bed streams, and are generally considered to be geomorphically stable. Geomorphic stability of these streams is a result of moderate to high entrenchment and coarse grained bed material capable of resisting erosion. A tributary to Homestake Creek that is representative of the Western Slope streams is shown in Figure 84. Geomorphic stability is typical of high mountain streams with high stream gradient such as those within the Western Slope study area.

Minor geomorphic instability has been documented for the Roaring Fork River near the Town of Basalt (about 15 miles downstream of the Western Slope diversions described in Section 3.9.5), where development within the floodplain, past attempts to realign and confine the channel with retaining walls, and flow obstructions such as bridges have caused sedimentation and reduction of the capacity of the river to convey peak flows near Basalt (Elliot 2002). Sediment is transported from upstream reaches and deposited in downstream reaches at peak flows at least equal to the 10-year recurrence interval peak flow of about 6,100 cfs. However, geomorphic instability caused by sediment transport at peak flows is minimal for flows less than the 10-year peak flow (Elliot 2002).

3.9.5 Environmental Consequences

Direct and indirect effects are discussed in Section 3.9.5.1 and cumulative effects are discussed in Section 3.9.5.2 for each stream segment where geomorphic effects would be expected. Effects greater than "negligible" are emphasized in these sections. Additional details of the environmental consequences are provided in the Water Resources Effects Analysis Report (MWH 2008i) and the Water Resources Administrative Record Documentation (MWH 2008j).

3.9.5.1 Direct and Indirect Effects

Direct and indirect effects are summarized in this subsection by segment for locations and alternatives where effects would be expected to occur. Most geomorphic effects described in this subsection would be considered indirect. The geomorphic effects described herein would be the short-term effects, which may lead to additional long-term effects and dynamic adjustment by the stream as a result of the interaction of riparian vegetation, hydrology, and geomorphic characteristics such as sediment size. Reach-averaged long-term effects are estimated using the conceptual model relationship between geomorphic controls such as riparian vegetation, sediment supply, and stream slope.

Western Slope Streams

Increased Western Slope diversions associated with proposed SDS operations (there would be no new infrastructure) could affect

Figure 84. Tributary of Homestake Creek.

geomorphology of the streams where Western Slope diversions would occur. Western Slope diversions from the Homestake Creek and its tributaries, the Fryingpan River and its tributaries, and the Roaring Fork River and its tributaries would reduce streamflow in the streams and potentially affect geomorphic stability of the streams.

The proposed Western Slope diversions would reduce streamflow within the streams where diversions would occur, resulting in the potential for reduced erosion in general. Erosion is not presently a geomorphic concern on the streams where increased diversions would be made. The reduction in streamflow would have a negligible to slight beneficial effect on the geomorphology of the streams.

Reduced streamflow within Homestake Creek, Fryingpan River, and Roaring Fork River could have an adverse effect on downstream geomorphology where these streams merge with larger, potentially lower gradient streams, and where geomorphic stability may be lower. Reduced streamflow in these downstream rivers could result in geomorphic effects such as an increase in sedimentation. However, these downstream effects would likely be negligible because of the small fraction of downstream flow contributed by these upstream tributaries above the diversion points, and because any differences in streamflow would be tempered by other activities within the larger watershed area. For example, the closest known geomorphic instability on the Western Slope streams occurs on the Roaring Fork River near the town of Basalt. As described in Section 3.9.4.2, geomorphic instability exists for the Roaring Fork River near the town of Basalt where sediment deposition occurs in some reaches at flows exceeding the 10-year peak flows (Elliot 2002). This sediment deposition has resulted in decreased flood flow capacity. The greatest average monthly difference in streamflow would occur on the Roaring Fork River for the No Action Alternative, which shows a reduction in average monthly streamflow from Existing Conditions in June of about 50 cfs at the Roaring Fork above Difficult Creek Gage. Relative to the No Action Alternative, all Action Alternatives would have an increase in streamflow of 3 to 34 cfs. The reductions on the Roaring Fork River would have a negligible effect on peak flows, which is the flow condition during which sediment deposition occurs. As a result, the Western Slope diversions would be expected to have negligible effects on the sedimentation currently occurring on the Roaring Fork River near Basalt.

Localized sedimentation and erosion could occur in the Western Slope streams near the existing diversion locations. Sediment transport capacity can be reduced within streamflow pooled behind the diversion structure, resulting in trapping of sediment behind the diversion. An example of a diversion structure for the Western Slope streams is shown in Figure 85. Streamflow downstream of the diversion structures as a result of seepage or overtopping has low sediment concentrations and is "sediment hungry" water capable of erosion. Erosion could occur downstream of the diversion structures up to a point where sediment concentrations are equal to sediment transport capacity. Although minor localized erosion could occur downstream of the diversion structures as a result of sediment trapping behind the structures, the high geomorphic stability of the Western Slope streams would limit the potential for substantial effects.

Figure 85. A Western Slope Diversion Structure.

Lake Creek between Twin Lakes and the Arkansas River

A flow exceedance curve for Lake Creek is shown in Figure 86. None of the alternatives would affect the frequency of streamflows at or above the bankfull discharge of 1,000 cfs. Therefore, no moderate or major geomorphic effects would be expected to occur. Changes to riparian vegetation may occur as a result of changes to Lake Creek baseflows. However, riparian vegetation is not a major influence on the geomorphic stability of Lake Creek because the Lake Creek streambed is predominantly cohesive bedrock and is not heavily influenced by stabilization from vegetation. Compared to Existing Conditions, the No Action Alternative would have substantially higher streamflows between the 40th (100 cfs for Existing Conditions and 200 cfs for the No Action Alternative) and 95th (20 cfs) percentiles as a result of increased releases from Twin Lakes, likely resulting in minor erosion. Streamflows and, thus, geomorphic effects, for the Highway 115 Alternative would

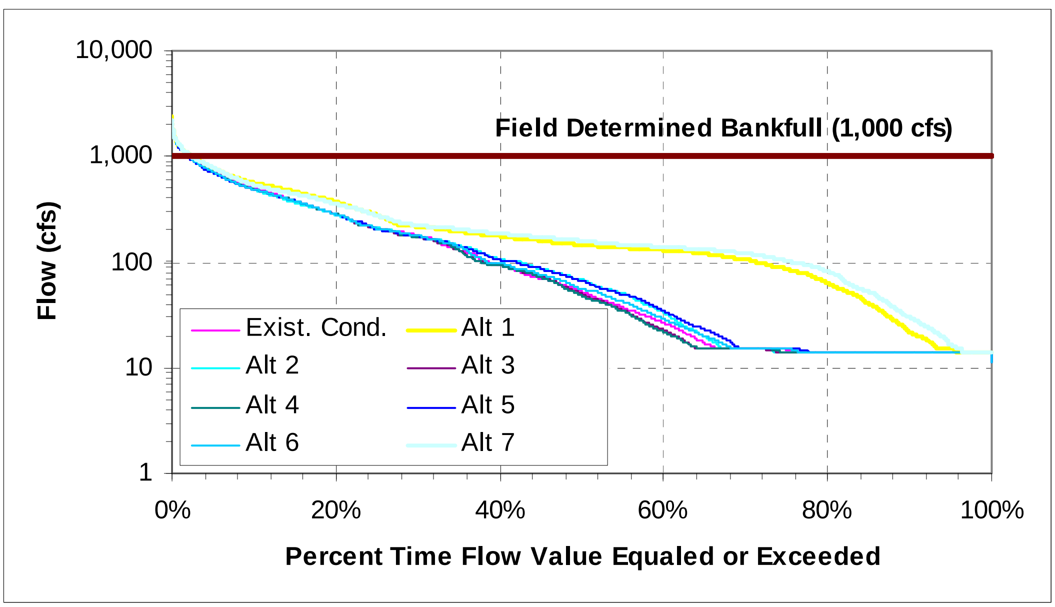


Figure 86. Lake Creek Direct and Indirect Effects Exceedance Flow Curves.

be similar to the No Action Alternative. Minor erosion in the short term could lead to a flattening of the slope of Lake Creek and potentially an increase in the sinuosity of the creek for the No Action and Highway 115 alternatives relative to Existing Conditions over the long term. All of the other Action Alternatives would have streamflows that are lower than the No Action Alternative. The Participants' Proposed Action, Wetland, Fountain Creek, and Downstream Intake alternatives would have more frequent streamflows between 20 and 100 cfs than occur under Existing Conditions. Minor geomorphic changes in Lake Creek for each of these alternatives may include slight channel migration in the upper segment of Lake Creek (about halfway between Twin Lakes and the confluence with the Arkansas River). This upper segment would likely be the only portion of Lake Creek that would be affected as a result of its current meandering form and primarily sand and gravel bed composition. Geomorphic effects of the Arkansas River Alternative would be negligible because streamflows would be similar to Existing Conditions. The remaining Action Alternatives would have more frequent low streamflow than the No Action Alternative (shown by the lower streamflow values in Figure 86 for all Action Alternatives except for the Highway 115 Alternative), indicating the potential for minor sedimentation for these alternatives compared to the No Action Alternative.

Arkansas River

Geomorphic effects of the No Action Alternative on the Arkansas River between the Portland Gage and Pueblo Reservoir compared to Existing Conditions would be negligible. Decreased peak flow sediment transport capacity for the Arkansas River downstream of Fountain Creek (Table 96) would cause minor sedimentation for the No Action Alternative compared to Existing Conditions as a result of incidental reduction in peak flows due to Williams Creek Reservoir. Long-term effects associated with minor sedimentation could include a decrease in stream sinuosity or an increase in channel slope to offset the decrease in peak flow sediment transport capacity as the stream adjusts toward a new equilibrium. Reduced channel capacity also could occur over the long term as a result of sedimentation.

Geomorphic effects of the Wetland and Arkansas River alternatives compared to the No Action Alternative would include minor erosion at baseflow conditions for the Arkansas River between Colorado 115 and Pueblo Reservoir (Table 97) because of increased baseflow in the reach associated with the Highway 115 Return Flow Pipeline. Long-term effects of this erosion could include reduced stream slope or increased sinuosity to offset the increase in baseflow. Reduced sedimentation would occur for the Arkansas River downstream of Fountain Creek for these alternatives relative to the No Action Alternative because of increased peak flow sediment transport capacity because of the absence of Williams Creek Reservoir for these alternatives. Reduced sedimentation would

Table 96. Indirect Geomorphic Effects of the No Action Alternative on the Arkansas River.

Parameter†	Colorado 115 to Pueblo Reservoir	Downstream of Fountain Creek
Change in Baseflow Mobile Grain Size	-1%	+3%
Change in Peak Flow Sediment Transport Capacity	~0%	-6%

† Changes are compared to Existing Conditions.

Table 97. Indirect Geomorphic Effects of the Wetland and Arkansas River Alternatives on the Arkansas River.

Parameter[†]	Colorado 115 to Pueblo Reservoir	Downstream of Fountain Creek
Change in Baseflow Mobile Grain Size	+10 to +11%	-4 to -5%
Change in Peak Flow Sediment Transport Capacity	~0%	+7%

[†] Changes are compared to the No Action Alternative.

increase the overall geomorphic equilibrium of the Arkansas River downstream of Fountain Creek in the long-term. Because the current geomorphic trend for this reach is sedimentation, a reduction in sediment supply from Fountain Creek would bring the sediment supply and sediment transport capacity more closely into equilibrium. Geomorphic effects of the remaining Action Alternatives would be negligible relative to the No Action Alternative.

Fountain Creek

Relative to Existing Conditions, the No Action Alternative would cause a moderate to major increase in erosion in Fountain Creek upstream of Williams Creek as a result of increased baseflow mobile grain size due to increased wastewater return flows, and a moderate increase in sedimentation downstream of Williams Creek as a result of decreased peak flow sediment transport capacity (Table 98) associated with Williams Creek Reservoir. In both segments, the mobile grain size at baseflows would have a moderate to major increase because of increased wastewater return flows. Sediment transport capacity under peak flows would decrease by about 9 percent in the downstream segment (moderate sedimentation) due to incidental flood attenuation in Williams Creek Reservoir (Section 3.8). The annual sediment transport capacity deficit (i.e., less capacity for the downstream segment than the upstream segment) for the downstream segment indicates the potential for a negligible decrease in sedimentation in the downstream reach (4 percent less for No Action than Existing Conditions).

There may be minor erosion for the No Action Alternative relative to Existing Conditions for Fountain Creek near Fountain and Security because of the potential reduction in riparian vegetation associated with ground water pumping for the No Action Alternative for Fountain and Security (Section 3.11). Long-term effects of the No Action Alternative could include reduced stream slope or increased sinuosity for Fountain Creek near Fountain and Security in response to the minor erosion as the creek attempts to attain equilibrium. Downstream of Williams Creek, long-term

Table 98. Indirect Geomorphic Effects of the No Action Alternative on Fountain Creek.

Parameter[†]	Upstream of Williams Creek	Downstream of Williams Creek
Change in Baseflow Mobile Grain Size	+12 to +17%	+12%
Change in Peak Flow Sediment Transport Capacity	~0%	-9%
Changes in Upstream to Downstream Difference in Sediment Transport Capacity	20 tons/day (-4%)	

[†] Changes are compared to Existing Conditions.

effects of the No Action Alternative on Fountain Creek could include a decrease in stream sinuosity, an increase in channel slope, or stream braiding in order to offset the decrease in peak flow sediment transport capacity as the stream adjusts toward a new equilibrium. Additional long-term effects of the sedimentation could include reduced channel capacity.

Minor localized erosion on Fountain Creek would occur as a result of the discharge of return flows to Fountain Creek for alternatives with the Williams Creek Return Flow Conveyance Pipeline (No Action Alternative, Participants' Proposed Action, Downstream Intake, and Highway 115 alternatives). Discharge from the Williams Creek Return Flow Conveyance Pipeline would occur on Fountain Creek just south of the city of Fountain. The pipeline would be designed with an energy dissipation structure to minimize the potential for erosion. However, minor localized erosion may occur downstream of the dissipation structure as low sediment concentration flow from the return flow pipeline picks up sediment, up to a point where sediment concentration would be equal to sediment transport capacity. Potential geomorphic effects downstream of the Williams Creek Return Flow Conveyance Pipeline include:

- Minor widening of the active channel within the main channel (delineated by the channel/floodplain boundary)
- Minor deepening of the active channel
- Minor potential for bank erosion where the active channel would come into contact with the channel/floodplain boundary
- Minor increase of the meander width of the active channel

There would be minor sedimentation for the Wetland and Arkansas River alternatives compared to the No Action Alternative for Fountain Creek downstream of Williams Creek as a result of a decrease in baseflow mobile grain size (Table 99) associated with return flows being conveyed to the Arkansas River via the Highway 115 Return Flow Pipeline in lieu of Fountain Creek. Long-term effects of this sedimentation could include reduced stream sinuosity, increased slope, or stream braiding to offset the sedimentation as the stream adjusts toward a new equilibrium. Reduced channel capacity as a result of sedimentation is also a possible long-term effect. Sediment transport capacity under peak flows would increase by about 9 percent in the downstream segment due to the absence of incidental flood attenuation in Williams Creek Reservoir. Long-term effects of increased peak flow sediment transport capacity could include increased stream sinuosity or decreased slope to offset the increase in discharge. The annual sediment transport

Table 99. Indirect Geomorphic Effects of the Wetland and Arkansas River Alternatives on Fountain Creek.

Parameter†	Upstream of Williams Creek	Downstream of Williams Creek
Change in Baseflow Mobile Grain Size	0 to -17%	-31%
Change in Peak Flow Sediment Transport Capacity	~0%	+9%
Changes in Upstream to Downstream Difference in Sediment Transport Capacity	130 to 180 tons/day (-25 to -37%)	

† Changes are compared to the No Action Alternative.

capacity deficit for the downstream segment indicates the potential for a decreased sediment transport capacity deficit (classified as a negligible effect).

Geomorphic effects for the Fountain Creek Alternative would be major sedimentation in the downstream reach because of a 32 percent decrease in baseflow mobile grain size for the downstream reach relative to the No Action Alternative (Table 100). Diversion of Fountain Creek return flows to the Eastern Return Flow Pipeline would result in decreased sediment transport capacity for baseflow downstream of Fountain. There also would be major sedimentation for Fountain Creek downstream of Williams Creek because of an increase in the average annual sediment transport capacity deficit because of diversions from Fountain Creek to the Eastern Return Flow Pipeline. Long-term effects of this sedimentation could include reduced stream sinuosity, increased slope, or stream braiding to offset the sedimentation as the stream adjusts toward a new equilibrium. Additional long-term effects of sedimentation could be reduced channel capacity. Changes in peak flow geomorphic properties would be negligible.

Table 100. Indirect Geomorphic Effects of the Fountain Creek Alternative on Fountain Creek.

Parameter†	Upstream of Williams Creek	Downstream of Williams Creek
Change in Baseflow Mobile Grain Size	0 to -18%	-32%
Change in Peak Flow Sediment Transport Capacity	~0%	~0%
Changes in Upstream to Downstream Difference in Sediment Transport Capacity	-430 tons/day (+86%)	

† Changes are compared to the No Action Alternative.

Minor localized erosion on Fountain Creek would occur as a result of the discharge of return flows to Fountain Creek for alternatives with the Eastern Return Flow Pipeline (Fountain Creek Alternative). An energy dissipation structure, included in the design of the Eastern Return Flow Pipeline, would limit geomorphic effects at the discharge location to minor erosion. Localized erosion would occur directly downstream of the Eastern Return Flow Pipeline discharge location (directly upstream of the confluence with the Arkansas River) because of "sediment hungry" water being discharged from the pipeline. Return flows in the pipeline would increase sediment transport capacity at the return flow discharge point, leading to the following geomorphic effects:

- Minor widening of the active channel within the main channel (delineated by the channel/floodplain boundary)
- Minor deepening of the active channel
- Minor potential for bank erosion where the active channel would come into contact with the channel/floodplain boundary
- Minor increase of the meander width of the active channel

The Participants' Proposed Action, Downstream Intake, and Highway 115 alternatives would cause minor erosion in the upstream reach relative to the No Action Alternative because of an increase in baseflow mobile grain size (Table 101) due to increased baseflow associated with differences in the operations of Fountain Creek return flows. Long-term effects of this erosion would include increased stream sinuosity or decreased slope to offset the increase in

Table 101. Indirect Geomorphic Effects of the Proposed Action, Downstream Intake, and Highway 115 Alternatives on Fountain Creek.

Parameter†	Upstream of Williams Creek	Downstream of Williams Creek
Change in Baseflow Mobile Grain Size	-5% to +7%	-4 to +5%
Change in Peak Flow Sediment Transport Capacity	~0%	~0%
Changes in Upstream to Downstream Difference in Sediment Transport Capacity	20 to 150 tons/day (-4 to -31%)	

† Changes are compared to the No Action Alternative.

discharge. Other effects would be beneficial or negligible.

Jimmy Camp Creek

Peak flow sediment transport capacity for the No Action Alternative would be similar to Existing Conditions (i.e., the alternatives would not affect Jimmy Camp Creek peak flows because Jimmy Camp Creek Reservoir would have a negligible effect on peak flows as described in Section 3.8). There would be a substantial increase in baseflow mobile grain size for the No Action Alternative (Table 102) because of increased development in the basin. As discussed in the Surface Water Hydrology section (Section 3.5), this growth-related effect (i.e., cumulative effect) is reflected in the direct and indirect effects. Major erosion would occur for Jimmy Camp Creek for the No Action Alternative compared to Existing Conditions because the increase in baseflow would cause Jimmy Camp Creek to change from a stream that flows for only parts of the year (i.e., intermittent stream) to one that flows throughout the year (i.e., perennial stream). This substantial hydrologic change would lead to moderate to major erosion of Jimmy Camp Creek streambanks. Long-term effects of this erosion would include increased stream sinuosity or decreased slope to offset the increase in discharge. The consistent presence of water in the stream could lead to development of riparian vegetation along the streambanks, which would armor the banks and potentially offset some of the erosion of Jimmy Camp Creek. However, the offsetting effects of riparian vegetation armoring would likely not result in a substantial reduction in streambank erosion.

Table 102. Indirect Geomorphic Effects of the No Action Alternative on Jimmy Camp Creek.

Parameter†	Jimmy Camp Creek at Fountain
Change in Baseflow Mobile Grain Size	+78%
Change in Peak Flow Sediment Transport Capacity	~0%

† Changes are compared to Existing Conditions.

There would be no substantial differences in geomorphic properties for the Action Alternatives relative to the No Action Alternative, resulting in negligible geomorphic effects for Jimmy Camp Creek.

Williams Creek

Proposed reservoirs on Williams Creek could have minor effects on the geomorphology of the stream, including settling of sediment in the reservoirs and a reduction in peak flow sediment transport capacity downstream of the reservoirs. Settling of sediment in the proposed Williams Creek Reservoir (No Action, Participants' Proposed Action, Fountain Creek, Downstream Intake, and Highway 115 alternatives) could occur, which would result in low sediment concentration "sediment hungry" water downstream of the dam. Williams Creek streamflow downstream of the dam from seepage through the dam or stormflow passed through the dam's outlet or spillway would have sediment transport capacity, but would have low sediment concentrations. Minor erosion could occur downstream of the dam up to the point where sediment concentrations would equal sediment transport capacity. Sediment settling and the associated potential for downstream erosion would not be expected for the Upper Williams Creek Reservoir (Participants' Proposed Action and Wetland alternatives) because of the location of the reservoir high in the watershed where there would be negligible contributing watershed area and limited sediment supply to the reservoir.

Peak flow sediment transport capacity in Williams Creek for the No Action Alternative would be 64 percent less than for Existing Conditions due to incidental flood storage in Williams Creek Reservoir, indicating a tendency toward less peak flow erosion. Baseflow mobile grain size for the No Action Alternative would be equal to that for Existing Conditions, which would result in negligible effects relative to Existing Conditions. As discussed above for Jimmy Camp Creek, riparian vegetation could result from the change to a perennial stream, which may increase geomorphic stability of Williams Creek.

The Wetland and Arkansas River alternatives would have a major increase in peak flow sediment transport capacity and a negligible effect on baseflow mobile grain size relative to the No Action Alternative (Table 103), because these alternatives would not have the proposed Williams Creek Reservoir. Although the changes in peak flow sediment transport capacity would be classified as major relative

Table 103. Direct and Indirect Geomorphic Effects of the Wetland and Arkansas River Alternatives on Williams Creek.

Parameter†	Williams Creek at Fountain Creek Confluence
Change in Baseflow Mobile Grain Size	0%
Change in Peak Flow Sediment Transport Capacity	+173 to 175%

† Changes are compared to the No Action Alternative.

to the No Action Alternative, there would be no differences for these alternatives relative to Existing Conditions.

There would be negligible effects on baseflow mobile grain size and peak flow sediment transport capacity in Williams Creek for the Participants' Proposed Action, Fountain Creek, Downstream Intake, and Highway 115 alternatives relative to the No Action Alternative.

3.9.5.2 Cumulative Effects

Two reasonably foreseeable actions would affect geomorphology under the cumulative effects analysis: urban and suburban development within El Paso, Pueblo, and Fremont counties, and the Colorado Springs Stormwater Enterprise (as described in Section 3.1.3.1). Cumulative effects peak flows and baseflows would be different than direct and indirect effects described for Fountain Creek downstream of Colorado Springs, Jimmy Camp Creek, and Williams Creek.

The Colorado Springs Stormwater Enterprise would affect geomorphology under peak flow conditions only. As described in the Flood Hydrology and Floodplains section (Section 3.8), development within the Fountain Creek Basin would increase peak flow discharge and sediment transport capacity (i.e., increased erosion would be possible as a result of increased stormwater runoff) for the cumulative effects relative to direct and indirect effects. Although development would result in increased peak flow sediment transport capacity for most of the analysis area, the Colorado Springs Stormwater Enterprise would maintain future conditions (2046) peak flows, and thus peak flow sediment transport capacity, at Existing Conditions (2006) levels for areas within the Colorado Springs through the use of regional flood control structures and flood control requirements for new development. Development throughout the basin is likely to include controls to prevent substantial geomorphic effects, which may include culverts and grade control and bank stabilization structures that may reduce geomorphic instabilities associated with the development.

Development would increase baseflow mobile grain size relative to the direct and indirect effects analysis as a result of increased water use and the associated increase in return flows to Fountain Creek. The increase in baseflow mobile grain size would cause increased erosion at baseflow conditions.

Cumulative effects are described by segment where cumulative effects would be different than direct and indirect effects. As with the direct and indirect effects, cumulative effects may include additional long-term effects and dynamic adjustment by the stream as a result of the interaction of riparian vegetation, hydrology, and geomorphic characteristics such as sediment size. Stream segments would adjust to the geomorphic cumulative effects described herein as a new geomorphic equilibrium is approached or established. These long-term effects that would occur as equilibrium is established were estimated using the conceptual geomorphic model, and could include the following:

- Riparian vegetation encroachment as a result of increased baseflow. Increased baseflow could lead to short-term erosion followed by riparian vegetation encroachment, which may stabilize streambanks and prevent long-term erosion.
- Long-term, dynamic adjustments to fluvial geomorphology as streams adjust to short-term effects (e.g., establishment of new geomorphic equilibrium following erosion or changes in stream meander patterns).

Long-term geomorphic cumulative effects are discussed for each individual reach where cumulative effects would be different than direct and indirect effects.

Arkansas River

Cumulative effects for the Arkansas River would be similar to those described for direct and indirect effects

Fountain Creek

Cumulative effects for Fountain Creek upstream of Williams Creek would be equal to those for direct and indirect effects, with the exception of major erosion that would occur upstream of Williams Creek as a result of a 15 to 38 percent increase in peak flow sediment transport capacity for the No Action Alternative relative to Existing Conditions (Table 104). Major erosion for the No Action Alternative associated with peak flow sediment transport capacity under cumulative effects would be an increase from moderate to major erosion for direct and indirect effects associated with increased baseflow mobile grain size. The major erosion would be a result of development within the Fountain Creek Basin under cumulative effects. Cumulative effects for the Action Alternatives,

Table 104. Cumulative Geomorphic Effects of the No Action Alternative on Fountain Creek.

Parameter†	Upstream of Williams Creek	Downstream of Williams Creek
Change in Baseflow Mobile Grain Size	+13 to 16%	+11%
Change in Peak Flow Sediment Transport Capacity	+15 to 38%	-13%
Changes in Upstream to Downstream Difference in Sediment Transport Capacity	-26 tons/day (+7%)	

† Changes are compared to Existing Conditions.

relative to the No Action Alternative, would be comparable to direct and indirect effects for Fountain Creek described above. The only exception would be for Fountain Creek downstream of Fountain. For this reach, an increase from negligible sedimentation for direct and indirect effects to minor sedimentation for cumulative effects for the Participants' Proposed Action and Highway 115 alternatives would occur as a result of an increased deficit of average annual sediment transport capacity from upstream to downstream of 160 tons/day (37 percent increase) and 130 tons/day (31 percent increase), respectively.

Minor erosion may also occur for the Action Alternatives for Fountain Creek near Fountain because of reasonably foreseeable alluvial ground water development that would reduce riparian vegetation.

Jimmy Camp Creek

Cumulative geomorphic effects for Jimmy Camp Creek would be similar to the direct and indirect effects described above, with the exception of major erosion that would occur as a result of a 31 percent increase in peak flow sediment transport capacity for the No Action Alternative relative to Existing Conditions under cumulative effects. This increase in peak flow sediment transport capacity would occur as a result of development within the Jimmy Camp Creek Basin.

Williams Creek

Cumulative effects for Williams Creek would be similar to direct and indirect effects for all alternatives.

3.9.5.3 Resource Commitments

There would be no irreversible commitments of geomorphological resources. Irretrievable commitments of resources would include erosion and reduction of channel banks upstream on Fountain Creek near the city of Colorado Springs as a result of baseflow channel erosion. An irretrievable commitment of resources could occur for Lake Creek between Twin Lakes and the Arkansas River because of minor erosion associated with changes in daily streamflow. Similarly, sedimentation would reduce the river stage available to accommodate flooding during peak flows downstream on Fountain Creek near Pueblo and the Arkansas River downstream of Fountain Creek. Channel capacity could be recovered following erosion or dredging of the segments where sedimentation would occur.

3.9.5.4 Mitigation Measures

Proposed Measures

The following mitigation measures would be implemented for all alternatives:

- Prepare a geomorphic mitigation plan and secure Reclamation approval prior to executing any contracts for the SDS

Project. This plan could include, but is not limited to:

1. Evaluate and consider strategies to remove sediments that reduce the effectiveness of Corps levees located near Fountain Creek at its confluence with the Arkansas River
2. Evaluate and consider strategies to increase the sinuosity of Fountain Creek at appropriate locations in order to reduce undesirable erosion and sedimentation
3. Evaluate and consider strategies at appropriate locations along Fountain Creek to reduce undesirable erosion and sedimentation

- Select geomorphic mitigation measures for SDS Project effects that are, to the extent practicable, consistent with priority projects identified in the Corps' Fountain Creek Watershed Study and the Fountain Creek Corridor Master Plan. Locations where geomorphic mitigation projects could occur include, but are not limited to:
  1. Fountain Creek at the Clear Spring Ranch site, directly upstream and downstream of the confluence of Little Fountain Creek and Fountain Creek (approximately 4 miles)
  2. Fountain Creek from upstream of Fountain Boulevard to upstream of Colorado 85/87 at the Sand Creek confluence (approximately 3 miles)
- Complete pre-project geomorphic mitigation, including channel stabilization projects and non-structural options such as conservation easements, before the project is operational. Channel stabilization could include, but is not limited to, increasing stream sinuosity, flattening of steep side slopes, installation of grade control structures, and use of buried riprap, erosion blankets, and/or vegetative cover for channel stabilization in areas of high and/or erosive velocities.
- Design and construct an energy dissipation structure that will protect against erosion at the outlet of the return flow pipeline to Fountain Creek or the Arkansas River
- Evaluate and implement appropriate future geomorphic stabilization projects, if such future projects are determined to be necessary after the project is operational

Mitigated Effects

When implemented, these recommendations would mitigate potential adverse effects on geomorphology by avoiding or minimizing effects of return flow discharges through an energy dissipation structure, compensating for anticipated effects, and responding to effects identified after project operations begin.

3.10 Aquatic Life

Aquatic resources are being evaluated because they could be affected by changes in streamflow, storage patterns in reservoirs, water quality, flooding, channel geomorphology, or riparian vegetation. The SDS Project could potentially affect fish and invertebrate communities and their habitat in the analysis area. The indicators for aquatic resources evaluated in this analysis are:

- Number of fish species
- Abundance of fish species
- Number of benthic invertebrate species
- Abundance of benthic invertebrate species

3.10.1 Summary of Effects

All alternatives would result in a combination of beneficial and adverse direct and indirect effects throughout the analysis area (Figure 87). Most of the effects would be indirect effects, through changes in streamflow or reservoir operation. Direct effects would be limited to the inundation of the stream channel with the creation of proposed reservoirs. For convenience, both indirect and direct effects have been combined and referred to as direct effects. The differences in hydrology among the alternatives would generally result in negligible or minor indirect effects on fish and invertebrates. A few moderate or major beneficial or adverse effects also would occur in some segments of the analysis area with some alternatives, which are summarized below.

In most Western Slope streams, there would be negligible effects of increased diversions and lower flows with all alternatives. In the Roaring Fork River and Ivanhoe Creek, there would be minor beneficial or minor adverse effects with some alternatives. In Homestake Reservoir, the No Action Alternative would have a moderate adverse effect with a lower volume of stored water compared to Existing Conditions. The Highway 115 Alternative would have a minor beneficial effect on the reservoir compared to The No Action Alternative with more storage of water.

In Lake Creek, the No Action Alternative would have a moderate beneficial effect with more favorable winter flows compared to Existing Conditions. All Action Alternatives except the Highway 115 Alternative would have much lower winter flows and moderate adverse effects compared to the No Action Alternative. These differences may result in fewer species and lower abundance of fish and invertebrates for these alternatives.

In most segments of the Arkansas River, there would be negligible to minor beneficial and adverse effects on aquatic life. The Wetland and Arkansas River alternatives would have moderate beneficial effects compared to the No Action Alternative in the river downstream of the Highway 115 Return Flow Pipeline with higher winter flows, higher nutrient concentrations, and moderated water temperatures with fewer fluctuations. These two alternatives would increase biological productivity in the segment of the river upstream of Pueblo Reservoir. The No Action Alternative would have a moderate adverse effect on aquatic resources in the Arkansas River between Wildhorse Creek and Fountain Creek compared to Existing Conditions with zero-flow days in most years and less favorable winter flows. The Arkansas River Alternative would have more favorable winter flows and no zero-flow days, resulting in a moderate beneficial effect compared to the No Action Alternative. The Highway 115 Alternative would have a moderate adverse effect on the Arkansas River from Pueblo Dam to Fountain Creek with lower winter flows compared to the No Action Alternative.

In Fountain Creek, the alternatives would result in a range of flows and effects. Most of the effects would be negligible or minor. The No Action Alternative would result in higher flows and minor to moderate adverse effects compared to Existing Conditions in all four segments of Fountain Creek. The Wetland and Arkansas River alternatives would have lower flows and moderate adverse effects in Segments 1 and 3 (Segments are depicted on Figure 87) and the Fountain Creek Alternative would have a moderate adverse effect in Segment 3 with less habitat availability compared to the No Action Alternative.

In Segment 4 of Fountain Creek (Segments are depicted on Figure 87), the Participants' Proposed Action and Highway 115 alternatives would have moderate adverse effects, compared to the No Action Alternative, with lower fish habitat availability due to releases from Williams Creek Reservoir. The higher flows in this reach and resulting higher water velocities would reduce habitat availability for shiners, the smaller life stages of white sucker, and other small-bodied fishes and invertebrates, especially in wet and dry years. The Wetland, Arkansas River, and Fountain Creek alternatives would have greater habitat availability and moderate beneficial effects compared to the No Action Alternative.

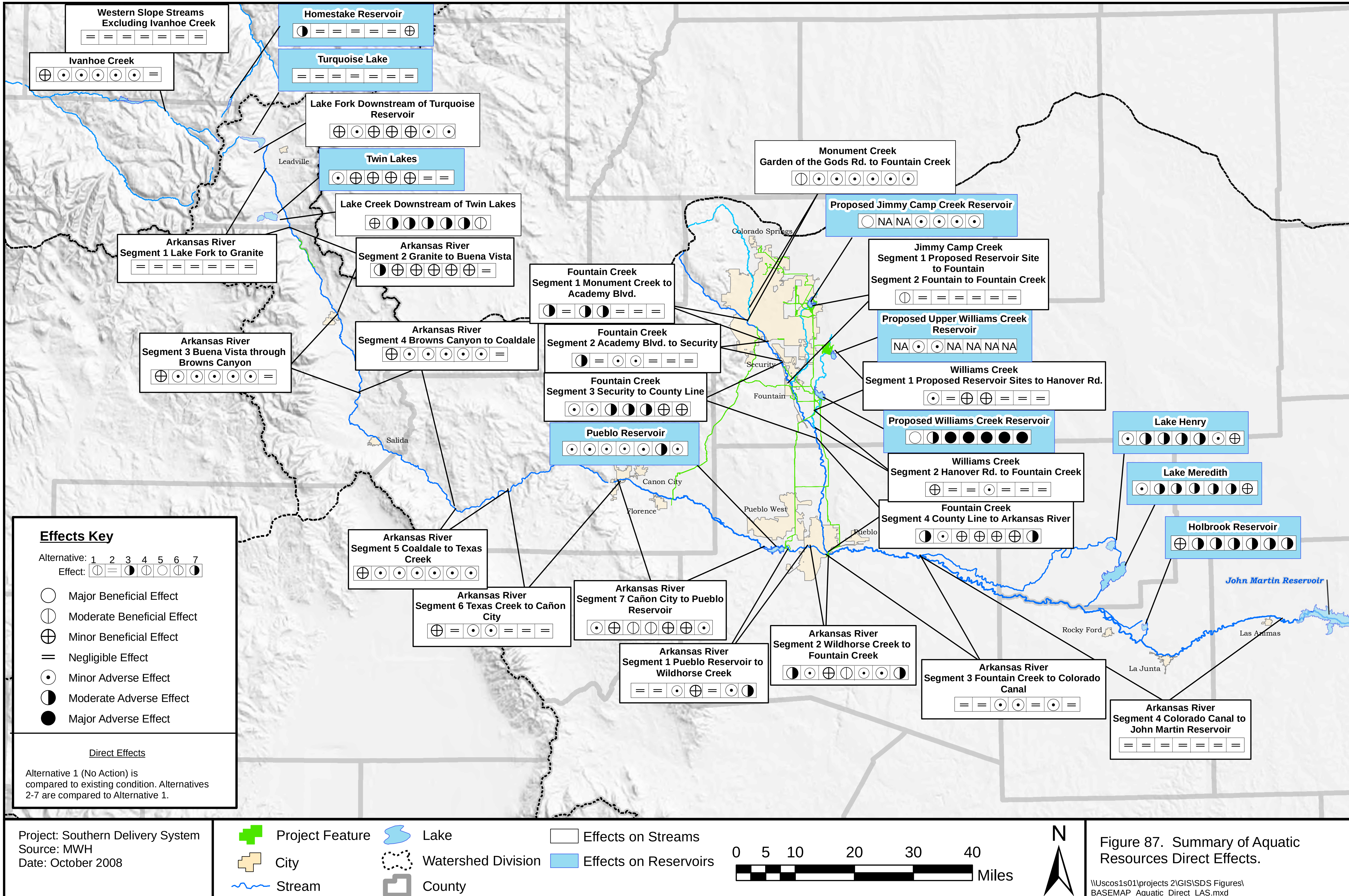
In Jimmy Camp Creek, flows would be perennial due to non-sewered return flows from development (a cumulative effect attributed to direct and indirect effects hydrology as described in Section 3.5.3) along sections of the stream downstream of Bradley Road that are now dry much of the time. Perennial flows would be a major beneficial effect of the No Action Alternative compared to Existing Conditions. All Action Alternatives would have similar hydrology to the No Action Alternative. Because of the non-sewered return flows in Jimmy Camp Creek, all alternatives would allow invertebrates and probably fish to become established in this section of the stream that is currently dry between Bradley Road and Fountain.

None of the alternatives would affect aquatic resources in Williams Creek

In Pueblo Reservoir, the alternatives would have effects varying from moderate beneficial to moderate adverse. In Lake Henry, most Action Alternatives would have major adverse effects compared to the No Action Alternative with more severe drawdowns. In Lake Meredith, the Action Alternatives would have effects ranging from minor adverse to negligible and minor beneficial. The Action Alternatives would have moderate adverse effects compared to the No Action Alternative in Holbrook Reservoir.

The creation of the proposed Jimmy Camp Creek terminal storage reservoir would represent major beneficial effects for the No Action Alternative compared to Existing Conditions. The reservoir would be open to the public and would be suitable for supporting recreational fishing. The Action Alternatives would have either the Jimmy Camp Creek Reservoir or the Upper Williams Creek Reservoir with a similar fishery.

The Williams Creek Reservoir would be full for much of the year under the No Action Alternative and would support fish and invertebrates, representing a major beneficial effect compared to Existing Conditions. This reservoir likely would be closed to the public and would not have a recreational fishery.



Project: Southern Delivery System
Source: MWH
Date: October 2008

Figure 87. Summary of Aquatic Resources Direct Effects.

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All other alternatives would have much less storage or would not include this reservoir and would represent moderate to major adverse effects compared to the No Action Alternative

3.10.2 Regulatory Framework

Federally threatened and endangered species are protected under the ESA of 1973, as amended. The ESA defines an endangered species as "a species in danger of becoming extinct throughout all or a large portion of its range" and a threatened species as "a species likely to become endangered in the foreseeable future." If a project with a federal action would have adverse effects on a federally listed plant species or its habitat, consultation with the Service under Section 7 of the ESA would be required.

Candidate species are species for which there is sufficient information on their biological vulnerability to support federal listing as endangered or threatened (Service 2008), but listing is precluded by other higher priority listing activities. No regulations require consultation for effects on candidate species; however, if a candidate species occurring in the analysis area becomes listed during project planning or construction, consultation with the Service may be required.

No listed threatened or endangered aquatic species occur in the analysis area. One species of fish, the Arkansas darter, is a candidate for listing and occurs in the analysis area.

The Colorado Division of Wildlife (CDOW) is responsible for the management of the aquatic wildlife species in Colorado. CDOW manages game and non-game species by setting regulations, stocking fish, protecting habitat, and other activities. Three fish species in the analysis area are listed by CDOW as special status species: the suckermouth minnow (state endangered); Arkansas darter (state threatened); and flathead chub (species of special concern).

3.10.3 Analysis Area and Methods

3.10.3.1 Analysis Area

The analysis area for the aquatic resources effects analysis is the same as that for the hydrology effects analysis (Section 3.5) and includes water bodies potentially affected by the SDS Project because of modified hydrology or changes to water quality, flood hydrology, channel geomorphology, or riparian vegetation. Figure 87 identifies stream segments and water features in the aquatic resources analysis area.

3.10.3.2 Affected Environment Methods

To describe the existing aquatic biological resources in the analysis area, information was collected primarily through review of past studies by state and federal agencies. Supplemental data were collected specifically for the SDS Project on fish, invertebrates, and habitat in several stream segments where data gaps were identified during the agency scoping process. Much of the existing information was collected by CDOW; all supplemental information was collected by Chadwick Ecological Consultants, Inc. (CEC) (2006), sometimes in cooperation with CDOW.

The data collection and summary concentrated on aspects of aquatic resources that were relevant for assessing potential effects on fish and invertebrate communities and their habitat. For fish and invertebrates, the relevant parameters focus on measures of abundance and species composition (Table 105). Existing conditions for aquatic resources are described in the Aquatic Resources Technical Report (CEC 2006).

3.10.3.3 Effects Analysis Methods

The methods used to evaluate effects on fish and benthic invertebrate communities and their habitat are described in detail in the Aquatic Resources Effects Analysis (GEI 2008a) and in the Aquatic Resources Administrative Record Documentation (GEI 2008b). The water bodies in the analysis area were grouped into three general categories: coldwater streams, warmwater streams, and reservoirs (Table 106). Briefly, coldwater streams have water temperatures low enough throughout the year to support trout. In the analysis area, coldwater streams include Lake Fork Creek, Lake Creek, and the Arkansas River upstream of Wildhorse Creek in Pueblo. Warmwater streams have higher water temperatures and include the lower Arkansas River downstream of Wildhorse Creek and streams in the Fountain Creek Basin. Seven existing and three proposed reservoirs also are included in the analysis area (Table 106).

Potential effects in the Western Slope analysis area were evaluated qualitatively using simulated hydrologic data. In the Arkansas River Basin, two separate simulation methods were used for evaluating the effects of the alternatives (Table 106): the Indicators of Hydrologic Alteration (IHA) and the Instream Flow Incremental Methodology (IFIM). The IHA method summarizes changes in hydrology using parameters relevant to habitat conditions for fish and invertebrates. The IFIM method simulates a relationship between fish habitat availability and streamflow. The IHA and IFIM methods are described below. These methods were used, along with professional judgment, to evaluate how hydrologic characteristics of the alternatives may affect fish and benthic invertebrate communities. These two methods were simulated independently (i.e., the hydrology and results from IHA were not used as input for the IFIM simulation). The simulations were based on separate hydrology from the Daily Model as described below.

Indicators of Hydrologic Alteration (IHA)

Evaluation of output from the IHA method (Richter et al. 1996, 1997; The Nature Conservancy 2006) was the primary tool used for assessing potential hydrology-based effects on aquatic resources in all streams and reservoirs in the Arkansas River Basin analysis area (Table 106). The IHA method was applied to simulated daily streamflow data over the period of record for the stream segments in the analysis area and daily reservoir volume for the reservoirs (Section 3.5). The period of record for the hydrology was 23 years, from 1982 through 2004. Simulated water surface elevation data were

Table 105. Fish and Benthic Invertebrate Parameters Used as Indicators to Characterize Existing Conditions and Evaluate Effects.

Water Body Type	Fish Community Parameters	Benthic Invertebrate Community Parameters
Coldwater Streams	Number of self-sustaining and stocked species Biomass of self-sustaining and stocked species	Number of species Density
Warmwater Streams	Number of self-sustaining and stocked species Abundance of self-sustaining and stocked species	Number of species Abundance
Reservoirs	Number of self-sustaining and stocked species Abundance of self-sustaining and stocked species	Qualitative effects

Table 106. Summary of Analysis Categories and Methods in Water Bodies of the Analysis Area.

Water Body	Category	IHA Used?	IFIM Used?
Western Slope			
Streams	Coldwater Streams	No (qualitative)	No (qualitative)
Homestake Reservoir	Reservoir	No (qualitative)	No (qualitative)
Lake Fork Creek			
Downstream of Turquoise Lake	Coldwater Stream	Yes	No
Lake Creek			
Downstream of Twin Lakes	Coldwater Stream	Yes	No
Upper Arkansas River			
Segment 1 Lake Fork Creek to Granite	Coldwater Stream	Yes	Yes
Segment 2 Granite to Buena Vista	Coldwater Stream	Yes	Yes
Segment 3 Buena Vista through Browns Canyon	Coldwater Stream	Yes	Yes
Segment 4 Browns Canyon to Coaldale	Coldwater Stream	Yes	Yes
Segment 5 Coaldale to Texas Creek	Coldwater Stream	Yes	Yes
Segment 6 Texas Creek to Canon City	Coldwater Stream	Yes	Yes
Segment 7 Canon City to Pueblo Reservoir	Coldwater Stream	Yes	No
Lower Arkansas River			
Segment 1 Pueblo Reservoir to Wildhorse Creek	Coldwater Stream	Yes	Yes
Segment 2 Wildhorse Creek to Fountain Creek	Warmwater Stream	Yes	No
Segment 3 Fountain Creek to Colorado Canal	Warmwater Stream	Yes	No
Segment 4 Colorado Canal to John Martin Reservoir	Warmwater Stream	Yes	No
Monument Creek			
Garden of the Gods Road to Fountain Creek	Warmwater Stream	Yes	No
Fountain Creek			
Segment 1 Monument Creek to Academy Boulevard	Warmwater Stream	Yes	Yes
Segment 2 Academy Boulevard to Security	Warmwater Stream	Yes	Yes
Segment 3 Security to County Line	Warmwater Stream	Yes	Yes
Segment 4 County Line to Arkansas River	Warmwater Stream	Yes	Yes
Jimmy Camp Creek			
Segment 1 Proposed Reservoir Site to Fountain	Warmwater Stream	Yes	No
Segment 2 Fountain to Fountain Creek	Warmwater Stream	Yes	No
Williams Creek			
Segment 1 Proposed Upper Williams Creek Reservoir to Hanover Road	Warmwater Stream	Yes	No
Segment 2 Hanover Road to Fountain Creek	Warmwater Stream	Yes	No
Arkansas River Basin Reservoirs			
Turquoise Lake	Reservoir	Yes	No
Twin Lakes	Reservoir	Yes	No
Pueblo Reservoir	Reservoir	Yes	No
Lake Henry	Reservoir	Yes	No
Lake Meredith	Reservoir	Yes	No
Holbrook Reservoir	Reservoir	Yes	No
Proposed Reservoirs			
Jimmy Camp Creek Reservoir	Reservoir	Yes	No
Upper Williams Creek Reservoir	Reservoir	Yes	No
Williams Creek Reservoir	Reservoir	Yes	No

also reviewed using IHA for reservoirs within the analysis area.

The IHA software package developed by The Nature Conservancy calculates 67 parameters for hydrologic data. The effects analysis focused on the key parameters most likely to influence fish and benthic invertebrate communities in the analysis area (Table 107). In general, the key parameters emphasize aspects of the flow regime that have the most potential to limit habitat availability or quality for fish and invertebrates. In streams, these parameters describe high and low flow events. During high flows, water velocity makes habitat less suitable for fish and invertebrates; they have to expend more energy to hold their position, and risk being dislodged downstream and out of preferred habitat locations. During low flows, shallow depths and water receding away from portions of the channel may result in less habitat and lower quality habitat. Decreasing the magnitude of low flows (making them more severe) or increasing the magnitude of high flows (more extreme) may have adverse effects on aquatic resources. Increasing low flows or decreasing high flows may have beneficial effects. In reservoirs, higher volume typically provides better habitat for aquatic resources. In both reservoirs and streams, parameters that summarize the timing and fluctuations in flow and storage volume were also evaluated. Fluctuations result in less stable habitat conditions. Decreasing fluctuations would represent a beneficial effect. In addition to the key parameters listed in Table 107, other parameters were suggested by CDOW for specific water bodies in the analysis area. These other IHA parameters also were evaluated in the effects analysis.

The IHA parameters are explained in detail by The Nature Conservancy (2006). The Group 1 parameters (Table 107) are the median flow or reservoir volume for the specified months. The Group 2 parameters are the minimum and maximum flows over the specified periods. The 1-day minimum is the lowest daily flow of the year. The 7-day, 30-day, and 90-day minimums are the median flows for these durations during the low flow period of the year. The maximum flow parameters describe these statistics for the high flow portions of the year. The Group 3 parameters are the date of the highest and lowest daily flows of the year. The Group 4 parameters describe low flow periods (pulses) that are lower than the 85th percentile flow and high flow pulses greater than the 15th percentile. The number of reversals in parameter Group 5 is the number of times in a year that the trend in flow (or reservoir storage volume) changes. A change from rising flows to falling flows is a reversal. The number of zero-flow days is an important IHA parameter; however, the IHA output for almost all streams indicated no zero days. This parameter was evaluated for the few segments of stream where there were zero-flow days: in the lower Arkansas River between Wildhorse and Fountain creeks and in Jimmy Camp and Williams creeks.

Instream Flow Incremental Methodology (IFIM)

IFIM (Bovee 1982) was used for many of the stream segments in the analysis area (Table 107). The output of the Physical Habitat Simulation Model (PHABSIM) of IFIM used in this analysis is habitat versus flow relationships for different species of fish. This relationship provides the habitat availability, expressed as square feet of Weighted Usable Area (WUA) per 1,000 feet of stream (ft^2/1000 ft.) available over a range of flows. Combining this relationship with simulated streamflow data, the fish habitat availability for the alternatives was evaluated.

Table 107. List of Key IHA Parameters for Effects Analysis in Arkansas River Basin Coldwater Streams, Warmwater Streams, and Reservoirs.

Parameter/Group	Coldwater Streams	Warmwater Streams	Reservoirs
Parameter Group 1 (cfs or ac-ft)			
January flow/volume†	X	X	--
February flow/volume	X	X	--
March flow/volume	X	X	--
June flow/volume	X	X	--
July flow/volume	--	X	--
August flow/volume	--	X	--
Parameter Group 2 (cfs or ac-ft)			
1-day minimum flow/volume	X	X	X
7-day minimum flow/volume	X	X	X
30-day minimum flow/volume	X	X	--
90-day minimum flow/volume	--	--	X
1-day maximum flow/volume	X	X	X
7-day maximum flow/volume	X	X	X
30-day minimum flow/volume	X	X	--
90-day maximum flow/volume	--	X	X
Parameter Group 3 (date)			
Date of minimum	--	X	X
Date of maximum	--	X	X
Parameter Group 4 (count)			
Low pulse count	X	X	X
Low pulse duration	--	--	X
High pulse count	X	X	X
High pulse duration	--	--	X
Parameter Group 5 (count)			
Number of reversals	X	X	X

† Flow/Volume denotes flow (cfs) in streams, storage volume (ac-ft) in reservoirs.

IFIM simulates and represents habitat for specific segments of stream. To provide fish community information compatible with effects analysis with IFIM, the fish data were organized according to the appropriate IFIM segments. Previous IFIM work by CDOW divided the upper Arkansas River upstream of Pueblo Reservoir into seven separate IFIM segments, six of which had appropriate IFIM relationships available (Table 106). In the Arkansas River downstream of Pueblo Reservoir, four segments were defined, with IFIM data available only for the coldwater segment (Lower Arkansas River Segment 1) from Pueblo Dam downstream to Wildhorse Creek. In the upper Arkansas River, brown trout are the resident species and rainbow trout are stocked by CDOW. In the coldwater section downstream of Pueblo Dam, neither brown nor rainbow trout maintain self-sustaining populations; both species are stocked by CDOW. In all coldwater sections of the Arkansas River, habitat was simulated for several life stages of brown and rainbow trout, the two more important species managed for recreational fishing (Table 108).

Table 108. Summary of IFIM Habitat Simulation in the Streams in the Analysis Area.

Stream Segment	Species Simulated	Life Stages Simulated	Basis for Selection
Upper Arkansas River			
Segment 1 Segment 2 Segment 3	Brown and Rainbow Trout	Brown trout Adult Juvenile Fry Spawning	Brown trout are the dominant, self-sustaining, resident species with all life stages present
Segment 4 Segment 5 Segment 6		Rainbow trout Adult Juvenile	Rainbow trout are stocked as juveniles or adults, and are not self-sustaining; the spawning and fry life stages are rare or absent
Lower Arkansas River			
Segment 1	Brown and Rainbow Trout	Brown trout Adult Juvenile Rainbow trout Adult	Brown and rainbow trout are recreationally important species stocked as juveniles and/or adults, and are not self-sustaining; other life stages are rare or absent
Fountain Creek			
Segment 1 Segment 2	Red Shiner (Segments 3 and 4 only) , Sand Shiner, Flathead chub, and White Sucker	Red and Sand Shiner Adult	These life stages are the ones with IFIM habitat relationships available for these native, self-sustaining, resident species
Segment 3 Segment 4		Flathead chub and White Sucker Adult Fry Spawning	

Fountain Creek between Colorado Springs and Pueblo was divided into four segments (Table 106). Habitat for sand shiner, flathead chub, and white sucker was simulated in all four segments and habitat for red shiner was simulated in Segments 3 and 4 (Table 108). These four species are native to Fountain Creek and generally represent habitat requirements for much of the fish community in Fountain Creek.

Habitat availability was simulated for three separate types of years: typical (median), wet, and dry years using daily streamflow as the time step. These three year types were developed from hydrology over the 23-year period of record (1982 through 2004). Fish populations are generally influenced by extremes in flow and habitat conditions that can act as a bottleneck to limit population size. The focus of the effects analysis was to determine the minimum habitat levels for each life stage for each species in each year type (typical, wet, or dry).

3.10.3.4 Effects Analysis

Using the simulated hydrology for Existing Conditions and the alternatives as described in MWH (2007c, 2008d), differences in hydrology were evaluated with IHA (Arkansas River Basin) or qualitatively (Western Slope). Differences in habitat availability for fish were evaluated with IFIM. Daily hydrology for typical (median) years also was plotted for all streams and reservoirs in the analysis area as a qualitative evaluation technique to further assess the biological significance of the differences in hydrology between the alternatives.

For the purposes of evaluating effects relative to Existing Conditions, simulated streamflow and reservoir storage volume for the No Action Alternative were compared to simulated Existing Conditions hydrology. This comparison evaluated the changes in hydrology and habitat for fish and invertebrates that would occur for the No Action Alternative. For the purposes of evaluating effects among alternatives, simulated streamflow and reservoir storage volume for the Action Alternatives were compared to results for the No Action Alternative. Discussions of differences between Action Alternatives and Existing Conditions were added where relevant to further characterize the magnitude of effects in a few cases.

This analysis also incorporated information from other resource areas. The suitability of a stream to support aquatic resources is also influenced by habitat availability and water quality. Water quality, flooding, geomorphology, and riparian vegetation have an influence on habitat availability. Therefore, the results of water quality (Section 3.7), flood hydrology (Section 3.8), channel geomorphology (Section 3.9), and riparian vegetation (Section 3.11) analyses also were incorporated into the evaluation of effects on aquatic resources using professional judgment of the effects on the suitability of the water body to support fish and invertebrates.

3.10.3.5 Interpretation of Effects

Effects could be negligible, beneficial, or adverse. In coldwater streams, warmwater streams, and reservoirs, a negligible effect would be no detectable differences between alternatives in the number and abundance of fish and invertebrate species. A negligible effect would indicate that fish and invertebrate populations would continue to fluctuate within the normal historical range and any changes, either beneficial or adverse, would be too small to detect or measure using conventional sampling and evaluation techniques. Western Slope effects were determined qualitatively based on simulated hydrology. For the Arkansas River Basin, a negligible effect determination resulted when all IHA and IFIM parameters had differences of less than 10 percent. Differences in key IHA or IFIM parameters of less than 10 percent would be unlikely to result in adverse or beneficial effects on aquatic biota due to the natural variability in the hydrological and biological data, which would tend to result in differences less than 10 percent being undetectable. A negligible effect also resulted when one to several of the IHA or IFIM parameters had differences of 10 percent or more but were judged to have no detectable effect on fish and invertebrate populations. This was the case when the differences represented a combination of a small number of both favorable and unfavorable effects with no consistent trend.

The changes in IHA and IFIM output were evaluated independently. Changes in IHA parameters of 10 percent or greater may or may not result in changes in IFIM parameters of 10 percent. Likewise, small changes in hydrology of less than 10 percent could still result in changes in IFIM parameters of more than 10 percent in some ranges of the habitat relationships where habitat is very sensitive to changes in flow.

Beneficial and adverse effects could vary in intensity from minor to moderate or major (Table 109). The intensity of effects was evaluated on a case-by-case basis for each stream segment and reservoir in the analysis area, given the IHA and IFIM output and the status of the existing environment.

A minor effect, either beneficial or adverse, would be very small and would likely be detectable only through repeated sampling of fish or invertebrates with an alternative in place. However, to predict and compare potential future effects of an alternative before it is in place, model results and the methods described herein were used. A minor effect resulted when there were differences in one to several IHA parameters that were greater than 10 percent or cases with a trend of several IHA and IFIM parameters with differences greater than 10 percent that were judged to have an effect on fish or invertebrate populations. In coldwater streams, the dominant species of fish—brown trout—would persist and the invertebrate species composition would continue to be diverse. The differences in the biomass of trout or the abundance of invertebrates between alternatives would be less than 25 percent. The variability in biomass and abundance would shift to a slightly higher overlapping range, exceeding historical peaks and lows (beneficial effect) or shift to a slightly lower overlapping range, not meeting historical peaks and lows (adverse effect). The differences would be apparent only by continued sampling over a number of years. In warmwater streams, species composition would still include a few abundant species and many less common species. In reservoirs, a minor beneficial or adverse effect would result in the gain/loss of one or two of the self-sustaining species of fish; the reservoir would still be suitable for sustaining stocked species. Abundance of fish and invertebrates would be within 25 percent of historical data.

A moderate effect resulted from cases with differences in several IHA parameters and IFIM parameters that were substantially greater than 10 percent. The differences included several parameters indicating a consistent trend toward beneficial or adverse effects. In coldwater streams, brown trout would continue to be the dominant fish species. Differences in fish biomass or invertebrate abundance would be 25 to 50 percent compared to the historical range of data. In warmwater streams, a moderate beneficial or adverse effect would result in the gain/loss of several species of fish or invertebrates. Differences in fish or invertebrate abundance would be 25 to 50 percent. In reservoirs, a moderate beneficial or adverse effect would result in the gain/loss of several self-sustaining species of fish and one or two stocked species. Differences in the abundance of fish or invertebrates would be 25 to 50 percent.

Table 109. Summary of Effect Intensity on Fish and Invertebrates.

Water Body Type	Indicator	Adverse Effects			Beneficial Effects		
		Major	Moderate	Minor	Minor	Moderate	Major
Coldwater Streams	Number of fish and invertebrate species	≥- 2 fish > - many invertebrates	≥- 2 fish - several invertebrates	- 0-1 fish - few invertebrates	+ 0-1 fish + few invertebrates	≥+ 2 fish + several invertebrates	≥+ 2 fish >+ many invertebrates
	Biomass of fish and density of invertebrates	>- 50% fish >- 50% invertebrates Variation over a substantially smaller range than historical data	- 25-50% fish - 25-50% invertebrates Variation over a substantially smaller range than historical data	- up to 25% fish - up to 25 invertebrates Variation over a slightly smaller range than historical data	+ up to 25% fish + up to 25% invertebrates Variation over a slightly larger range than historical data	+ 25-50% fish + 25-50% invertebrates Variation over a substantially larger range than historical data	>+ 50% fish >+ 50% invertebrates Variation over a substantially larger range than historical data
Warmwater Streams	Number of fish and invertebrate species	≥- many fish > - many invertebrates	- several fish - several invertebrates	- few fish - few invertebrates	+ few fish + few invertebrates	+ several fish + several invertebrates	≥+ many fish >+ many invertebrates
	Biomass of fish and density of invertebrates	>- 50% fish >- 50% invertebrates Variation over a substantially smaller range than historical data	- 25-50% fish - 25-50% invertebrates Variation over a substantially smaller range than historical data	- up to 25% fish - up to 25 invertebrates Variation over a slightly smaller range than historical data	+ up to 25% fish + up to 25% invertebrates Variation over a slightly larger range than historical data	+ 25-50% fish + 25-50% invertebrates Variation over a substantially larger range than historical data	>+ 50% fish >+ 50% invertebrates Variation over a substantially larger range than historical data
Reservoirs	Number of fish species	≥- many fish	- several fish	- 1-2 fish	+ 1-2 fish	+ several fish	≥+ many fish
	Biomass of fish and abundance of invertebrates	>- 50% fish >- 50% invertebrates Variation over a substantially smaller range than historical data	- 25-50% fish - 25-50% invertebrates Variation over a substantially smaller range than historical data	- up to 25% fish - up to 25 invertebrates Variation over a slightly smaller range than historical data	+ up to 25% fish + up to 25% invertebrates Variation over a slightly larger range than historical data	+ 25-50% fish + 25-50% invertebrates Variation over a substantially larger range than historical data	>+ 50% fish >+ 50% invertebrates Variation over a substantially larger range than historical data

Major effects resulted from fundamentally different streamflow and reservoir storage patterns between alternatives, for example, the creation of a reservoir or when there were multiple IHA parameters and IFIM parameters with differences between alternatives of 100 percent or more and a consistent trend toward beneficial or adverse effects. A major beneficial effect would represent substantial improvements to fish or invertebrate communities. A major adverse effect would substantially compromise the functions of the aquatic community. In coldwater streams, a major beneficial effect would result in two or more fish species and many more invertebrate species becoming part of the community. Differences in long-term fish biomass and invertebrate abundance would be 50 percent or more than the historical data. A major adverse effect in coldwater streams would result in the elimination of most fish species, except for the dominant brown trout. The number of invertebrate species would be reduced by 50 percent. Differences in long-term trout biomass and invertebrate abundance would be 50 percent or more. In warmwater streams, a major beneficial effect would mean that many more fish and invertebrate species would be part of the community. Abundance of fish and invertebrates would increase by 50 percent or more. A major adverse effect in warmwater streams would result in the loss of 50 percent or more of the fish or invertebrate species, with 50 percent lower abundance. A major beneficial effect in reservoirs would result in the reservoir being suitable to support many more species of self-sustaining and stocked fish. Differences in abundance of fish and invertebrates would be 50 percent or more. A major adverse effect in reservoirs would result in the loss of 50 percent or more of the species and abundance of fish and invertebrates.

Limitations

A direct link between IHA output and populations of fish and invertebrates has not been demonstrated in the literature. However, IHA is a collection of hydrologic output that summarizes a broad range of statistics that have been widely used in predicting effects on fish and invertebrate populations. The generalized relationships between IHA parameters and aquatic organisms reflect the state of the art in fish biology in Colorado. Such relationships are used in flow management plans and other activities that focus on high and low flows for fisheries protection and enhancement.

The use of IFIM assumes that the size of fish populations in streams is directly related to habitat availability as simulated by IFIM. A basic criticism of IFIM is that this direct relationship has been demonstrated only rarely. There are also two factors to consider with the specific use of IFIM in the analysis. The first is that the habitat relationships developed by the CDOW for the upper Arkansas River simulated habitat in some segments at flows up to 1,300 to 1,400 cfs while the hydrologic data indicate that peak daily flows reach over 2,000 cfs in some segments. To simulate habitat availability at the higher flows, the CDOW habitat relationships were extrapolated; however, because high flow periods usually represent low habitat availability and may represent the minimum habitat availability in a year, effects conclusions are based on extrapolated information in these cases. The second factor is that data collection for IFIM in Fountain Creek was complicated by the unstable nature of the stream. IFIM data collection and habitat simulation is most reliable for stream channels that are stable over a wide range of flows. Although modeling adequately represents the major habitat features in Fountain Creek, the shifting sand substrate and unstable banks were a limitation on the overall quality of the data collection and IFIM simulations for Fountain Creek.

The IFIM data analysis focused on minimum habitat availability, while the IHA parameters evaluated a much broader range of statistics. With IFIM, the minimum habitat availability is usually a function of the 1-day maximum or 1-day minimum flow in a year. The IHA method summarizes many other aspects of the hydrology. The IHA and IFIM methods occasionally led to conflicting results concerning fish habitat and the effects of differences in hydrology. These inconsistencies were evaluated using professional judgment in the cases where they occurred. Procedures for evaluating IHA and IFIM data together have not been previously developed, and there is no consensus on the relative importance of IHA versus IFIM data. Also, specific responses of fish and invertebrate populations to each of the IHA and IFIM parameters have not been developed in general, and not for this analysis area in particular. However, the general anticipated responses of the communities, either beneficial or adverse, to these variables have been described by GEI (2008a).

3.10.4 Affected Environment

The present status of the aquatic biological communities in the analysis area is a result of historical and current activities and differs from the natural ecosystem that existed prior to settlement. Activities that have influenced the aquatic ecosystem have caused changes in hydrology, water quality, and channel morphology. Also, some fish populations are managed for recreational fishing. These activities resulted in changes in species composition, species distribution, and habitat from pre-settlement conditions. This section focuses on Existing Conditions and does not attempt to document changes from pre-settlement conditions.

Western Slope

The streams in the Western Slope analysis area include Homestake Creek, French Creek, Missouri Creek, Sopris Creek, Fancy Creek, East Fork Homestake Creek, Roaring Fork River, Lost Man Creek, Lincoln Creek, Tabor Creek, Brooklyn Creek, New York Creek, and Ivanhoe Creek. Homestake Reservoir is also in the Western Slope analysis area. These streams are small to medium sized high-gradient streams. The streams and reservoir contain coldwater aquatic communities of fish and invertebrates (Table 110).

Upper Arkansas River Basin, Upstream of Cañon City

Lake Fork Creek, Lake Creek, and the upper Arkansas River upstream of Cañon City contain a coldwater fishery with brown trout as the most abundant species. Rainbow trout, a much smaller proportion of the fishery, are stocked by CDOW. Brook trout, cutthroat trout, cutthroat-rainbow (cutbow) hybrids, longnose sucker, white sucker, and longnose dace are also present in low numbers in this portion of the analysis area (CEC 2006).

Brown trout biomass (pounds of fish per acre, lbs/ac) varies considerably between sites and between years. However, brown trout biomass is typically 80 to 110 lbs/ac in this portion of the analysis area. Biomass for the other species is typically less than 5 lbs/ac.

Benthic invertebrate communities in the Lake Fork Creek and Upper Arkansas River are abundant and diverse. The communities are characterized by a wide variety of insects and other invertebrates including stoneflies, mayflies, caddisflies, and midges. Many of

Table 110. Summary of Existing Conditions for Fish and Benthic Invertebrates in the Analysis Area.

Water Body	Fish	Benthic Invertebrates
Western Slope Streams and Reservoir	Coldwater fish communities	Coldwater invertebrate communities
Arkansas River Basin Upstream of Cañon City	Brown trout fishery, some stocked rainbow trout, low numbers of other trout species, suckers, and longnose dace	Abundant and diverse assemblage of species including a high proportion of sensitive species
Arkansas River Cañon City to Pueblo Reservoir	Transition zone fishery includes brown trout and other coldwater species as well as suckers, longnose dace, and other minnow species including the flathead chub (SC)	Abundant and diverse assemblage of species, including a moderate proportion of sensitive species
Arkansas River Pueblo Reservoir to Wildhorse Creek	Transition zone fishery, including coldwater and warmwater species including flathead chub (SC) and fish that move downstream from Pueblo Reservoir. Stocked brown and rainbow trout are the basis of the recreational fishery	Abundant and diverse assemblage of species including a moderate proportion of sensitive species
Arkansas River Wildhorse Creek to John Martin Reservoir	Warmwater fishery with numerous species including suckers, minnows and sunfishes, including suckermouth minnow (SE), Arkansas darter (ST) and flathead chub (SC)	Abundance and diversity less than in upstream segments, lower proportion of sensitive species
Monument Creek and Fountain Creek	Warmwater fishery with numerous species including suckers, minnows and a few sunfishes, including Arkansas darter (ST) and flathead chub (SC)	Low abundance and diversity, few sensitive species, mostly tolerant species
Jimmy Camp Creek and Williams Creek	Fish community mostly confined to downstream sections near the mouth. Fish include numerous species including suckers, minnows, sunfishes, and a few Arkansas darters (ST)	Abundant and diverse assemblage in downstream sections with few sensitive species
Turquoise Lake and Twin Lakes	Coldwater fishery for stocked lake trout and rainbow trout, suckers also common	Typical invertebrates for reservoirs in this area
Pueblo Reservoir	Two-tiered fishery, with stocked rainbow trout and numerous species of warmwater fish. Forage base is gizzard shad	Typical invertebrates for reservoirs in this area
Lake Henry, Lake Meredith, and Holbrook Reservoir	Warmwater fisheries for numerous species, especially stocked catfish, saugeye and wipers	Typical invertebrates for reservoirs in this area

Species status: SE-Colorado State Endangered, ST: Colorado State Threatened, SC-Colorado State Species of Special Concern.

these are sensitive species intolerant of degraded water or habitat quality (CEC 2006).

Sampling of benthic invertebrates typically results in the collection of 35 to 45 species at a site. About 15 to 25 of these species are sensitive stonefly, mayfly, and caddisfly species. The proportion of sensitive species of the communities is moderate, indicating that water quality and habitat conditions are suitable to support sensitive, intolerant species.

Arkansas River, Cañon City to Pueblo Reservoir

The upper Arkansas River downstream of Cañon City to the inlet of Pueblo Reservoir is classified as a coldwater segment but is a transitional segment of stream between coldwater and warmwater aquatic communities. A brown trout fishery is located in the section of the river near Cañon City with more of a warmwater fishery toward Pueblo Reservoir. Fish include coldwater species such as brown trout; species with wide temperature tolerances such as longnose dace and white sucker; and warmwater species such as black bullhead, green sunfish, and numerous minnows. Flathead chub, a state species of special concern, is also present in this segment. Eleven species have been collected in this segment of the Arkansas River since 1979 (CEC 2006).

This river segment also contains species of fish that migrate upstream from Pueblo Reservoir, typically during spawning seasons. This includes rainbow trout in early spring, walleye in mid-spring, wipers later in spring, and channel catfish in late spring and summer.

No information prior to 2003 on the benthic invertebrate community in this river segment exists. Supplemental data collected in 2003 and 2004 demonstrated the presence of an abundant and diverse community (CEC 2006). The samples contained between 26 and 42 species, with nine to 16 of these species being sensitive stonefly, mayfly, and caddisfly species. The low to moderate tolerance composition of the community indicates a mix of tolerant and intolerant species, indicating that water quality and habitat in this segment of the river are sufficient to support numerous species, including sensitive species.

Arkansas River, Pueblo Reservoir to Wildhorse Creek

The segment of the Arkansas River from Pueblo Reservoir to Wildhorse Creek contains a wide variety of fish species ranging from stocked coldwater species (i.e., brown and rainbow trout) to native warmwater species. This segment also includes fish that escape from Pueblo Reservoir and move downstream. Studies from 1979 through 2004 collected 23 species and three varieties of hybrid fish (cutbow, saugeye, and wiper) (CEC 2006). Eighteen different species and hybrids of fish were collected in 2004 during supplemental sampling. The 2004 sampling indicated that white sucker was the most common species and that central stoneroller and longnose sucker also were common. Flathead chub, a state species of special concern, was also collected.

CDOW stocks this segment of the river every year with brown trout, rainbow trout, and occasionally cutthroat trout or cutbow hybrids. These fish are the basis for recreational fishing in this segment.

The benthic invertebrate community is abundant and diverse. Supplemental data collection in 2003 and 2004 found 26 to 36 different species in the samples, with five to 10 sensitive stonefly, mayfly, and caddisfly species (CEC 2006). The tolerance composition was moderate indicating that the benthic invertebrate community in this segment of the Arkansas River is impaired to some degree by water quality and/or habitat. Since these samples were collected, this segment of the Arkansas River has undergone habitat improvements. Observations of the channel after these habitat alterations indicated no fundamental change in the habitat that would alter the species composition of the invertebrate community or this analysis of effects (D. Conklin, GEI Consultants, Inc., personal communication).

Arkansas River, Downstream of Wildhorse Creek to John Martin Reservoir Inlet

The segment of the Arkansas River downstream of Wildhorse Creek contains a warmwater fish community. Since 1979, 27 fish species have been collected including 24 species in 2005 alone (CEC 2006). The community includes a mix of minnows, suckers, and sunfishes. Red shiner and sand shiner, two native species, are most abundant. Several other native species, fathead minnow, flathead chub (a Colorado species of special concern), and plains killifish also are abundant. Sampling in 2005 found 19 Arkansas darters, a Colorado state threatened species, and 12 suckermouth minnows, a Colorado state endangered species (CEC 2006).

Supplemental benthic invertebrate data collection in 2003 and 2004 indicated the community has moderate abundance and diversity. Between 19 and 41 species were collected in the samples, but typically only four to eight of these species were sensitive mayflies and caddisflies. Midges (a type of small fly) are the most abundant species at almost all sites in this segment of the river. Asiatic clams, an invasive mollusk, were also present. The moderate to high tolerance composition indicates a higher proportion of tolerant invertebrates, which indicates some habitat and/or water quality impairment of the community (CEC 2006).

Monument and Fountain Creeks

Monument and Fountain creeks contain warmwater fish communities. Most of the species present are in the minnow family (Cyprinidae). Longnose dace and flathead chub (a state species of special concern) are common throughout these two streams. Sand shiner, red shiner, and plains killifish are also common in sections of Fountain Creek near Pueblo (CEC 2006).

The number of species increases in a downstream direction in these streams. Seven species have been collected in Monument Creek, increasing to 15 species in Fountain Creek near Pueblo. A few Arkansas darters were collected in Fountain Creek in Pueblo County between 1994 and 2004. This state threatened species is more common in small tributary streams, but is occasionally found in Fountain Creek and the Arkansas River.

Benthic invertebrate samples from Monument and Fountain creeks exhibit a wide range in community parameters among the various sites and years sampled. There are trends toward higher abundance and more species in samples collected since 1998 compared to previous samples. Overall, the benthic invertebrate communities in these two streams typically contain from 25 to 30 species, of which only four to six are sensitive mayfly and caddisfly species. Diversity is low to moderate and there are more tolerant species than sensitive species. The data indicate that the communities are impaired by water quality and/or habitat (CEC 2006).

Jimmy Camp and Williams Creeks

Both Jimmy Camp Creek and Williams Creek are dry along much of their length. Both streams have short sections of flowing water in downstream sections just above their confluences with Fountain Creek. Both streams include about a dozen fish species, mostly minnows, in these lower reaches. Brook stickleback, green sunfish, mosquito-fish, and white sucker also have been collected from each stream (CEC 2006). The state threatened Arkansas darter was collected on at least two occasions in both streams. The small stream habitat of Jimmy Camp and Williams creeks provides suitable habitat for this species.

In 2004, fish were sampled or observed in several isolated pools in Williams Creek near the proposed Williams Creek Reservoir site (GEI 2008a). Some of these isolated pools contained green sunfish. During sampling, another species—probably fathead minnow—was observed in these pools.

Supplemental benthic invertebrate sampling in 2003 and 2004 resulted in the collection of abundant and diverse invertebrates from the lower sections of both streams (CEC 2006). The species composition is more typical of pond habitat, with species of dragonflies, damselflies, beetles, and crustaceans more common than stoneflies, mayflies, and caddisflies. During this sampling, the communities of both streams contained more tolerant than sensitive species, which indicates impairment due to degraded water quality or low flow.

Turquoise Lake and Twin Lakes

CDOW manages Tuquoise Lake and Twin Lakes reservoirs as coldwater fisheries, mainly for lake trout and rainbow trout. Lake trout populations are maintained primarily by stocking, with some natural reproduction. Rainbow trout are maintained by stocking. Since 1999, CDOW also has stocked brown trout, cutthroat trout, and cutbow hybrids into one or both of these reservoirs.

CDOW sampling data indicate that longnose and white suckers are the two most common species in both reservoirs. Both of these species maintain populations through natural reproduction. Although no recent data were available, the invertebrate communities of these two reservoirs probably contain midges and worms (Oligochaeta) typical of reservoirs.

Pueblo Reservoir

Pueblo Reservoir contains a mix of many different species of fish. The two-tiered fishery contains rainbow trout as the coldwater species and numerous warmwater species. Since 1999, CDOW has collected 17 fish species and three hybrids. Most of these species are game fish, providing opportunities for recreational fishing. Gizzard shad is the predominant forage fish species.

CDOW annually stocks the reservoir with a variety of game fish species and hybrids. Channel catfish, largemouth bass, rainbow trout, walleye, and wiper were stocked each year between 1999 and 2004. No data were available on the benthic invertebrate community of Pueblo Reservoir. The community probably consists of midges and worms typical of reservoirs. Zebra and quagga mussels, invasive mollusk species, were recently found in the reservoir (USGS 2008b).

Lake Henry, Lake Meredith, and Holbrook Reservoir

Lake Henry, Lake Meredith, and Holbrook Reservoir have warmwater fisheries that are limited by water level fluctuations. All three reservoirs have had very low water levels during one or more years since 2001 (a drought period), which has disrupted the normal management of the fisheries.

All three reservoirs contain numerous species of warmwater game fish as well as gizzard shad as the main forage base. The reservoirs are stocked by CDOW with numerous species of warmwater game fish. Black crappie, blue catfish, channel catfish, saugeye, and wiper have been stocked into one or more of these reservoirs. No data were available on the benthic invertebrate community of these three reservoirs. The communities probably consist of midges and worms typical of reservoirs.

3.10.5 Environmental Consequences

The direct and cumulative effects hydrology, as well as the differences in water quality, flooding, channel geomorphology, and riparian vegetation with the alternatives would result in different patterns of beneficial and adverse effects on aquatic resources in the analysis area (Figure 87) (GEI 2008a, 2008b).

3.10.5.1 Direct and Indirect Effects

Western Slope

All alternatives would divert more water from the Western Slope streams in May, June, July, and August (Section 3.5). In most streams, the changes in streamflow would be 1 or 2 cfs or less and would have a negligible effect on habitat for aquatic organisms or stream geomorphology. These high-gradient streams would continue to flush sediment from the substrate so that it does not accumulate. In Ivanhoe Creek, the No Action Alternative would have a minor beneficial effect compared to Existing Conditions with lower peak flows. All Action Alternatives except for the Highway 115 Alternative would have minor adverse effects compared to the No Action Alternative. The Highway 115 Alternative would have a negligible effect. In the Roaring Fork River, the No Action Alternative would have a minor beneficial effect and all Action Alternatives would have a negligible effect on aquatic organisms.

In Homestake Reservoir, the No Action Alternative would store an average of 17 percent less water than Existing Conditions with a resulting drawdown of the water level of 22 feet. This would provide a smaller volume of water for fish and invertebrates and a moderate adverse effect. All Action Alternatives except for the Highway 115 Alternative would have similar storage to the No Action Alternative and negligible effects. The Highway 115 Alternative would store more water and have a minor beneficial effect compared to the No Action Alternative.

Lake Fork Creek

For much of the year in this segment of stream, the hydrology in Lake Fork Creek in all alternatives would meet the operational minimum streamflow targets set by Reclamation of 4 cfs in winter and 15 cfs in summer. The No Action Alternative would have lower 1-day and 7-day maximum streamflows and fewer high pulses and reversals (fluctuations) than Existing Conditions. Lower maximum streamflows would tend to provide more favorable habitat availability for fish and invertebrates. The No Action Alternative would have a minor beneficial effect on fish and invertebrates in Lake Fork Creek. The Action Alternatives would have monthly hydrology similar to the No Action Alternative, but there would be differences in maximum streamflows and fluctuations. The Participants' Proposed Action, Downstream Intake, and Highway 115 alternatives would have higher maximum streamflows and more fluctuations than the No Action Alternative, which would tend to provide less favorable habitat availability for both fish and invertebrates. These alternatives would have minor adverse effects compared to the No Action Alternative. The Wetland, Arkansas River, and Fountain Creek alternatives would have lower maximum streamflows, greater habitat availability, and minor beneficial effects compared to the No Action Alternative.

Lake Creek

The No Action Alternative would have up to 373 percent higher streamflows in winter and would improve winter habitat conditions for fish and invertebrates compared to Existing Conditions. However, the No Action Alternative would also have declining streamflows from fall through early winter, which could dry some brown trout eggs deposited at higher fall streamflows. This would limit the beneficial effects of higher winter streamflows. The No Action Alternative would have a minor beneficial effect compared to Existing Conditions in Lake Creek. All Action Alternatives except the Highway 115 Alternative would have streamflows in February and March up to 80 percent lower than for the No Action Alternative. The lower streamflows would provide less favorable winter habitat conditions for fish and invertebrates than the No Action Alternative. These five alternatives also would have much lower streamflows in September and October. Except for the Highway 115 Alternative, the Action Alternatives would have moderate adverse effects compared to the No Action Alternative. The Highway 115 Alternative would have winter streamflows up to 143 percent higher than the No Action Alternative, which would provide greater habitat availability and would have a moderate beneficial effect. All Action Alternatives would have stable or increasing streamflows through the fall spawning period and winter egg incubation period for brown trout. These alternatives would avoid dewatering brown trout redds and eggs.

Arkansas River, Upstream of Cañon City

In Segment 1 of the upper Arkansas River, the No Action Alternative and the Action Alternatives would have similar hydrology to Existing Conditions and would have negligible effects on fish and invertebrates.

Streamflows for all Action Alternatives in Segment 2 of the upper Arkansas River would be similar. The No Action Alternative would have slightly lower winter streamflows than Existing Conditions in this segment. The Action Alternatives would have 10 to 68 percent higher 1-day and 7-day minimum streamflows than the No Action Alternative. Simulated trout habitat also would be similar for all Action Alternatives. The No Action Alternative would have up to 27 percent lower habitat availability for adult and juvenile brown and rainbow trout in typical and dry years compared to Existing Conditions. The Action Alternatives would have more favorable habitat in typical, wet, and dry years compared to the No Action Alternative. The No Action Alternative would have a moderate adverse effect compared to Existing Conditions in Segment 2. Higher short-term minimum streamflows for the Action Alternatives would have negligible to minor beneficial effects on fish and invertebrates compared to the No Action Alternative.

In Segments 3, 4, 5, and 6 of the upper Arkansas River, the No Action Alternative would have lower 1-day and 7-day maximum streamflows and greater habitat availability for brown and rainbow trout in wet years, resulting in minor beneficial effects compared to Existing Conditions. The Action Alternatives would have similar hydrology and similar habitat availability in typical years in Segments 3, 4, 5, and 6. These alternatives would have slightly higher short-term maximum streamflows and slightly lower habitat availability for brown and rainbow trout in wet years. All Action Alternatives would have negligible or minor adverse effects compared to the No Action Alternative in these four segments of the river.

Arkansas River, Cañon City to Pueblo Reservoir

In the upper Arkansas River from near Cañon City to the inlet of Pueblo Reservoir (Segment 7), the No Action Alternative would have up to 16 percent lower 1-day, 7-day, and 30-day minimum streamflows and more fluctuations than Existing Conditions. This would result in less favorable habitat in winter for fish and invertebrates and a minor adverse effect compared to Existing Conditions. The Wetland and Arkansas River alternatives would include the Highway 115 Return Flow Pipeline. This would result in higher streamflow throughout the year, higher nutrient concentrations, and moderated (less fluctuating) temperatures compared to the No Action Alternative. The higher winter streamflows would provide more favorable winter habitat conditions. These two alternatives would have a moderate beneficial effect compared to the No Action Alternative. The four remaining Action Alternatives would have streamflows and habitat similar to the No Action Alternative and would result in effects ranging from minor beneficial to minor adverse.

Arkansas River, Pueblo Reservoir to Wildhorse Creek

In Segment 1, the coldwater section of the lower Arkansas River, the No Action Alternative would have similar streamflows and habitat availability and a negligible effect compared to Existing Conditions. The Participants' Proposed Action, Wetland, Arkansas River, Fountain Creek, and Downstream Intake alternatives would have effects ranging from minor beneficial to minor adverse in this segment compared to the No Action Alternative. The Participants' Proposed Action, Wetland, and Fountain Creek alternatives would have slightly more frequent daily fluctuations in streamflow compared to the No Action Alternative. This effect would be caused by dam release adjustments to meet the "Equitable Allocation of Operational Hours" provision of the PFMP (described in Section 3.2.6.1). These fluctuations were taken into account for determining effects on aquatic resources. The Highway 115 Alternative would have up to 25 percent lower streamflows in winter, lower short-term minimum streamflows, higher maximum streamflows, and 19 to 24 percent lower habitat availability for adult brown trout in typical and dry years. All of these differences would be unfavorable to fish and invertebrates and would result in a moderate adverse effect compared to the No Action Alternative.

Arkansas River, Wildhorse Creek to Fountain Creek

Simulated concentrations of dissolved selenium in Segment 2 of the Arkansas River (between Wildhorse Creek and Fountain Creek) would be substantially higher than Existing Conditions for all alternatives except the Arkansas River Alternative (Section 3.7.5.1). WQS for selenium in this reach of the river are currently exceeded with Existing Conditions and would be exceeded with all alternatives except the Arkansas River Alternative. However, a recent study (EPA 2008b) reflects the current research on selenium toxicity and focuses on the concentration of selenium in fish tissue as the mechanism for toxic effects, not on the concentration in the water. Fish tissue concentrations of selenium are directly related to selenium in the diet and can be affected by a variety of site-specific factors (refer to CDPHE 2008c).

The existing fish and invertebrate communities in this reach of the Arkansas River are present in spite of exceedences of WQS probably because they are able to tolerate exposure to relatively high selenium concentrations or because site-specific conditions are not conducive to transfer the high concentrations in the water through the food web. Regardless, the fish and invertebrate communities in this reach are probably more closely related to hydrologic factors, such as low flows, than selenium concentrations. The simulated increases in dissolved selenium concentrations for most alternatives would likely have a negligible to minor effect on aquatic resources in this reach of the Arkansas River.

In the short section of the lower Arkansas River between Wildhorse and Fountain creeks (Segment 2 of the lower Arkansas River), the No Action Alternative would have lower streamflows in many months compared to Existing Conditions. The No Action Alternative would have lower short-term minimum streamflows with no zero-flow days in most years but a maximum of 30 zero-flow days in some years. Currently, there are no zero-flow days in most years, but up to 25 zero-flow days in some years with Existing Conditions. During periods of zero flow in this segment, there would probably be enough water in some of the pools to sustain some fish and invertebrates for several days. A few zero-flow days probably would reduce fish and invertebrate abundance to very low levels, but would not eliminate them. However, zero-flow days for longer periods would eliminate all or almost all fish and invertebrates. After long periods of no flow, the fish and invertebrate communities may need several years to recover. The No Action Alternative would have more stressful low streamflow conditions and would result in a moderate adverse effect compared to Existing Conditions.

The Participants' Proposed Action would have lower winter streamflows compared to the No Action Alternative with a median of one zero-streamflow day and up to 28 zero-flow days in some years. This alternative would have a minor adverse effect compared to the No Action Alternative.

The Wetland Alternative would have winter streamflows and short-term minimum streamflows that would be more favorable to fish and invertebrates, including no zero-flow days in most years. This alternative would have a minor beneficial effect compared to the No Action Alternative.

The Arkansas River Alternative would have up to 69 percent higher winter streamflows, no zero-flow days, and a substantially higher 1-day minimum streamflow than the No Action Alternative. The higher and more consistent streamflows through winter indicate that this alternative would have a moderate beneficial effect compared to the No Action Alternative.

The Fountain Creek Alternative would have a median of one and up to 30 zero-flow days and lower winter streamflows compared to the No Action Alternative. The Fountain Creek Alternative would have a minor adverse effect compared to the No Action Alternative.

The Downstream Intake Alternative would have more stressful streamflows with 28 percent lower streamflows in January and 11 to 16 percent higher peak flows compared to the No Action Alternative. This alternative would have a minor adverse effect compared to the No Action Alternative.

The Highway 115 Alternative would have a median of two and up to 40 zero-flow days and lower winter streamflows than the No Action Alternative. These differences would make the winter period more stressful for fish and invertebrates. The Highway 115 Alternative would have a moderate adverse effect compared to the No Action Alternative.

Arkansas River, Fountain Creek to John Martin Reservoir Inlet

Downstream of Fountain Creek in Segments 3 and 4 of the lower Arkansas River, the No Action Alternative would have streamflows similar to Existing Conditions and would have a negligible effect compared to Existing Conditions. There would be few differences in hydrology among the Action Alternatives. Habitat and streamflow conditions would be similar to the No Action Alternative. All Action Alternatives would have negligible or minor adverse effects in Segment 3 and negligible effects in Segment 4 compared to the No Action Alternative.

Monument Creek

In Monument Creek, the No Action Alternative would result in a moderate beneficial effect compared to Existing Conditions due to higher streamflows for much of the year. The Action Alternatives would have slightly higher maximum streamflows and more fluctuations and would have minor adverse effects compared to the No Action Alternative.

Fountain Creek

In Fountain Creek, the alternatives would result in different hydrology and complex patterns of effects on aquatic species among the alternatives. The No Action Alternative would have higher streamflows throughout the year compared to Existing Conditions in Fountain Creek from the confluence with Monument Creek downstream to Academy Boulevard (Segment 1). More water in winter months and more favorable minimum streamflow statistics can be beneficial to some species of fish, but in this case, the higher flows would result in up to 70 percent less habitat availability for sand shiner and some life stages of flathead chub in typical and dry years and less favorable conditions for invertebrates. However, the greater depths with the higher streamflows would result in up to 185 percent more habitat availability for adult flathead chub and up to 43 percent more habitat availability for the larger-bodied white sucker adults. This combination of factors includes several favorable and unfavorable differences between the No Action Alternative and Existing Conditions. The higher streamflows and decreases in habitat for sand shiner, some life stages of flathead chub, and invertebrates would result in a moderate adverse effect for the No Action Alternative compared to Existing Conditions. Some of the larger-bodied species of fish may benefit from the greater depths with the higher streamflows, but this would not compensate for the adverse effects on other species.

The Participants' Proposed Action, Fountain Creek, Downstream Intake, and Highway 115 alternatives would have hydrology and habitat availability similar to the No Action Alternative in Fountain Creek Segment 1, resulting in negligible effects.

Due to diversions to the Highway 115 Return Flow Pipeline, the Wetland and Arkansas River alternatives would result in substantially lower streamflows in Segment 1 of Fountain Creek compared to the No Action Alternative. Reductions in 1-day, 7-day, and 30-day minimum streamflows compared to the No Action Alternative would range up to 83 percent. Habitat availability for the smaller-bodied sand shiner would be up to 37 percent higher because of the lower velocity preferred by this species; however, this would not compensate for habitat availability for adult flathead chub, adult white sucker, and invertebrates, which would be much lower with lower streamflows. The Wetland and Arkansas River alternatives would have moderate adverse effects relative to the No Action Alternative in Segment 1 of Fountain Creek.

In Segment 2 of Fountain Creek, from Academy Boulevard downstream to Security, the No Action Alternative would result in higher streamflows throughout the year than Existing Conditions. Similar to the scenario for Segment 1, the higher streamflows would have a moderate adverse effect in Segment 2 with less habitat availability for white suckers, some life stages of flathead chub, and invertebrates for the No Action Alternative compared to Existing Conditions. The Participants' Proposed Action, Fountain Creek, Downstream Intake, and Highway 115 alternatives would have hydrology similar to the No Action Alternative and negligible effects.

Diversions to the Highway 115 Return Flow Pipeline would cause lower streamflows for the Wetland and Arkansas River alternatives compared to the No Action Alternative in Segment 2 of Fountain Creek. Streamflows in winter months would be more than 50 percent lower and streamflows in the summer months would be up to 49 percent lower for the Wetland and Arkansas River alternatives. The lower streamflows would result in greater habitat availability for sand shiner and most life stages of flathead chub and white sucker in typical dry, and/or wet years. However, habitat for adult flathead chub would be 57 percent lower in typical years and 65 percent lower in wet years. The Wetland and Arkansas River alternatives would have minor adverse effects compared to the No Action Alternative.

In Fountain Creek between Security and the El Paso/Pueblo County line (Segment 3), the No Action Alternative would have higher streamflows throughout the year and less habitat availability for fish and invertebrates compared to Existing Conditions. The No Action Alternative would have a minor adverse effect compared to Existing Conditions.

Hydrology for all alternatives would be very different in Segment 3, reflecting the different operations of the alternatives. The Participants' Proposed Action would have similar habitat availability and streamflows in much of the year, but slightly lower winter streamflows compared to the No Action Alternative resulting in a minor adverse effect. The Wetland, Arkansas River, and Fountain Creek alternatives would have moderate adverse effects due to lower streamflows much of the year and up to 34 percent less habitat availability for adult white sucker compared to the No Action Alternative. The Downstream Intake and Highway 115 alternatives would have higher streamflows much of the year and up to 116 percent higher 1-day, 7-day, and 30-day minimum streamflows compared to the No Action Alternative. There would be similar habitat for red and sand shiners, but greater habitat availability for adult flathead chub and white sucker in some years. These two alternatives would have minor beneficial effects compared to the No Action Alternative.

In Segment 4 of Fountain Creek from the El Paso/Pueblo County line downstream to the confluence with the Arkansas River, the No Action Alternative would have higher streamflows compared to Existing Conditions. Flows in winter and summer months, and the 1-day, 7-day, and 30-day minimum streamflows would be from 36 to 102 percent higher. The higher streamflows and resulting higher water velocities would reduce habitat availability for shiners, flathead chub, and the smaller life stages of white sucker, and other small-bodied fishes and invertebrates. The No Action Alternative would have a moderate adverse effect compared to Existing Conditions.

The Participants' Proposed Action would have lower minimum streamflows, higher maximum streamflows, more fluctuations, and lower fish habitat availability for most species in Segment 4 compared to the No Action Alternative although habitat availability for adult flathead chub would be higher in typical and dry years. These differences would be unfavorable to most fish and invertebrates resulting in a minor adverse effect compared to the No Action Alternative.

The Wetland, Arkansas River, Fountain Creek, and Downstream Intake alternatives would have lower streamflows in Segment 4 and greater habitat availability for the smaller-bodied fishes in this segment of the river resulting in minor beneficial effects compared to the No Action Alternative. The Highway 115 Alternative would have a different pattern of streamflows with an unusual low flow period in February, a very high streamflow pulse in March, and up to 42 percent less habitat for shiners and adult flathead chub in typical, and dry year types. This alternative would have a moderate adverse effect on fish and invertebrates compared to the No Action Alternative.

Jimmy Camp and Williams Creeks

All alternatives would increase the amount of water flowing in Jimmy Camp Creek over Existing Conditions due to return flows from development and landscape irrigation. This minor growth-related effect (i.e., cumulative effect) is reflected in the direct effects hydrology (refer to Section 3.5.3). Segment 1 of the stream is now dry much of the time and Segment 2 has low flows. However, the non-sewered return flows from developed areas may not be suitable for all aquatic species and may limit to some extent the establishment of aquatic life. The increased streamflows would represent moderate beneficial effects on fish and invertebrates for the No Action Alternative compared to Existing Conditions. This includes the portion of lower Jimmy Camp Creek that now supports Arkansas darters, which may be able to expand their range upstream in Jimmy Camp Creek. The Action Alternatives would have hydrology similar to the No Action Alternative and negligible effects.

There was public concern that the increased perennial surface flow in Jimmy Camp Creek could increase the occurrence of mosquitoes and the incidence of West Nile Virus near the Colorado Centre development. A site visit to the area in early September 2008 found two species of mosquitoes that carry West Nile Virus, *Culex tarsalis* and *Aedes vexans* (GEI 2008b). This represents two of the three Colorado species that carry the virus. During the visit there was habitat that contained mosquito larvae in and near the channel of Jimmy Camp Creek. Suitable habitat that could contain water and mosquito larvae after rains (but was dry at the time of the visit), such as storm drainage ditches, discarded tires in the channel of Jimmy Camp Creek, and depression in the floodplain of the stream, were observed in many locations in the area. Therefore, the area of Jimmy Camp Creek near the Colorado Centre development evidently contains the habitat and mosquitoes of species that carry West Nile Virus. The perennial flows in Jimmy Camp Creek resulting from all alternatives would not provide suitable habitat for mosquitoes as they do not live in flowing water. The flowing water would eliminate the standing water pools that currently exist in the channel and inundate the discarded tires in the channel, which would render these habitats unsuitable for mosquito larvae, which could be beneficial. However, the perennial flows would have no effect on the off-channel areas that now serve as habitat for mosquitoes. Therefore, all alternatives would likely have a negligible effect on the incidence of mosquitoes and the West Nile Virus in the area of the Colorado Centre development.

In Williams Creek, all alternatives except the Wetland and Arkansas River Alternatives would include Williams Creek Reservoir, which would reduce peak flood flows and reduce storm peaks downstream in Williams Creek. The Wetland Alternative would include the Upper Williams Creek Reservoir which would also reduce peak flood flows, although not as much as the other alternatives. The Arkansas River Alternative would have no reservoir on Williams Creek and would not reduce flooding. The reduced peak flows with most alternatives would tend to be favorable to aquatic organisms in lower Williams Creek. No alternative would convey return flows down Williams Creek. All alternatives would include a return flow pipeline to Fountain Creek or the Arkansas River.

In Williams Creek between the Upper Williams Creek Reservoir and Williams Creek Reservoir sites, the hydrology would not change substantially, and all alternatives would have negligible effects. The No Action Alternative would include the Williams Creek Reservoir, which would inundate a limited community of fish and invertebrates at the reservoir site. This would have a minor adverse effect compared to Existing Conditions. All other alternatives except for the Wetland and Arkansas River alternatives also would include Williams Creek Reservoir and would have a negligible effect compared to the No Action Alternative. The Wetland and Arkansas River alternatives would not include the reservoir and would not inundate the community at the reservoir site. These two alternatives would represent a minor beneficial effect at the reservoir site compared to the No Action Alternative.

In Segment 2 of lower Williams Creek, the No Action Alternative would have reduced peak flood flows and a minor beneficial effect on the aquatic community near the mouth of Williams Creek. This community includes Arkansas darters, which could benefit from the reduced peak flows. All Action Alternatives except for the Arkansas River Alternative also would reduce peak flows and have a negligible effect compared to the No Action Alternative. The Arkansas River Alternative would have no reservoir on Williams Creek, would not reduce peak flows, and would have a minor adverse effect compared to the No Action Alternative.

Turquoise Lake and Twin Lakes

In Turquoise Lake and Twin Lakes, there would be only minimal differences in storage volume for Existing Conditions and the alternatives. For all alternatives, the effects would be negligible in Turquoise Lake. However, for Twin Lakes, the No Action Alternative would have a minor adverse effect with larger drawdowns than Existing Conditions. The Action Alternatives would have negligible or minor beneficial effects on Twin Lakes.

Pueblo Reservoir

In Pueblo Reservoir, the alternatives would result in a range of effects on aquatic resources. The No Action Alternative would have lower storage volume and lower water levels, especially in spring, and a minor adverse effect compared to Existing Conditions. The Participants' Proposed Action, Fountain Creek, and Highway 115 alternatives would have greater drawdowns and longer low pulse durations, which would be unfavorable. These three alternatives would have minor adverse effects compared to the No Action Alternative. The Wetland and Arkansas River alternatives would have greater drawdowns than the No Action Alternative and would have higher nutrients and more productivity from the return flows from the Highway 115 Return Flow Pipeline. The higher productivity may result in reduced water clarity and would not benefit the fishery. Relative to the No Action Alternative, minor adverse effects would result from these two alternatives. The Downstream Intake Alternative would have larger drawdowns, more fluctuations, and a moderate adverse effect compared to the No Action Alternative.

Lake Henry, Lake Meredith, and Holbrook Reservoir
The three plains reservoirs, Lake Henry, Lake Meredith, and Holbrook Reservoir, would have several hydrologic differences among the alternatives. The No Action Alternative would have similar hydrology to Existing Conditions and result in only minor adverse effects in all three reservoirs.

In Lake Henry, all of the Action Alternatives except the Highway 115 Alternative would store less water, especially during the spring spawning season for game fish, and have minor to moderate adverse effects compared to the No Action Alternative. The Highway 115 Alternative would have less severe drawdowns and a shorter low pulse duration and result in a minor beneficial effect compared to the No Action Alternative.

All Action Alternatives except the Highway 115 Alternative would have more severe drawdowns, 10 to 25 percent less water during the spring spawning season, and moderate adverse effects on Lake Meredith compared to the No Action Alternative. The Highway 115 Alternative would have less severe drawdowns, more water in June during spawning, and fewer fluctuations resulting in a moderate beneficial effect compared to the No Action Alternative.

The No Action Alternative would have a minor adverse effect on Holbrook Reservoir compared to Existing Conditions with less water during the spring spawning period. All Action Alternatives would have less water in Holbrook Reservoir for much of the year and would have moderate adverse effects compared to the No Action Alternative.

Proposed Reservoirs
Jimmy Camp Creek Reservoir would be the terminal storage reservoir for all alternatives except for the Participants' Proposed Action and Wetland alternatives, which would include the proposed Upper Williams Creek Reservoir. Both of these reservoirs would be suitable for recreational fishing and other activities. These two reservoirs would represent a gain of reservoir aquatic habitat where none now exists. Consequently, the No Action Alternative would represent a major beneficial effect compared to Existing Conditions. The Action Alternatives would store slightly less water in either of these new reservoirs in summer and fall, and would have minor adverse effects compared to the No Action Alternative. Nonetheless, the Action Alternatives would also create new open water habitat and cause a beneficial effect relative to Existing Conditions.

Zebra and quagga mussels are present in Pueblo Reservoir and will probably spread to the Arkansas River downstream of the reservoir (USGS 2008b). All alternatives except for the No Action and Highway 115 alternatives would have an untreated water intake from Pueblo Reservoir or the Arkansas River downstream of the reservoir. It is likely (for zebra mussels) or possible (for quagga mussels) that the larval stage (veliger) would be transported through the untreated water pipeline to the terminal storage reservoirs where these invasive species may become established with these alternatives. Asiatic clams are present in the Arkansas River downstream of Pueblo Reservoir (CEC 2006). However, the veliger stage of this species is much shorter than that of the zebra or quagga mussels. It is unlikely that Asiatic clams would be spread through the untreated water pipelines with any of the alternatives.

Williams Creek Reservoir would be constructed for all alternatives except the Wetland and Arkansas River alternatives. This new reservoir would represent a gain of reservoir aquatic habitat where none now exists. For the No Action Alternative, the reservoir would be nearly full much of the time and would provide habitat suitable for fish and invertebrates and represent a major beneficial effect. For the four remaining alternatives that include this reservoir, suitability for fish and invertebrates would be limited due to fluctuations and drawdowns to lower levels. These alternatives would result in moderate to major adverse effects compared to the No Action Alternative. Nonetheless, these four alternatives would create new open water habitat and a beneficial effect relative to Existing Conditions. With no reservoir for the Wetland and Arkansas River alternatives, these two alternatives would represent major adverse effects compared to the No Action Alternative or the absence of a beneficial effect compared to Existing Conditions.

3.10.5.2 Cumulative Effects

The reasonably foreseeable actions considered in this FEIS are described in Section 3.1.3.1. For most of the analysis area, cumulative effects would be similar to direct and indirect effects (Figure 88). Substantial differences between direct and indirect effects and cumulative effects (i.e., those resulting in different moderate or major effects) within the analysis area are summarized below.

In Segment 2 of the lower Arkansas River, the Highway 115 Alternative would have a moderate adverse direct effect but only a minor adverse cumulative effect. This alternative would have less severe differences in winter flows for cumulative effects than for direct effects when compared to the No Action Alternative.

In Pueblo Reservoir, the No Action Alternative would have a minor adverse direct effect, but a moderate adverse cumulative effect. In Lake Henry, the Downstream Intake Alternative would have a minor adverse direct effect but a moderate adverse cumulative effect with lower water levels during the spring spawning season.

3.10.5.3 Resource Commitments

There would be no irreversible commitments of aquatic resources in the stream segments or the reservoirs in the analysis area due to project construction or changes in hydrology.

Negligible or minor effects on aquatic resources would be undetectable and would not represent irretrievable commitments of resources. Moderate and major adverse effects compared to Existing Conditions would be detectable and represent irretrievable commitments of fish and invertebrate communities. There would be only a few irretrievable commitments of resources in the stream segments and reservoirs in the analysis area.

In Homestake Reservoir, the No Action Alternative would have moderate adverse direct and cumulative effects with less stored water. This would limit the available volume and area for fish and invertebrates.

In Segment 2 of the upper Arkansas River, the No Action Alternative would have moderate adverse direct and cumulative effects with lower minimum streamflows and less habitat availability for brown and rainbow trout in typical and dry years. In lower Arkansas River Segment 1, the Highway 115 Alternative would have lower winter streamflows, higher peak flows, and less habitat availability for adult brown trout and would have moderate adverse direct and cumulative effects. These effects would result in reductions in the number and abundance of fish and invertebrate species of more than 25 percent.

In lower Arkansas River Segment 2, the No Action and Highway 115 alternatives would have moderate adverse direct and cumulative effects with lower winter streamflows and more zero-flow days than Existing Conditions. This would reduce the number and abundance of fish and invertebrates by more than 25 percent.

In Segment 1 of Fountain Creek, the No Action, Wetland, and Arkansas River alternatives would have much different streamflows than Existing Conditions. These three alternatives would have moderate direct and cumulative effects with less habitat availability for white sucker and benthic invertebrates. In Segment 4 of Fountain Creek, the No Action, Participants' Proposed Action, and Highway 115 alternatives would have moderate adverse direct effects with higher streamflows and lower habitat availability for shiners. The Wetland and Highway 115 alternatives also would have moderate adverse cumulative effects. The adverse effects would reduce the number and abundance of fish and invertebrate species by more than 25 percent.

In Lake Henry, all Action Alternatives except for the Downstream Intake and Highway 115 alternatives would have lower storage volume in the fall through spring compared to the No Action Alternative and Existing Conditions. These four alternatives would have moderate adverse direct effects and major adverse cumulative effects compared to the No Action Alternative. All Action Alternatives except the Highway 115 Alternative would have moderate adverse effects in Lake Meredith. All Action Alternatives would store much less water in Holbrook Reservoir throughout the year than Existing Conditions. These six alternatives would have moderate adverse direct and cumulative effects compared to the No Action Alternative. These alternatives would reduce the suitability of Lake Henry and Holbrook Reservoir to support fish and invertebrates.

The inundation of sections of ephemeral streams at the proposed reservoir sites in Jimmy Camp and Williams creeks would be irretrievable commitments. Inundation would change the character of the water body from ephemeral stream habitat to reservoir habitat.

3.10.5.4 Mitigation

Proposed Measures

The following mitigation measures would be implemented for all alternatives:

- Submit a proposed wildlife mitigation plan to the Colorado Wildlife Commission pursuant to C.R.S. § 37-60-122.2
- In the event that operation of the SDS Project causes, or threatens to cause, streamflows in Fountain Creek or the Arkansas River to diminish to low levels that could contribute significantly to impairment of aquatic life, coordinate with Reclamation, CDPHE, CDOW and other interested parties to evaluate and select measures to mitigate adverse effects
- Mitigation measures for dissolved selenium in Section 3.7.5.4 should avoid adverse effects on aquatic life from construction and operation of the proposed SDS Project
- Evaluate and consider participation in CDOW fish hatchery programs
- Monitor the effects of the operation of the SDS Project upon aquatic life in Fountain Creek and the Arkansas River between Pueblo Dam and the Las

Animas Gage. Aquatic sampling will be conducted once per year at up to 10 locations. Monitoring methods and locations will be identified in the proposed wildlife mitigation plan. Use the information from this monitoring in the adaptive management program for the SDS Project (Appendix F)

Mitigated Effects

When implemented, these recommendations would mitigate potential adverse effects on aquatic life by avoiding or minimizing effects, compensating for anticipated effects, and detecting and responding to effects identified after project operations begin.

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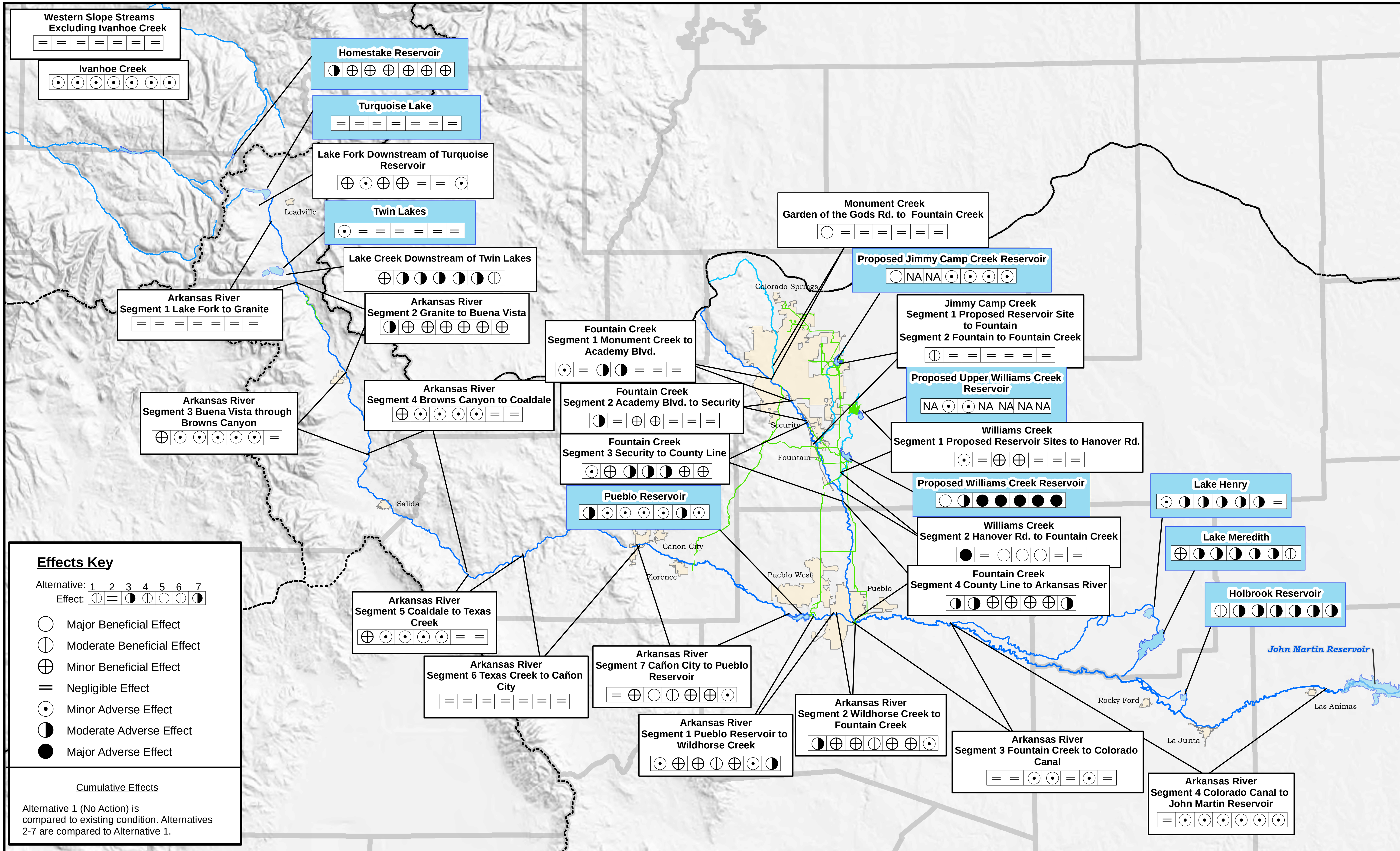

Project: Southern Delivery System
Source: MWH
Date: October 2008

Project Feature
City
Stream
Lake
Watershed Division
County
Effects on Streams
Effects on Reservoirs

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Figure 88. Summary of Aquatic Resources Cumulative Effects.

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3.11 Wetlands, Waters, and Riparian Vegetation

Wetlands, waters of the U.S. (waters), and riparian vegetation are being assessed because the SDS Project may affect these resources and because effects on wetlands were identified as a concern during scoping. Direct effects on wetlands, waters such as ponds, lakes and ditches, and riparian areas are measured in acres, and direct effects on waters that are streams are measured in linear miles of streambed. Indirect and cumulative effects on wetlands and riparian areas are qualitatively assessed or measured in acres when possible. Riparian vegetation is the same as native and introduced mesic cover types discussed in the Vegetation Section (3.12).

3.11.1 Summary of Effects

All alternatives would affect wetlands, waters, and riparian resources. The No Action Alternative would have 25.6 acres of direct effects on wetlands, the greatest effect on wetlands of the alternatives. The Participants' Proposed Action would directly affect 16.3 acres of wetlands, 9.3 acres less than the No Action Alternative. Direct wetland effects would be similar for the Fountain Creek Alternative (21.8 acres), Downstream Intake Alternative (21.5 acres), and Highway 115 Alternative (21.1 acres) – about 4 acres less than the No Action Alternative. The Wetland Alternative would have the fewest direct effects on wetlands with 7.0 acres (18.6 acres less than the No Action Alternative), followed by the Arkansas River Alternative with 11.3 acres (14.3 acres less than the No Action Alternative).

The jurisdictional status of wetlands (either subject to Corps jurisdiction or isolated) was preliminarily determined. The No Action, Arkansas River, Fountain Creek, Downstream Intake, and Highway 115 alternatives would have between 6 and 8 acres of permanent effects on potentially jurisdictional wetlands. The Participants' Proposed Action would permanently affect 1.4 acres of potentially jurisdictional wetlands, about 5.7 acres less than the No Action Alternative, while the Wetland Alternative would permanently affect 0.6 acre of potentially jurisdictional wetlands, 6.5 acres less than the No Action Alternative.

Category I wetlands are the highest quality wetlands; Category IV wetlands are the lowest (Berglund 1999). The No Action Alternative would affect 0.5 acre of Category I wetlands; none of the Action Alternatives would affect Category I wetlands. Most of the effects would be on Category III wetlands and would range from 2.7 acres for the Wetland Alternative to 22 acres for the No Action Alternative.

Temporary, short-term wetland effects, such as at pipeline crossings, would require on-site restoration of wetlands that provide similar functions and values. Permanent wetland effects would require on-site or off-site compensatory mitigation. The Downstream Intake Alternative would have about 19.7 acres of permanent wetland effects, the highest of the alternatives, followed by the Fountain Creek Alternative with 19.5 acres and the No Action and Highway 115 alternatives, both with 19.1 acres of permanent direct wetland effects. The Participants' Proposed Action would have fewer permanent wetland effects with 13.4 acres. The Arkansas River Alternative would have 6.8 acres of permanent wetland effects, and the Wetland Alternative would have the fewest permanent wetland effects with 1.4 acres.

Direct effects on waters (streambed length) would vary considerably among alternatives. The greatest effect on streambed length, 12 miles for the No Action and the Highway 115 alternatives, would be 5 miles more than the Wetland Alternative, the alternative with the fewest effects on streambed length. The Fountain Creek Alternative would affect 11 miles of streambed followed by the Downstream Intake Alternative with 10 miles, and the Participants' Proposed Action and Arkansas River alternatives, both with 9 miles of effect on streambed length.

The Fountain Creek Alternative would have the greatest total direct effect on the three riparian vegetation types (grassland, shrubland, and woodland) with 272 acres. The Downstream Intake Alternative would have 268 acres of effects on riparian vegetation, similar to the 266 acres for the No Action Alternative. The Highway 115 Alternative would have 256 acres of riparian vegetation effects, followed by the Participants' Proposed Action with 229 acres, the Arkansas River Alternative with 118 acres, and the Wetland Alternative with 94 acres of riparian vegetation effects. The alternatives would have similar effects on riparian woodland, ranging from between 22 and 28 acres in the No Action, Participants' Proposed Action, Wetland, Fountain Creek, Downstream Intake, and Highway 115 alternatives to 16 acres in the Arkansas River Alternative.

The greatest indirect effect on wetland and riparian vegetation would occur on Fountain Creek under the No Action Alternative because of Security and Fountain's ground water pumping adjacent to Fountain Creek under this alternative. The combined ground water pumping may result in major indirect effects on riparian vegetation, including high quality cottonwood woodlands. Indirect effects of the other alternatives would be negligible to minor in all stream reaches. Cumulative effects would be similar for all the alternatives.

Although diversions from Western Slope streams, including the Homestake Creek and its tributaries, the Fryingpan River and its tributaries, and the Roaring Fork River and its tributaries, would reduce streamflow, the effects on wetland and riparian vegetation associated with these streams would be negligible. Effects on ground water, peak flows, floodplains, and geomorphology would be negligible for Western Slope streams. There may be some increase in willow-dominated riparian vegetation from reduced streamflow as vegetation encroaches into the channel, a beneficial effect for all alternatives. Because of the lack of wetland and riparian vegetation at Homestake Reservoir, the effects from the increased diversions would be negligible. Similarly, effects on wetland and riparian vegetation at Pueblo Reservoir, Lake Henry, Lake Meredith, and Holbrook Reservoir would be negligible for all alternatives.

3.11.2 Regulatory Framework

The Clean Water Act (CWA) was passed in 1972 to protect the physical, biological, and chemical quality of waters of the U.S. (rivers, streams, ponds, lakes, and wetlands). The Corps' Regulatory Program administers and enforces Section 404 of the CWA, which regulates the discharge of dredged or fill material into waters of the U.S., including wetlands. Under Section 404, a Corps permit is required for the discharge of dredged or fill material into wetlands and other waters subject to Corps jurisdiction. Waters of the U.S. are defined broadly in Corps regulations to include a wide variety of waters and wetlands. The Corps defines "wetlands" as those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas (33 CFR 328.3 (b)). Compensatory wetland mitigation for unavoidable, adverse impacts that remain after all appropriate and practicable avoidance and minimization has been achieved would be required for this project. The Corps determines a water to be subject to its jurisdiction if the water body is a traditionally navigable water, if the water body is relatively permanent, if the water body is a wetland that directly abuts a traditionally navigable or relatively permanent water body, or if a water body, in combination with all wetlands adjacent to that water body, has a significant nexus with traditionally navigable waters (Corps and EPA 2007).

Projects subject to permitting by the Corps under the CWA also must comply with the 404(b)(1) Guidelines for discharge of dredged and fill material into wetlands and waters of the U.S. (40 CFR 230). It is anticipated that one or more SDS Project facilities would need a 404 permit from the Corps. Application for a 404 permit for any SDS Project alternative would be an independent process from Reclamation's NEPA compliance. The Participants will continue to work closely with the Albuquerque District, Regulatory Division, of the Corps, to address Clean Water Act requirements, including compliance with the 404(b)(1) Guidelines for the Project. The 404(b)(1) Guidelines require an assessment of the potential short-term or long-term effects of a proposed discharge on a number of physical, chemical and biological components of the aquatic environment. Only the least environmentally damaging, practicable alternative can be permitted under the 404(b)(1) guidelines (40 CFR 230.10 (a)). Additional discussion of the Guidelines is found in Section 1.3.2. The Corps will discuss compliance with the Guidelines in its decision on a 404 permit application.

Federal agencies have responsibilities to avoid, minimize, and mitigate unavoidable impacts on wetlands under EO 11990. EO 11990 requires federal agencies to "consider factors relevant to a proposal's effect on the survival and quality of the wetlands." EO 11990 requires that adverse effects on wetlands and other waters of the U.S. be avoided where possible in implementing federal actions.

3.11.3 Analysis Area and Methods

3.11.3.1 Analysis Area

Existing wetlands, waters, and riparian vegetation were mapped and described for the study area (ERO 2007f, 2008d). The analysis area was used to assess direct effects. To assess indirect and cumulative effects on riparian vegetation, the analysis area included the following stream reaches:

- Fountain Creek from the confluence with Monument Creek to the confluence with the Arkansas River
- Jimmy Camp Creek from the proposed reservoir site downstream to the confluence with Fountain Creek
- Williams Creek from the proposed Upper Williams Creek Reservoir site downstream to the confluence with Fountain Creek
- Arkansas River from Lake Fork Creek downstream to the Las Animas Gage, including Pueblo Reservoir
- Lake Fork Creek below the Sugar Loaf dam
- Lake Creek below Twin Lake Reservoir to the Arkansas River

- Western Slope streams discussed in the Surface Water Hydrology (Section 3.5): Homestake Creek and its tributaries, the Fryingpan River and its tributaries, and the Roaring Fork River and its tributaries
- Lake Henry, Lake Meredith, Holbrook Reservoir, and Homestake Reservoir

3.11.3.2 Methods

Effects on wetland and riparian vegetation are summarized by alternative. Effects on wetlands were classified into threshold categories using professional judgement. The lower limits are based on acreage thresholds of the Corps' permitting program and of which the upper limits are based on the amount of wetland impacts the Corps has previously permitted regionally. Permanent effects were classified into the following effects threshold categories:

- Negligible – wetlands and riparian vegetation would not be directly affected, or less than 0.5 acre would be permanently affected
- Minor – between 0.5 acre and 5 acres of wetland or riparian vegetation would be permanently affected
- Moderate – between 5 acres and 20 acres of wetland or riparian vegetation would be permanently affected
- Major – greater than 20 acres of wetland or riparian vegetation would be permanently affected

It was assumed that all temporary wetland effects would be negligible because the effects would be short-term and wetland functions and values would not be permanently lost. Indirect and cumulative effects on wetlands and riparian vegetation are described qualitatively.

Direct Effects

Wetland and Other Waters

Wetlands were delineated in all areas potentially directly impacted by the alternatives between December 2003 to September 2008 following methods outlined in the Corps of Engineer's Wetland Delineation Manual (Corps 1987). The boundaries of delineated wetlands and waters were mapped using a Global Positioning System (GPS) unit or drawn onto aerial photography. Final boundaries were incorporated onto aerial photography using Geographic Information System (GIS) software. Wetlands were mapped by aerial photography interpretation in limited areas that were inaccessible. Boundaries of wetlands and waters were converted to ArcGIS files and then intersected with analysis area shapefiles (CH2M HILL 2007h). To determine effects, GIS analyses were conducted using ESRI's ArcGIS 9.2 software. Wetlands and other waters identified in the study area are described in detail in the Wetlands, Waters, and Riparian Resources Technical Report (ERO 2007f) and Wetland and Riparian Resources Administrative Record Documentation (ERO 2008d).

Wetland functions and values were evaluated using the Montana Wetland Assessment Method (Montana Method) (Berglund 1999). The Montana Method uses a classification system that combines the Service's classification system (Cowardin et al. 1979) with a hydrogeomorphic (HGM) approach (Brinson 1993). HGM classes are riverine (associated with a stream channel, floodplain, or terrace), lacustrine fringe (topographic depression with permanent water >6.6 feet deep), depressional (topographic depression without permanent water >6.6 feet deep), and slope (located on a topographic slope with ground water as primary water source). The Cowardin palustrine system includes all nontidal wetlands dominated by trees, shrubs, and persistent emergents. Emergents are erect, rooted, herbaceous flowering plants that may be temporarily to permanently flooded. The two Cowardin wetland classes found in the study area are emergent and scrub-shrub. The scrub-shrub class has woody plants less than 20 feet tall.

Each wetland in the study area was assessed for functions and values based on its HGM and Cowardin classification, abundance, and disturbance. The Montana Method provides a rating of low, moderate, high, exceptional, or not applicable based on observations and responses to questions on each of the below functions and values. The following functions and values were assessed for each wetland:

- Federally listed and proposed threatened and endangered species habitat
- Colorado Natural Heritage Program species habitat
- General wildlife habitat
- General fish and aquatic habitat
- Flood attenuation
- Short- and long-term surface water storage
- Sediments/nutrient/toxicant removal
- Sediment and/or shoreline stabilization
- Food chain support and/or production export
- Ground water discharge and recharge
- Uniqueness
- Recreation and education potential

For each evaluated wetland, the Montana Method scores each function or value on a scale of 0.1 (lowest) to 1.0 (highest) functional points with a maximum number of 12 when totaled for all functions and values. Once the total functional points for each wetland were calculated, each wetland was assigned to one of four categories described in the Montana Method, with Category I being the highest quality wetlands and Category IV being the lowest quality wetlands. The Montana Method is described in the Wetlands, Waters, and Riparian Resources Technical Report (ERO 2007f).

Riparian Vegetation

Riparian vegetation forms the transition zones between terrestrial and aquatic ecosystems and relies on water supplied by the aquatic ecosystem. CDOW uses the following definition of riparian areas: "riparian areas are those plant communities adjacent to and affected by surface or ground water of perennial or ephemeral water bodies such as rivers, streams, lakes, ponds, playas, or drainage ways. These areas have distinctly different vegetation than adjacent areas or have species similar to surrounding areas that exhibit a more vigorous or robust growth form" (CDOW 2006a).

Site visits to map riparian vegetation within the study area were conducted. Vegetation communities were mapped based on dominant growth type (woodlands, shrublands, or grasslands) (ERO 2007e, 2008d). When associated with a stream or water source, these communities compose riparian vegetation. Vegetation communities not associated with a water body or surface flow were excluded from consideration as riparian vegetation for this EIS but are described in the Vegetation Resources Technical Report (ERO 2007e, 2008d) and Section 3.11.

Indirect and Cumulative Effects

Wetland and Riparian Mapping

Riparian mapping from the CDOW riparian mapping project (CDOW 2006a) was used for streams within the indirect effects analysis area. The CDOW data include general riparian vegetation types such as riparian shrub and riparian herbaceous, and also provide more specific types including cottonwood and willow, and some wetland types. CDOW's vegetation classification scheme provides dominant and subdominant riparian communities; however, to facilitate mapping, dominant vegetation types were primarily used for the assessment (ERO 2007d). While the CDOW riparian mapping is inclusive of wetlands subject to Corps jurisdiction, jurisdictional wetlands are not delineated or mapped separately from riparian vegetation. Although ERO (2007f, 2008d) mapped wetland and riparian vegetation in portions of the study area, the entire analysis area for riparian vegetation effects was not mapped. Consequently, the CDOW data provide a consistent data set for the analysis of riparian vegetation effects, and the ERO (2007f, 2008d) data were not used.

Analysis Method

Potential effects in the Western Slope analysis area were evaluated qualitatively using simulated hydrologic data. For the Arkansas River Basin, the IHA Method (described in Section 3.10) was used to determine stream reaches where hydrologic conditions would be substantially different as the result of one or more alternative. Key IHA parameters for Existing Conditions and each alternative were determined using the software program developed for computing IHA parameters. The key IHA parameters are median values of stream stage for April through September, 1-day, 3-day, 7-day, 30-day, and 90-day minimum stream stage and the 1-day, 3-day, 7-day, 30-day, and 90-day maximum stream stage. These parameters were selected as key IHA parameters because they provide information on soil moisture available to plants and potential anaerobic or drought stress on plants. Other parameters were excluded from the analysis because it was assumed that changes for short periods, reflected by pulse data, would not have a strong influence on existing riparian vegetation. Changes in peak flows are presented in the Water Resources Effects Analysis (MWH 2008j).

IHA input data were generated for existing stream gages or at selected locations using the Daily Model (MWH 2007d). IHA analysis provides the direction and magnitude of hydrologic change, which was used to qualitatively assess potential changes in riparian vegetation based on the types of communities present. Stream reaches were determined based primarily on the location of stream gages.

Stream reaches where riparian vegetation is likely supported by hydrologic input other than streamflow, such as ground water movement from upland areas or irrigated fields (MWH 2007b), were not included in the analysis (except for reaches with ground water pumping under one or more alternative). If the IHA analysis indicated substantial hydrologic changes in these locations, it was assumed riparian vegetation would not be affected in these reaches. Changes in key hydrologic indicators of 10 percent or less were assumed to be within the normal fluctuation of hydrologic conditions. Once stream reaches in the study area were identified as having a greater than 10 percent change in key hydrologic indicators, only changes of 1 foot or greater in key hydrologic conditions were considered to be substantial enough to affect riparian vegetation.

IHA does not show potential effects on channel morphology or ground water levels. For example, if a stream is adjacent to an agricultural field, irrigation could have a stronger influence on ground water levels, and subsequently riparian vegetation, than streamflow. An overall determination of effects on riparian vegetation was based on the combined effects of the magnitude of changes in hydrologic indicators, channel morphology, and ground water levels using professional judgement (ERO 2007d, 2008d). A range of acreage of potential effects was estimated, and effects were classified into the threshold categories. The indirect and cumulative effects on riparian vegetation were determined using changes in mean ground water levels from April through September at five distances from the channel. Ground water changes were generated from ground water data used in the alluvial ground water effects analysis (MWH 2007b, 2008a) for the gages within the study reaches. Information about changes in stream channel morphology was obtained from the Water Resources Effects Analysis (2008i) and the Water Resources Administrative Record Documentation (MWH 2008j). Stream reaches with no indirect or cumulative effects on riparian vegetation are not discussed. To determine indirect effects on riparian vegetation associated with Pueblo Reservoir, Lake Henry, Lake Meredith, and Holbrook Reservoir, overall average simulated surface water areas based on hydrological modeling (Section 3.5) and the range of fluctuations throughout the growing season compared to existing conditions were evaluated.

3.11.3.3 Limitations

The area and location of wetlands and riparian communities are dynamic and can change from year-to-year and even within one season. Mapping should be viewed as the best representation of the existing conditions for the study period. The boundary of some wetlands, waters, and riparian areas that were inaccessible were mapped using aerial photography interpretation; however, the accuracy of aerial photography interpretation is adequate for the level of analysis in the EIS. CDOW riparian mapping was conducted through aerial photography interpretation over several years and may have some inaccuracies because of changing conditions and the errors inherent in aerial photography interpretation.

The establishment and longevity of wetland and riparian communities rely on many factors and simple cause-and-effect relationships are not possible to identify when determining indirect and cumulative effects. Because there may not be direct correlations between changes in stream stage, ground water levels, and geomorphic processes, most of this assessment is qualitative.

IHA data were generated for existing stream gages or at selected locations using the Daily Model (MWH 2008c, 2008d). The IHA output is statistical data and may not capture all hydrologic changes that could affect riparian vegetation.

3.11.4 Affected Environment

Based on the HGM and Cowardin classification, eight wetland types were identified in the study area: riverine palustrine emergent, riverine palustrine scrub-shrub, depressional palustrine emergent, depressional palustrine scrub-shrub, lacustrine fringe palustrine emergent, lacustrine fringe palustrine scrub-shrub, slope palustrine emergent, and slope palustrine scrub-shrub. Riverine palustrine emergent and riverine palustrine scrub-shrub wetlands are associated with all alternatives and are common along Jimmy Camp Creek, Williams Creek, Fountain Creek, the Arkansas River, and other intermittent or perennial streams. Depressional palustrine emergent and depressional palustrine scrub-shrub wetlands occur within the Colorado Springs Treated Water Pipeline alignment, the Central Untreated Water Pipeline alignment, the Williams Creek and Upper Williams Creek reservoir sites, the Highway 115 Untreated Water and Return Flow Pipeline alignments, the Highway 115 Powerline alignment, the Chilcotte Ditch Return Flow Conveyance alignment, the Juniper Pump Station Powerline alignment, the Return Flow Pump Station No. 3, and the Security Treated Water Pipeline alignment.

Lacustrine fringe palustrine emergent and lacustrine fringe palustrine scrub-shrub wetlands occur within the Chilcotte Ditch Return Flow Conveyance alignment, below the Jimmy Camp Creek Reservoir site, within the Arkansas River Downstream of Confluence Pump Station study area, and the Highway 115 Return Flow and Untreated Water Pipeline alignments. Slope palustrine emergent and slope palustrine scrub-shrub wetlands occur within the Jimmy Camp Creek Reservoir site, the Denver Basin Ground Water System, the Highway 115 Untreated Water and Return Flow Pipeline alignments, Chilcotte Ditch Return Flow Conveyance alignment, Jimmy Camp Creek Treated Water Pipeline alignment, the Central Untreated Water Pipeline alignment, the Highway 115 Powerline alignment, the Williams Creek Return Flow Pipeline alignment, the Upper Williams Creek Reservoir site, and the Ark-Otero Powerline alignment.

3.11.4.1 Functions and Values Provided by Wetlands

Wetland functions and values vary widely throughout the study area. High quality Category I wetlands are along Kettle Creek and Black Squirrel Creek in the Denver Basin Ground Water System (No Action Alternative). Category II wetlands occur at facilities adjacent to Fountain Creek and the Arkansas River such as the FVA Connector Pump Station, the Highway 115 Untreated Water Pipeline, and the Highway 115 Untreated Water Intake. Category II wetlands are found in the analysis area of all alternatives. In general, large, structurally diverse wetlands with associated riparian habitat along perennial streams such as Fountain Creek or the Arkansas River, or in relatively undisturbed areas generally rate higher for more functions and values than more disturbed wetlands in the urbanized portions of the study area along small streams or roadside ditches. Wetlands along Fountain Creek and the Arkansas River are primarily Category I or II wetlands because they provide high to exceptional habitat for wildlife and rate high for most other functions and values.

Category III and IV wetlands are found in the analysis area of all alternatives and are more generally scattered throughout the analysis area along highway and road corridors or smaller, less diverse streams. These wetlands can be isolated from other wetlands and associated riparian vegetation in disturbed or urban areas.

3.11.4.2 Riparian Vegetation

Upper Arkansas River

The upper Arkansas River between Turquoise Lake and Pueblo Reservoir changes in elevation from about 9,860 to 4,800 feet. Accordingly, riparian vegetation changes from montane to plains vegetation communities. Between Turquoise Lake and Twin Lakes, willow shrublands occur adjacent to the river while seasonally moist grasslands occur extensively throughout the floodplain. This reach of the Arkansas River is not confined by landforms compared to the reach below Twin

Lakes to upstream of Salida, which flows through a canyon. Upstream of Twin Lakes, scattered willow shrublands with pockets of cottonwood and evergreen woodlands are found. Grasslands occur but appear more tied to tributaries or ground water flow from uplands. Reaches of the Arkansas River through rocky canyons where lateral movement is limited by the rocky substrate support only narrow bands of riparian vegetation or none at all. Near Cañon City and Florence, riparian grasslands become more dominant (influenced more by agriculture than by the river). Patches of saltcedar occur near Cañon City and become more abundant closer to Pueblo Reservoir, where cottonwood woodlands also occur. Riparian grasslands, shrublands (both willow and saltcedar), and cottonwood woodlands occur mostly along drainages that flow to Pueblo Reservoir.

Lower Arkansas River

Below Pueblo Reservoir, the Arkansas River flows through the City of Pueblo. Cottonwood woodlands and riparian grasslands are common for about 4.5 miles below the dam, at which point the river flows through a concrete-lined channel. Riparian vegetation through the concrete-lined reach is limited to a few cottonwood woodlands along with some shrublands. Downstream of the confluence with Fountain Creek, the floodplain of the Arkansas River broadens and supports a mosaic of community types including cottonwood woodlands, willow and saltcedar shrublands, and various grasslands along the river. Saltcedar and mixed shrublands become more dominant near John Martin Reservoir.

Lower Arkansas River Basin Reservoirs

Lake Henry, Lake Meredith, and Holbrook Reservoir are three storage reservoirs in the lower Arkansas River Basin potentially affected by the alternatives. At Lake Henry, bands of riparian grasslands occur on the south and east sides of the reservoir along the water's edge. Riparian, grasslands, willow shrublands, and cottonwood woodlands line a drainage on the east side of the reservoir; a portion of this vegetation is below the high water mark of the reservoir and may be periodically inundated.

At Lake Meredith, upland grassland and seasonally moist grassland occur above and below the high water mark of the reservoir and occur around most of the reservoir. Patches of saltcedar occur on the west side of the reservoir, and patches of Russian olive and cottonwood occur along a drainage on the northwest side of the reservoir. Vegetation below the high water mark is likely periodically inundated causing mortality and exposed soil suitable for establishment of vegetation.

Riparian vegetation around Holbrook Reservoir consists of riparian shrublands (willow and saltcedar) and grasslands on the north side with scattered patches of cottonwood woodlands. Periodic water level fluctuations likely inundate the existing vegetation and create newly exposed soil.

Fountain Creek

Fountain Creek through Colorado Springs is confined by urbanization, resulting in a relatively narrow riparian corridor. The dominant riparian vegetation types along Fountain Creek through Colorado Springs are riparian grasslands and cottonwood woodlands with a few scattered willow-dominated and other types of shrublands. Near the confluence with Williams Creek and continuing downstream, the riparian corridor broadens and cottonwood woodlands, riparian grasslands, and wetlands are common along the channel and throughout the floodplain. Closer to Pueblo and through the northern end of town, shrublands typically dominated by saltcedar and Russian olive become more dominant, although some cottonwood woodlands occur as well. Through Pueblo and closer to the confluence of Fountain Creek and the Arkansas River, the floodplain is truncated by development and only narrow bands of riparian grasslands and shrublands occur.

Jimmy Camp Creek

The upper reach of Jimmy Camp Creek has patches of riparian grasslands and wetlands with some cottonwood woodlands. Closer to the confluence with Fountain Creek, cottonwood woodlands become more prevalent and a few willow-dominated and other shrublands occur.

Williams Creek

Williams Creek from the Upper Williams Creek Reservoir site to its confluence with Fountain Creek supports riparian grasslands, which include wetlands, along the channel. Saltcedar shrublands are common along some reaches of Williams Creek (ERO 2007f). Cottonwood woodlands occur upstream of the Williams Creek Reservoir site and some smaller patches are found closer to the confluence with Fountain Creek. Also near the confluence, riparian grasslands and wetlands become broader with more available surface and ground water.

3.11.5 Environmental Consequences

3.11.5.1 Direct and Indirect Effects

No Action Alternative

Construction of the No Action Alternative would directly affect 12.5 acres of jurisdictional wetlands and 13.1 acres of isolated wetlands (Table 111). Of the 25.6 total acres of wetlands effects, 0.5 acre would be Category I wetlands, 1.5 acres would be Category II wetlands, 22.0 acres would be Category III wetlands, and 1.6 acres would be Category IV wetlands (Table 112). About 6.5 acres of the direct effects would be from pipeline crossings or other activities that would result in short-term disturbance. Temporarily affected wetlands would be restored in place. Project activities such as dam construction and reservoir inundation related to the No Action Alternative would permanently affect 19.1 acres of wetlands, a moderate effect on wetlands, and would require on-site or off-site compensatory mitigation.

The No Action Alternative would temporarily affect 1.8 acres and permanently affect 7.0 acres of ditches and ponds. A total of 2 miles of streambed would be temporarily affected and 10 miles of streambed would be permanently affected from this alternative.

The No Action Alternative would directly affect 266 acres of riparian vegetation, which would be a major effect on riparian resources. Of the 266 acres, 19 acres of riparian woodland typically dominated by plains cottonwood, 31 acres of riparian shrubland (dominated by either native sandbar willow or non-native saltcedar and Russian olive), and 169 acres of riparian grassland would be permanently affected. All other riparian vegetation effects would be short term.

Table 111. Permanent (P) and Temporary (T) Direct Effects on Wetlands, Waters, and Riparian Vegetation by Alternative.

Resource	No Action Alternative		Participants' Proposed Action		Wetland Alternative		Arkansas River Alternative		Fountain Creek Alternative		Downstream Intake Alternative		Highway 115 Alternative	
	P	T	P	T	P	T	P	T	P	T	P	T	P	T
Wetlands														
Jurisdictional Wetland (ac.)†	7.1	5.4	1.4	1.4	0.6	1.3	6.4	0.4	7.6	1.3	8.0	0.5	7.1	0.5
Isolated Wetland (ac.)†	12.0	1.1	12.0	1.5	0.8	4.3	0.4	4.1	11.9	1.0	11.7	1.3	12.0	1.5
Wetland (Jurisdictional and Isolated) (ac.)†	19.1	6.5	13.4	2.9	1.4	5.6	6.8	4.5	19.5	2.3	19.7	1.8	19.1	2.0
Total Wetland Effects (ac.)	**25.6**		**16.3**		**7.0**		**11.3**		**21.8**		**21.5**		**21.1**	
Waters														
Stream (miles)	10	2	8	1	5	2	6	3	9	2	9	1	10	2
Ditch (ac.)	6.8	0.3	6.7	0.2	0.0	0.5	0.0	0.5	6.6	0.1	6.5	0.2	6.8	0.4
Pond or Lake (ac.)	0.2	1.5	0.5	0.6	0.0	0.6	0.0	1.0	0.2	0.9	0.2	0.9	0.0	1.2
Riparian Vegetation														
Riparian Grassland (ac.)	169	36	104	38	12	27	77	21	175	30	178	31	169	30
Riparian Shrubland (ac.)	31	3	57	4	29	4	3	1	36	4	30	1	30	2
Riparian Woodland (ac.)	19	8	20	6	8	14	5	11	20	7	22	6	19	6

Total may differ from total present in Table 112 due to rounding.

†Jurisdictional status of wetlands was preliminarily determined and has not been approved by the Corps.

Source: GIS analysis for analysis area. Effects of Action Alternatives are not relative to the No Action Alternative.

Table 112. Direct Effects on each Montana Method Wetland Functional Category by Alternative.

Wetland Functional Category	No Action Alternative	Participants' Proposed Action	Wetland Alternative	Arkansas River Alternative	Fountain Creek Alternative	Downstream Intake Alternative	Highway 115 Alternative
I	0.5	0.0	0.0	0.0	0.0	0.0	0.0
II	1.5	2.1	1.6	0.2	1.9	1.7	0.8
III	22.0	12.1	2.7	8.6	17.9	18.0	18.9
IV	1.6	2.1	2.7	2.5	2	1.8	1.4
Total	25.6	16.3	7.0	11.3	21.8	21.5	21.1

Total may differ from total present in Table 111 due to rounding.

See Section 3.11.3.2 for explanation on the Montana Method Functional Categories.

All units are in acres and rounded to the nearest 0.1.

Source: GIS analysis for analysis area. Effects of Action Alternatives are not relative to the No Action Alternative.

The No Action Alternative may result in major indirect wetland and riparian vegetation effects (Table 113), primarily because of the potential effects from Security's and Fountain's ground water pumping along Fountain Creek (ERO 2007d). Security and Fountain have not designed their wellfields, and the ground water pumping effects were analyzed assuming a worst-case scenario of pumping from only one well for each Participant (MWH 2008a). Under the worst-case ground water pumping scenario, the combined pumping of Security and Fountain may result in 50 acres of indirect adverse effects on wetland and riparian vegetation, including high quality cottonwood woodlands. Greater ground water depths also may encourage the recruitment of saltcedar, a non-native, invasive species with a higher tolerance of deeper and more variable water table depths than cottonwood or willow. Wetland and riparian vegetation on Fountain Creek from Colorado Springs to Williams Creek would be adversely affected by increased erosion. Minor erosion also would also occur on Fountain Creek downstream of the Williams Creek Return Flow Conveyance Pipeline, which would have a negligible to minor effect on wetland and riparian vegetation. On Fountain Creek below Williams Creek to the confluence with the Arkansas River and on the Arkansas River reach below the confluence with Fountain Creek, the No Action Alternative may result in negligible to minor long-term beneficial effects on riparian vegetation as plants establish on the deposited sediment and riparian vegetation increases. Jimmy Camp Creek and Williams Creek are both intermittent streams. Below the proposed Jimmy Camp Creek Reservoir dam, seepage from the dam may provide a negligible beneficial effect on wetland and riparian vegetation by providing greater supportive hydrology within a small area. Williams Creek is dry with little riparian vegetation for a short reach below the Williams Creek Reservoir site. Seepage from the dam and slightly higher ground water levels immediately below the dam may have a negligible to minor beneficial effect on portions of William Creek that currently lack supportive hydrologic conditions for wetland

Table 113. Summary of Potential Indirect and Cumulative Effects on Riparian Vegetation.

Location	No Action Alternative	Participants' Proposed Action	Wetland Alternative	Arkansas River Alternative	Fountain Creek Alternative	Downstream Intake Alternative	Highway 115 Alternative
Indirect Effects							
Fountain Creek from Colorado Springs to above Security	Minor to moderate adverse effect from increased erosion	Same as No Action Alternative	Same as No Action Alternative	Same as No Action Alternative	Same as No Action Alternative	Same as No Action Alternative	Same as No Action Alternative
Fountain Creek near Security and Fountain	Potential major adverse effect from ground water pumping	No effect	No effect	No effect	No effect	No effect	No effect
Fountain Creek downstream of Williams Creek Return Flow Conveyance Pipeline	Negligible to minor adverse effect from minor erosion resulting from return flow releases	Same as No Action Alternative	No effect	No effect	No effect	Same as No Action Alternative	Same as No Action Alternative
Fountain Creek from Williams Creek confluence to the Arkansas River confluence	Negligible to minor beneficial effect as vegetation establishes on deposited sediment	Same as No Action Alternative	Minor beneficial effect as vegetation establishes on deposited sediment	Minor beneficial effect as vegetation establishes on deposited sediment	Minor beneficial effect as vegetation establishes on deposited sediment	Same as No Action Alternative	Same as No Action Alternative
Arkansas River below Fountain Creek confluence	Long-term negligible effect as vegetation establishes on deposited sediment	Same as No Action Alternative	Same as No Action Alternative	Same as No Action Alternative	Same as No Action Alternative	Same as No Action Alternative	Same as No Action Alternative
Jimmy Camp Creek	Negligible effect from dam seepage	Same as No Action Alternative	No effect	Same as No Action Alternative	Same as No Action Alternative	Same as No Action Alternative	Same as No Action Alternative
Williams Creek	Negligible to minor beneficial effect from seepage and higher ground water levels below Williams Creek Reservoir; negligible effect from erosion downstream of dam.	Negligible to minor beneficial effect from seepage and higher ground water levels below Williams Creek Reservoir and Upper Williams Creek Reservoir	Negligible effect from seepage that provides supportive wetland hydrology below Upper Williams Creek Reservoir	No Effect	Same as No Action	Same as No Action Alternative	Same as No Action Alternative

Location	No Action Alternative	Participants' Proposed Action	Wetland Alternative	Arkansas River Alternative	Fountain Creek Alternative	Downstream Intake Alternative	Highway 115 Alternative
Cumulative Effects							
Fountain Creek from Colorado Springs to Security	Negligible to minor adverse effect from increased erosion	Same as No Action Alternative	Same as No Action Alternative	Same as No Action Alternative	Same as No Action Alternative	Same as No Action Alternative	Same as No Action Alternative
Fountain Creek near Security and Fountain	Potential major short term adverse effect from ground water pumping; potentially greater major long-term adverse effect from increased erosion	Same as No Action Alternative	Same as No Action Alternative	Same as No Action Alternative	Same as No Action Alternative	Same as No Action Alternative	Same as No Action Alternative
Fountain Creek from Williams Creek confluence to the Arkansas River confluence	Negligible to minor beneficial effect as vegetation establishes on deposited sediment	Same as No Action Alternative	No effect	No effect	Same as No Action Alternative	Same as No Action Alternative	Same as No Action Alternative
Arkansas River below Fountain Creek confluence	Negligible to minor long-term beneficial effect as vegetation establishes on deposited sediment;	Same as No Action Alternative	No effect	No effect	Same as No Action Alternative	Same as No Action Alternative	Same as No Action Alternative
Jimmy Camp Creek	Minor adverse effect from increased peak flow and erosion	Same as No Action Alternative	Same as No Action Alternative	Same as No Action Alternative	Same as No Action Alternative	Same as No Action Alternative	Same as No Action Alternative
Williams Creek	No effect	No effect	No effect	No effect	No effect	No effect	No effect

Source: ERO 2007d, 2008d.

and riparian vegetation. Stormflows at a rate comparable to historical stormflows would be released from the reservoir, providing similar hydrologic conditions to wetland and riparian vegetation as currently exist. Minor erosion that would occur downstream of the dam from the release of stormflows would have a negligible effect on riparian vegetation, mostly because little riparian vegetation occurs in the reach immediately below the dam.

In general, streamflow within Western Slope streams within the analysis area would be slightly reduced compared to existing conditions. Effects on ground water, peak flows, floodplains, and geomorphology, important factors for maintaining riparian vegetation, were would be negligible for Western Slope streams. A slight reduction in streamflow along Western Slope streams may benefit willow-dominated shrublands by allowing encroachment into the channel. Because of the lack of wetland and riparian vegetation at Homestake Reservoir, the effects from the increased diversions would be negligible.

Changes in reservoir water levels on Pueblo Reservoir, Lake Meredith, Lake Henry, and Holbrook Reservoir could affect wetland and riparian vegetation; however, the water level fluctuations resulting from the SDS Project would be within the range of existing, normal fluctuations for each reservoir. Water levels that are lower than Existing Conditions for several years would allow wetland and riparian vegetation to establish on exposed soil including riparian grasslands, willow, saltcedar, cottonwood, or Russian olive; however, subsequent inundation likely would eliminate the vegetation leaving bare soil exposed once again. Saltcedar is a fierce competitor and may become more firmly established and persist where other native species do not. Although the water levels would differ under the No Action Alternative from Existing Conditions, the amount the reservoir levels fluctuate seasonally or between years would not substantially differ. Effects on wetland and riparian vegetation associated with the reservoirs would be negligible for No Action compared to Existing Conditions.

Participants' Proposed Action

The Participants' Proposed Action would directly affect 2.8 acres of jurisdictional wetlands and 13.5 acres of isolated wetlands, 9.3 acres less than the total wetland effects for the No Action Alternative (Table 111). The Participants' Proposed Action would not directly affect Category I wetlands, 0.5 acre less than the No Action Alternative. The greatest effect on wetlands, 12.1 acres, which is 9.9 acres less than the No Action Alternative, would be on Category III wetlands (Table 112).

About 2.9 acres of wetlands would be temporarily disturbed under the Participants' Proposed Action. These wetlands would be restored in place with wetland functions and values similar to the wetlands affected. About 13.4 acres of wetlands would require on- or off-site mitigation because of permanent impacts. This would be a moderate direct effect on wetlands. Construction of the Participants' Proposed Action would temporarily affect 0.8 acre and permanently affect 7.2 acres of ditches and ponds. A total of 8 miles of stream would be permanently affected and 1 mile of stream would be temporarily affected from this alternative.

The Participants' Proposed Action would directly affect 229 acres of riparian vegetation, 37 acres less than the No Action Alternative. The Participants' Proposed Action would have similar permanent effects on riparian woodland, greater permanent effects on riparian shrubland (57 acres versus 31 acres) and less permanent effects on riparian grassland (104 acres versus 169 acres) compared to the No Action Alternative.

The Participants' Proposed Action would have indirect wetland and riparian vegetation effects along Fountain Creek, the Arkansas River, and Williams Creek similar to the No Action Alternative. Because this alternative does not include the Jimmy Camp Creek Reservoir, no indirect effects would occur along Jimmy Camp Creek. The potential major adverse indirect effects on wetland and riparian vegetation along Fountain Creek from Security and Fountain's No Action Alternative ground water pumping would not occur (Table 113). Indirect effects on riparian vegetation along Western Slope streams and on Pueblo Reservoir, Lake Henry, Lake Meredith, and Holbrook Reservoir would be the same as the No Action Alternative.

Wetland Alternative

The Wetland Alternative would result in the fewest total direct wetland effects (7.0 acres) and the fewest permanent wetland effects (1.4 acres) of all the alternatives (Table 111), a minor direct effect. The Wetland Alternative would affect 1.9 acres of jurisdictional wetlands and 5.1 acres of isolated wetlands. Permanent wetland effects from this alternative are relatively low because one reservoir instead of two is proposed. The Jimmy Camp Creek Reservoir and the Williams Creek Reservoir are not part of this alternative, and the Upper Williams Creek Reservoir has few wetland resources. Total effects on wetlands from the Wetland Alternative would be 18.6 acres less than the effects from the No Action Alternative. Most of the wetland effects would occur to low quality Category III and IV wetlands, with only 1.6 acres of effects on Category II wetlands and no effect on Category I wetlands. The Wetland Alternative would temporarily affect 1.1 acres of ditches and ponds and 2 miles of streambed and would permanently affect 5 miles of streambed but no ditches or ponds.

This alternative would directly affect 94 acres of riparian vegetation (22 acres of riparian woodland, 3 acres of riparian shrubland, and 39 acres of riparian grassland). Most effects on riparian grassland and woodland would be temporary, but 12 acres of riparian grassland, 29 acres of riparian shrubland, and 8 acres of riparian woodland would be permanently affected. The Wetland Alternative would affect 172 acres less riparian habitat compared to the No Action Alternative.

The Wetland Alternative would have few indirect effects on riparian vegetation. Because this alternative does not include the Jimmy Camp Creek Reservoir, no indirect effects would occur along Jimmy Camp Creek. Because this alternative does not have the Williams Creek Reservoir, there would be no changes in erosion, and/or sedimentation on Williams Creek, Fountain Creek downstream of the Williams Creek Return Flow Conveyance Pipeline, or the Arkansas River as in the No Action Alternative; the Wetland Alternative would likely have no effect on wetland and riparian vegetation within these stream reaches. Compared to the No Action Alternative, riparian vegetation may increase slightly more on Fountain Creek from Williams Creek to the Arkansas River from higher sedimentation in that reach. Because this alternative has the Upper Williams Creek Reservoir for terminal storage, there would likely be negligible beneficial indirect effects on wetland and riparian vegetation from 1.15 cfs from seepage below the dam (CH2M HILL 2007f). Seepage and associated ground water would provide supportive hydrology for wetland and riparian vegetation immediately below the dam. Because Security and

Fountain's ground water pumping would not occur for this alternative, no change in wetland and riparian vegetation on Fountain Creek near Security and Fountain would be anticipated. Riparian vegetation effects along Western Slope streams and on Pueblo Reservoir, Lake Henry, Lake Meredith, and Holbrook Reservoir would be the same as the No Action Alternative.

Arkansas River Alternative

The total direct effect on wetlands of 11.3 acres under the Arkansas River Alternative would be 14.3 acres less than the No Action Alternative. Direct effects on wetlands would be lower compared to the No Action Alternative because only the Jimmy Camp Creek Reservoir is proposed. There would not be any effects on wetlands along Williams Creek because neither the Williams Creek Reservoir nor the Upper Williams Creek Reservoir are proposed for this alternative. Most of the wetland effects would be on Category III wetlands (8.6 acres) with 0.2 acre of effects on Category II wetlands and 2.5 acres on Category IV wetlands.

Of the 11.3 acres of wetlands that would be directly affected, 4.5 acres of effects would be mitigated in place with wetlands having similar functions and values as the affected wetlands. About 6.8 acres of permanently affected wetlands (a moderate effect) would require on-site or off-site mitigation. Of the 11.3 total acres of wetlands that would be affected, 6.8 acres would be jurisdictional and 4.5 acres would be isolated. The Arkansas River Alternative would temporarily affect 1.5 acres and permanently affect 0.0 acre of ditches and ponds. Effects on 6 miles of streambed would be permanent and effects on 3 miles of streambed would be temporary.

The Arkansas River Alternative would directly affect 118 acres of riparian vegetation, 148 acres less than the No Action Alternative. Of the 118 acres, 5 acres of riparian woodland, 3 acres of riparian shrubland, and 77 acres of riparian grassland would be permanently affected. All other effects on riparian vegetation would be temporary. This alternative would have the fewest effects on riparian shrubland and woodland of all alternatives because only one reservoir is proposed and its untreated water pipeline does not cross the Fountain Creek riparian corridor.

The Arkansas River Alternative would have wetland and riparian indirect effects along Jimmy Camp Creek (Table 113) similar to the No Action Alternative. Because Security and Fountain's ground water pumping would not occur for this alternative, no change in wetland and riparian vegetation on Fountain Creek near Security and Fountain would be anticipated. This alternative would not include the Williams Creek Reservoir or the Williams Creek Return Flow Conveyance Pipeline, and erosion and/or sedimentation that would occur under the No Action Alternative would not occur; therefore, no indirect effects along the Williams Creek channel or the Arkansas River would occur. Compared to the No Action Alternative riparian vegetation may increase slightly on Fountain Creek from Williams Creek to the Arkansas River from higher sedimentation in that reach. Indirect effects on riparian vegetation along Western Slope streams and on Pueblo Reservoir, Lake Henry, Lake Meredith, and Holbrook Reservoir would be the same as the No Action Alternative.

Fountain Creek Alternative

The Fountain Creek Alternative would result in 21.8 acres of direct effects on wetlands. Compared to the No Action Alternative, the Fountain Creek Alternative would affect 3.8 acres less wetlands. This alternative would not affect Category I wetlands and would only minimally affect Category II (1.9 acres) and Category IV wetlands (2.0 acres). The greatest effect, 17.9 acres, would be on Category III wetlands.

Most effects from this alternative would be permanent and would be mitigated on-site or off-site. The 19.5 acres of permanent effects on wetlands in this alternative would be a moderate effect. About 2.3 acres of wetland effects would be temporary, and wetlands would be restored in place. Under the Fountain Creek Alternative 8.9 acres of jurisdictional wetlands and 12.9 acres of isolated wetlands would be affected. Construction of the Fountain Creek Alternative would temporarily affect 1 acre and permanently affect 6.8 acres of ditches and ponds. A total of 9 miles of streambed would be permanently affected and 2 miles of streambed would be temporarily affected.

Construction of the Fountain Creek Alternative would directly affect 272 acres of riparian vegetation (27 acres of riparian woodland, 40 acres of riparian shrubland, and 205 acres of grassland). The Fountain Creek Alternative would affect 6 more acres of riparian vegetation than the No Action Alternative and would permanently affect 20 acres of riparian woodland, 1 acre more than the No Action Alternative.

The Fountain Creek Alternative would have wetland and riparian indirect effects along Jimmy Camp Creek and Williams Creek (Table 113) similar to the No Action Alternative. Indirect adverse effects on Fountain Creek would not occur because the Williams Creek Return Flow Conveyance Pipeline is not part of this alternative. Slightly greater beneficial effects on riparian vegetation may occur on Fountain Creek downstream of Williams Creek compared to the No Action Alternative. This alternative includes the Williams Creek Reservoir, which may result in a beneficial effect on wetland and riparian vegetation associated with dam seepage and slightly higher ground water levels immediately below the dam. Additionally, major adverse effects on wetland and riparian vegetation along Fountain Creek from ground water pumping under the No Action Alternative would not occur under this alternative. The Fountain Creek Alternative would have the same indirect effect on riparian vegetation along Western Slope streams and on Pueblo Reservoir, Lake Henry, Lake Meredith, and Holbrook Reservoir as the No Action Alternative.

Downstream Intake Alternative

The Downstream Intake Alternative would directly affect 13 acres of isolated and 8.5 acres of jurisdictional wetlands. Effects on isolated and jurisdictional wetlands from the Downstream Intake Alternative (21.5 acres) would be 4.1 acres less than the No Action Alternative. The distribution of effects on the wetland categories is similar to the No Action Alternative. Category III wetlands would be the most affected with 18 acres, followed by Category IV wetlands with 1.8 acres, and Category II wetlands with 1.7 acres of direct effects.

Pipelines and other temporary construction-related disturbances would affect 1.8 acres of wetlands. These wetlands would be restored in place. Project activities such as dam construction and reservoir inundation would permanently impact 19.7 acres of wetlands, a moderate effect on wetlands. Construction of the Downstream Intake Alternative would temporarily affect 1.1 acres of ditches and ponds and 1 mile of streambed and permanently affect 6.7 acres of ditches and ponds and 9 miles of streambed.

The Downstream Intake Alternative direct effects on riparian vegetation would be similar to the No Action Alternative with 268 acres compared to 266 acres. Most permanent effects would be to riparian grassland (178 acres). There would be 30 acres of permanent effects on riparian shrubland and 22 acres of permanent effects on riparian woodland.

The Downstream Intake Alternative would have indirect effects on wetland and riparian vegetation along Fountain Creek, the Arkansas River, Jimmy Camp Creek, and Williams Creek (Table 113) similar to the No Action Alternative. However, unlike under the No Action Alternative, wetland and riparian vegetation on Fountain Creek near Security and Fountain would not experience potential major adverse effects from ground water pumping. Indirect effects on riparian vegetation along Western Slope streams and on Pueblo Reservoir, Lake Henry, Lake Meredith, and Holbrook Reservoir would be the same as the No Action Alternative.

Highway 115 Alternative

The Highway 115 Alternative would directly affect 21.1 acres of isolated and jurisdictional wetlands, 4.5 acres less than the No Action Alternative. About 7.6 acres of jurisdictional wetlands and 13.5 acres of isolated wetlands would be affected. Most of the affected wetlands are Category III wetlands (18.9 acres), with no effects on Category I wetlands and less than 2 acres of each of the other categories. About 2 acres of wetlands would be temporarily disturbed and 19.1 acres of wetlands would be permanently disturbed. The Highway 115 Alternative would have a moderate effect on wetlands. Construction of the Highway 115 Alternative would temporarily affect 1.6 acres and permanently affect 6.8 acres of ditches and ponds. Effects on 10 miles of streambed would be permanent and effects on 2 miles of streambed would be temporary.

Construction of the Highway 115 Alternative would directly affect 256 acres of riparian vegetation, which would be a major effect. The Highway 115 Alternative would have slightly fewer effects on riparian vegetation (10 acres) than the No Action Alternative. Of the 256 acres, 19 acres of riparian woodland, typically dominated by plains cottonwood, would be permanently affected. In addition, 30 acres of riparian shrubland and 169 acres of riparian grassland would be permanently affected.

The Highway 115 Alternative would have indirect effects on wetland and riparian vegetation along Fountain Creek, the Arkansas River, Jimmy Camp Creek, and Williams Creek (Table 113) similar to the No Action Alternative. Potential major effects on wetland and riparian vegetation along Fountain Creek from ground water pumping under the No Action Alternative would not occur under this alternative. The Highway 115 Alternative would have the same indirect effects on riparian vegetation along Western Slope streams and on Pueblo Reservoir, Lake Henry, Lake Meredith, and Holbrook Reservoir as the No Action Alternative.

3.11.5.2 Cumulative Effects

As discussed in Section 3.1.3.1, reasonably foreseeable future actions that would result in cumulative effects, when combined with the effects of the proposed project, include urban development in El Paso and Pueblo counties that would directly impact wetlands or that would affect the hydrology of Fountain Creek, Jimmy Camp Creek, Williams Creek, and the Arkansas River, transportation projects, the Eastern Plains Transmission Project, and climate change. The cumulative effects from planned water projects (the Stormwater Enterprise and Fountain's water supply project) and changes in peak flows from increased development were calculated for the cumulative effects on streamflow, which was used to estimate cumulative effects on wetland and riparian vegetation. The cumulative effects on wetlands and riparian vegetation for each alternative and for actions that affect all alternatives are described below.

No Action Alternative

The No Action Alternative would result in major adverse cumulative effects on wetland and riparian vegetation along the upper reach of Fountain Creek, primarily from Fountain's proposed ground water pumping under its water supply project. Under a worst-case ground water pumping scenario, ground water declines of greater than 16 feet on the Fountain Creek alluvial aquifer are estimated (MWH 2008a). Ground water drawdown under the worst-case scenario may adversely affect greater than 200 acres of riparian vegetation. Increased erosion from development-related increased peak flows on Fountain Creek from Colorado Springs to the confluence with Williams Creek may result in major adverse incremental effects on wetland and riparian vegetation, with additional incremental long-term adverse effects as geomorphic processes and riparian vegetation loss create an ongoing cycle of adverse effects (Section 3.8). Below the confluence of Williams Creek, the cumulative effects on riparian vegetation along Fountain Creek would be similar to those described for indirect effects.

Hydrologic effects from this alternative combined with reasonably foreseeable actions may result in a long-term minor adverse cumulative effect on wetland and riparian vegetation on Jimmy Camp Creek from increased peak flows (Section 3.8), especially from an increase in the 2-year peak flows, which are typically considered channel-forming flows. An increase in the 2-year peak flow may increase the width of the channel, thereby reducing the riparian vegetation along the banks. If the increase in 10-year and 100-year peak flows scours more vegetation, an adverse effect may occur after a flood event; however, new vegetation would establish on the bare areas. If the increase in peak flows causes the channel to incise, which is typical of urban streams, there would be a major adverse cumulative effect over time.

Action Alternatives

The Action Alternatives would result in cumulative effects on wetland and riparian vegetation similar to the No Action Alternative.

Cumulative Effects Common to All Alternatives

Urban and Suburban Development

For all alternatives, urban and suburban development around Colorado Springs and Pueblo may have major cumulative effects on wetlands and riparian vegetation by causing direct or indirect impacts on the streams within the study area. The Eastern Plains Transmission Project would cross a portion of the SDS Project study area and may result in negligible cumulative adverse effects on wetland and riparian vegetation for the No Action, Participants' Proposed Action, Arkansas River, Fountain Creek, and Highway 115 alternatives.

Transportation Projects

Proposed transportation projects may result in cumulative effects on wetland and riparian vegetation. All impacts on wetlands from projects with a federal nexus would be mitigated, resulting in no net loss of area or of wetland functions and values for those projects. Local transportation projects without a federal nexus, such as federal funding or Corps-regulated wetland impacts, may result in minor to moderate unmitigated impacts to non-jurisdictional wetlands.

Climate Change

Climate change would affect all alternatives similarly. Higher temperatures in the summer could decrease water availability and soil moisture leading to a decrease in wetland area or change in species composition to more drought-tolerant species. A change in the timing of spring runoff could affect the distribution of cottonwood, a riparian species for which seed dispersal typically coincides with spring floods. A decrease in precipitation could reduce the amount of runoff, affecting the amount of ground water recharge and discharge along streams, which could stress or reduce the amount of wetlands and riparian vegetation supported by ground water. If more precipitation falls as rain instead of snow, increases of peak streamflows and baseflows could cause more erosion along streams and scouring of existing wetland and riparian vegetation.

3.11.5.3 Resource Commitments

There would be no irreversible commitment of resources for wetlands, waters, or riparian resources. Permanent and temporary effects on wetlands, waters, and riparian vegetation from construction of Jimmy Camp Creek Reservoir, Williams Creek Reservoir, Upper Williams Creek Reservoir, and other aboveground structures would cause an irretrievable commitment of resources while the reservoirs and structures are in place. If the reservoirs or structures are removed, these resources would continue to be lost until vegetation has re-established. Temporary effects from pipeline and other construction activities would cause an irretrievable commitment of resources until after construction is complete and wetland and riparian vegetation has re-established.

3.11.5.4 Mitigation

Proposed Measures

Mitigation would be required under Section 404 of the CWA and under EO 11990 for wetlands directly and indirectly affected by the SDS Project. The following mitigation measures would be implemented for all alternatives:

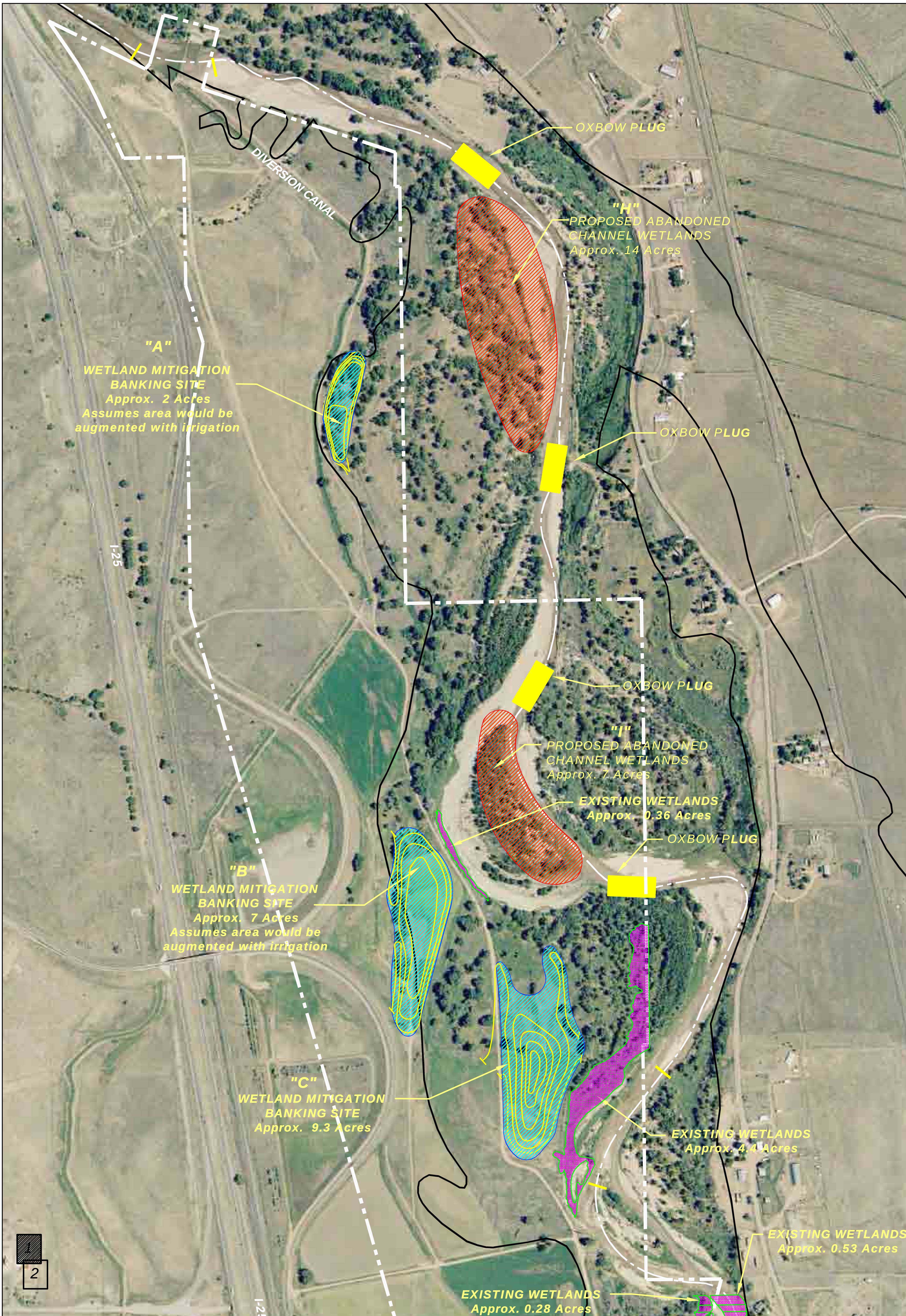
- Design final alignments and facilities for the selected alternative to avoid and minimize wetland impacts
- Assess alternative construction methods for pipeline crossings (i.e., directional drilling v. open cut) to minimize wetland/stream impacts
- Develop and implement a plan to control saltcedar that may establish around newly constructed reservoirs.
- Mitigate impacts to wetlands in areas of temporary, short-term effects such as pipeline crossings, on-site at the place of disturbance with similar wetlands and soils to replace existing wetland functions and values
- Mitigate all unavoidable, permanent wetland impacts with compensatory wetlands that replace existing wetland functions and values. Compensatory wetland mitigation would likely occur at the Clear Spring Ranch site on Fountain Creek downstream of the city of Fountain. Conceptual mitigation options at this site are described below.

Seven areas have been identified at the Clear Spring Ranch site as potential wetland creation or mitigation banking sites (Figure 89 and Figure 90). Sites A and B are upland areas that would require water to be diverted into this area to provide supportive hydrology for 2 and 7 acres, respectively, of wetlands and riparian habitat. The major limitation of Sites A and B is that they may require substantial grading and earthwork to create conditions suitable for wetland establishment. Site C is a 9.3-acre site located adjacent to existing wetlands. Sites D, E, and F are adjacent to Little Fountain Creek, a tributary to Fountain Creek. Site D would provide about 16.0 acres, Site E would provide about 5.2 acres, and Site F would provide about 9.2 acres of compensatory wetland mitigation. Site G is located adjacent to Fountain Creek and would contribute approximately 11.5 acres. Water typically used for agriculture or ground water recharge would be diverted to provide the supportive wetland hydrology at each site. Grading would be necessary to ensure an adequate area would be at the correct elevation. Overall functions and values of the impacted wetlands would be replaced by creating the target communities and ecological attributes similar to the areas of affected wetlands. Depressional palustrine emergent and scrub-shrub wetlands surrounded by woody riparian habitat would be established in these areas. Functions and values would be moderate to high for each of these areas (Category II).

Four additional areas (H through K) were also identified as potential areas for the creation of abandoned channel wetlands that could also be associated with Fountain Creek channel improvements and bank stabilization activities (Figure 89 and Figure 90). These abandoned channel wetland areas would range in size from 6.7 to 14 acres and are also potential candidate sites for compensatory wetland mitigation.

Mitigated Effects

By reviewing the location of wetlands during final design, effects on wetlands can be avoided and minimized. Specifically, the pipeline construction corridors through wetlands would be reduced to the minimum width practicable. Similarly, construction methods that do not involve trenching through a wetland would avoid impacts. Wetlands mitigated in place and off-site would replace affected wetlands on a 1:1 ratio and would provide similar functions and values.



EXISTING WETLANDS		PROPOSED WETLAND MITIGATION BANKING	
PROPOSED CONTOURS		PROPOSED ABANDONED CHANNEL WETLANDS	
100 YR FLOODPLAIN		CLEAR SPRING RANCH BOUNDARY	
EXISTING CREEK CENTERLINE			

0 250 500 1000 North
Scale: 1"=500'

Project: SOUTHERN DELIVERY SYSTEM
Prepared By: THK Associates, Inc.
Date: December 1, 2008

Figure 89. Proposed Wetland Mitigation Sites (Part 1).

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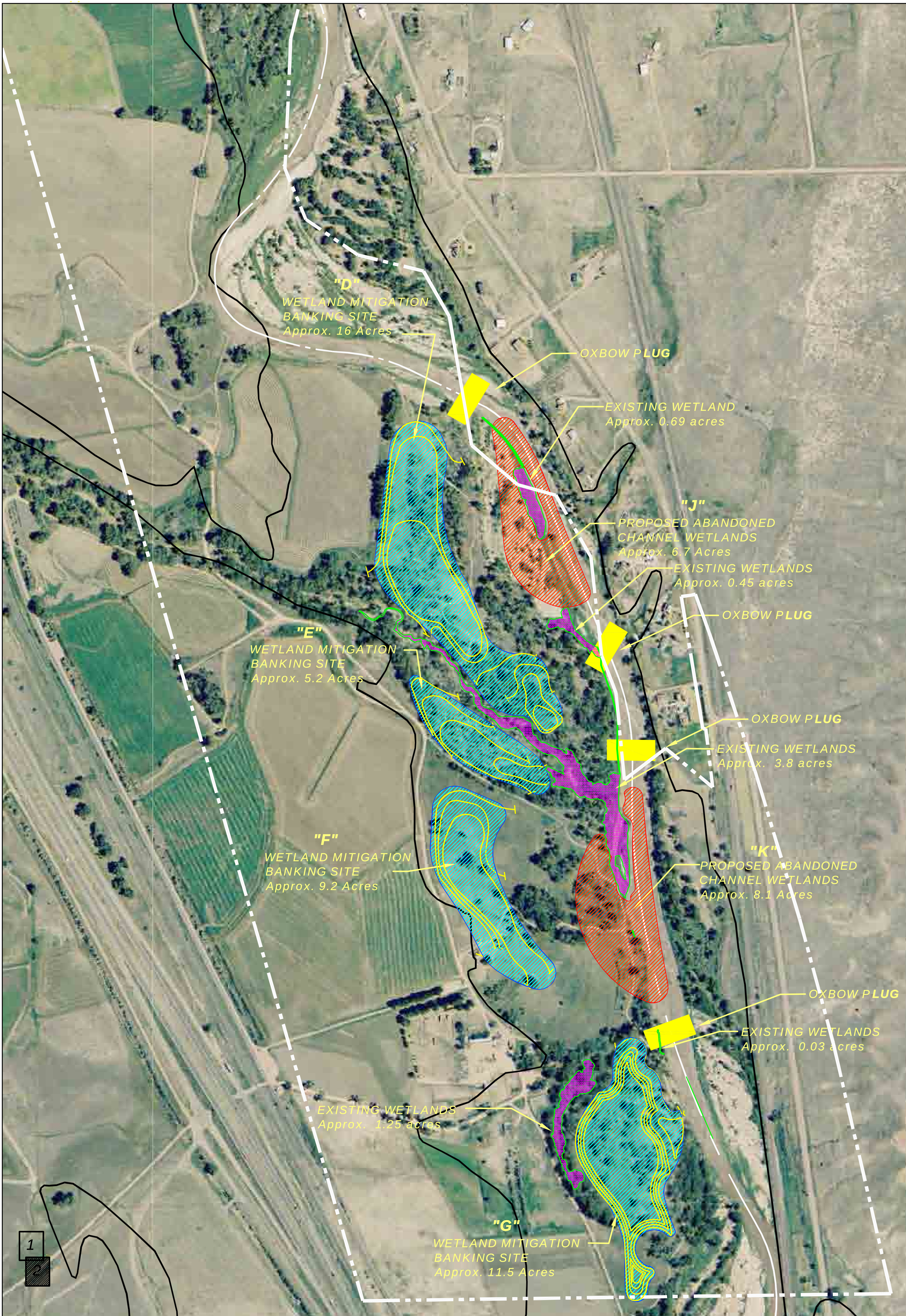

Project: SOUTHERN DELIVERY SYSTEM
Prepared By: THK Associates, Inc.
Date: December 1, 2008

EXISTING WETLANDS
PROPOSED CONTOURS
100 YR FLOODPLAIN
EXISTING CREEK CENTERLINE
PROPOSED WETLAND MITIGATION BANKING
PROPOSED ABANDONED CHANNEL WETLANDS
CLEAR SPRING RANCH BOUNDARY

0 250 500 1000 North

Figure 90. Proposed Wetland Mitigation Sites (Part 2).

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3.12 Vegetation

Vegetation resources are being assessed because of the potential effect of the SDS Project on native vegetation communities including sensitive plant communities and sensitive plant species. Four types of vegetation resources were assessed for this FEIS:

- Vegetation Cover Types – mapped and assessed according to indicators such as dominance by native or introduced species
- Threatened, Endangered, and Candidate (TE&C) species – listed under the ESA
- Plant species and communities – listed by the Colorado Natural Heritage Program (CNHP) as critically imperiled (S1) or imperiled (S2) in Colorado
- Noxious weeds – assessed to determine what type of weed control management plans would be needed for this project

Direct and cumulative effects on vegetation cover types are measured in acres and would consist of removing vegetation either permanently by replacing with some type of structure (such as roads) or temporarily during construction. As with vegetation cover types, effects on plant communities of concern are measured in acres and would consist of permanent and temporary effects. These effects on plant communities of concern were estimated by comparing them to the total acreage of known communities. The removal of plants from permanent and temporary impacts would affect plant species of concern; although, in temporarily affected areas, the plants may re-establish. These effects were estimated by comparing them to the total acreage of known population or numbers of known individuals. Indirect effects, such as susceptibility to noxious weed infestation, was qualitatively described for each alternative. Riparian resources are discussed in the Wetlands, Waters, and Riparian Vegetation section (Section 3.11).

3.12.1 Summary of Effects

3.12.1.1 Vegetation Cover Types

The No Action Alternative would have major direct effects on Native Grasslands both Upland and Mesic (or moist), permanently disturbing about 1,800 acres of these cover types. Most Action Alternatives would have similar major effects and would permanently disturb about 1,400 to 2,400 acres of these cover types, with the Participants' Proposed Action having the largest effect. The Arkansas River Alternative would have moderate effects on both types of Native Grasslands (886 acres of permanent effects), 906 acres less than the major effects for the No Action Alternative (1,792 acres of permanent effects).

The No Action Alternative would have major indirect effects on mesic vegetation cover types associated with Fountain Creek because of ground water pumping by Security and Fountain. These indirect effects include possible changes in plant species composition and invasion by noxious weeds. All other alternatives would have similar indirect effects on mesic native cover types (referred to as riparian vegetation in Section 3.11), as discussed in more detail in the Wetlands, Waters, and Riparian Vegetation section (Section 3.11).

3.12.1.2 Threatened, Endangered, and Candidate Species

None of the alternatives would directly or indirectly affect TE&C plant species because no TE&C plant species were found in the analysis area.

3.12.1.3 Plant Species and Plant Communities of Concern

The Western Untreated Water Pipeline in the Participants' Proposed Action, Wetland, and Fountain Creek alternatives would affect up to about 25 individuals of dwarf milkweed, which is critically imperiled to imperiled in Colorado. The loss of these individuals may result in the loss of genetic diversity of this species. The Participants' Proposed Action would have moderate effects on the survivability of the dwarf milkweed because about 5 percent of the total number of individuals known may be lost. Loss of the plants due to this project may result in the loss of genetic diversity of this species. Genetic diversity is considered advantageous to survival of a species. The No Action Alternative and other alternatives would not affect this species.

The No Action Alternative would permanently affect 15 acres (a minor effect) of the state imperiled or vulnerable plant community Needle and Threadgrass – Blue Grama Grassland community. The Participants' Proposed Action and the Wetland Alternative would have a greater permanent effect (114 acres) on the community. The remaining alternatives would have the same effect as the No Action Alternative. The No Action Alternative would have a minor temporary effect (68 acres) on Needle and Threadgrass – Blue Grama Grasslands because of construction of the Denver Basin Ground Water System. The Participants' Proposed Action and the Wetland Alternative would have the least temporary effect (1 acre) on the community. The remaining alternatives would temporarily affect 22 acres of the community, less the No Action Alternative

All alternatives would have similar indirect effects on plant species and communities of concern as the No Action Alternative. Indirectly, native vegetation cover types and plant species and communities of concern would be affected by fragmentation of the resource due to construction activities associated with the proposed project and spread of noxious weeds. Indirect effects on riparian resources from changes in stream flows are discussed in the Wetlands, Waters, and Riparian Vegetation section (Section 3.11).

3.12.1.4 Noxious Weeds

All alternatives would affect noxious weeds similarly because construction activities are likely to spread noxious weeds. Weed control, during and after construction, would minimize the spread of noxious weeds.

3.12.2 Regulatory Framework

3.12.2.1 Threatened, Endangered, and Candidate Species

Federally threatened and endangered species are protected under the ESA of 1973, as amended. The ESA defines an endangered species as "a species in danger of becoming extinct throughout all or a large portion of its range" and a threatened species as "a species likely to become endangered in the foreseeable future." If a project with a federal action would have adverse effects on a federally listed plant species or its habitat, consultation with the Service under Section 7 of the ESA is required.

Candidate species are species for which there is sufficient information on their biological vulnerability to support federal listing as endangered or threatened (Service 2008), but listing is precluded by other higher priority listing activities. No regulations require consultation for effects on candidate species; however, if a candidate species occurring in the analysis area becomes listed during project planning or construction, consultation with the Service may be required.

3.12.2.2 Plant Species and Plant Communities of Concern

The CNHP tracks plant species and plant communities that are critically imperiled (S1) or imperiled (S2) within Colorado (CNHP 2005a). S1 or S2 species and plant communities are not regulated by a federal or state entity. These critically imperiled or imperiled plant species and communities are assessed because they are potentially vulnerable to effects from a proposed project. The U.S. Forest Service (USFS) and BLM maintain lists of sensitive species that they monitor on lands they manage. Effects on species listed as sensitive by the USFS and BLM also were assessed for the alternatives.

3.12.2.3 Noxious Weeds

The Colorado Noxious Weed Management Act states that all landowners must manage noxious weeds that may be damaging to adjacent landowners. Noxious weeds are defined as plant species that are not native to Colorado and that negatively affect crops, native plant communities, livestock, and/or the management of natural or agricultural systems.

The Colorado Department of Agriculture maintains three lists of noxious weed species (Colorado Department of Agriculture 2006). The State A list contains noxious weed species targeted for eradication within Colorado. The State B list contains species that the state recommends controlling. The State C list contains species for which the state, in cooperation with other interested parties, will develop and implement weed-management plans.

3.12.3 Analysis Area and Methods

3.12.3.1 Study Area and Analysis Area

Existing vegetation resources were assessed and described for the study area (ERO 2007e, 2008c). The study area is larger than the actual area that would be affected by the alternatives (analysis area). The analysis area is the area to be disturbed for construction, operations, and maintenance of each of the alternatives. Effects on vegetation would be either temporary or permanent.

3.12.3.2 Methods

For each vegetation resource, the following methods were used to determine the resource in the study area and the direct and indirect effects of the alternatives on each resource within the analysis area. Direct effects include permanent effects, such as construction of reservoirs, and temporary construction effects, such as disturbance of vegetation during pipeline construction.

For comparison of direct effects for each alternative, impact thresholds were determined for vegetation cover types, plant species of concern, and plant communities of concern. These impact thresholds are for comparison among the different alternatives and were determined based on knowledge of the resource and known effects from other projects. The effects on vegetation cover types and plant species/communities of concern are not standardized for these unregulated resources because the level of research and understanding varies depending on the resource, and in some cases the effects are poorly understood.

For cumulative effects, the data gathered for each resource described below was compared to the estimated impacts for each reasonably foreseeable action described in Section 3.1.3.1.

Vegetation Cover Type
Vegetation cover types were mapped by field surveys and aerial photograph interpretation for areas with limited access. Field surveys were conducted periodically from December 2003 to February 2007 as described in more detail in the Vegetation Resources Technical Report (ERO 2007e). An additional survey of 231 acres of new study area was conducted in September 2008 because of revisions to the Participants' Proposed Action and is described in more detail in the Vegetation and Wildlife Resources Administrative Record Documentation (ERO 2008c).

Vegetation cover types were based on broad categories determined by dominant growth type (Woodland, Shrubland, or Grassland), moisture regime (Upland and Mesic), and dominance by native or introduced species. Additionally, areas such as Agricultural Lands that could not be categorized based on dominant growth types were mapped. Wetlands are included in the mesic cover types because they sometimes are a small portion of the cover type and have similar vegetation composition. Wetlands are described in more details in the Wetlands, Waters, and Riparian Vegetation section.

Vegetation cover types were digitized to GIS polygons and then intersected with analysis area shapefiles. To determine effects on vegetation resources, GIS analyses were conducted using ESRI's ArcGIS 9.2 software. Direct and cumulative effects on vegetation cover types were measured in acres.

Because native plant communities are more susceptible to disturbance and do not re-establish as easily or quickly as mixed or introduced vegetation cover types, the following criteria to determine direct effects of each alternative on native plant communities were used.

- Negligible – less than 50 acres of native grassland or shrubland, or less than 25 acres of native woodland would be permanently affected within the analysis area.
- Minor – between 50 and 500 acres of native grassland or shrubland, or between 25 and 250 acres of native woodland would be permanently affected within the analysis area.
- Moderate – between 500 and 1,000 acres of native grassland or shrubland, or between 250 and 1,500 acres of native woodland would be permanently affected within the analysis area.
- Major – more than 1,000 acres of native grassland or shrubland, or more than 1,500 acres of native woodland or forest would be permanently affected within the analysis area.

Threatened, Endangered, and Candidate Species
The potential habitat was assessed for TE&C plant species that may occur within the study area based on the Service's listing of TE&C species in each county. The Service lists two TE&C plant species as potentially occurring in El Paso County, Ute ladies'-tresses orchid (orchid) and slender moonwort. The Service does not list any TE&C plant species as potentially occurring in Pueblo, Chaffee, or Fremont counties (Service 2008).

The study area was assessed for suitable orchid habitat. Areas of suitable habitat were surveyed during flowering periods following orchid survey protocols (Service 1992). No orchid populations were observed during the surveys. Surveys for the slender moonwort were not conducted because suitable habitat for the species (above 7,900 feet in El Paso County) does not occur within the study area.

Because TE&C plant species were not found in the study area, they are not discussed further in this section.

Plant Species and Plant Communities of Concern

The CNHP lists several plant species and plant communities as occurring near the study area in El Paso, Pueblo, Fremont, and Chaffee counties (CNHP 2003, 2005b, 2006a, 2007). The study area was assessed for suitable habitat for all S1 and S2 plant species or plant communities, as well as USFS- and BLM-sensitive species (BLM 2007; USFS 2007). Plant species were identified according to Colorado Flora (Weber and Wittmann 2001), other taxonomical sources, and by review of specimens at the Denver Botanic Gardens Herbarium.

Suitable habitat for each species of concern was surveyed during the appropriate flowering period. For each plant species and community found, the area was mapped on aerial photographs (ERO 2007e, 2008c). For plant species of concern, the number of individuals found was estimated. The method of analysis was the same as for vegetation cover types.

If a plant species or plant community of concern was found in the study area, available sources (such as CNHP) were reviewed to determine the approximate known populations. How the available sources estimated the known populations depended on the source. Therefore, the effects on populations were estimated based on either number of individuals, number of occurrences, or acreages.

Based on these sources, the effects of the project were ranked as follows:

- Negligible – no S1 or S2 plant species or plant community of concern was found.
- Minor – less than 1 percent of the total Colorado populations of a S1 or S2 species is affected. For plant communities, less than 15 percent of an S1 or less than 25 percent of an S2 community is affected.
- Moderate – between 1 and 10 percent of an S1 or S2 Colorado population is affected. Between 15 and 25 percent of a plant community ranked S1 or between 25 and 50 percent of a community ranked S2 is affected.
- Major – more than 10 percent of an S1 or S2 plant species Colorado population) is affected. For plant communities, more than 25 percent of a community ranked S1 or more than 50 percent of a community ranked S2 is affected.

Noxious Weeds

The study area was surveyed for the presence of all noxious weeds listed by the Colorado Department of Agriculture as State A list species. Also surveyed for were noxious weed on the State B list that were listed by the counties as their top noxious weeds of concern or the state has management plans for the species within the study area (Colorado Department of Agriculture 2006). The susceptibility to noxious weed infestation was qualitatively described for each alternative.

3.12.3.3 Limitations

For inaccessible areas, vegetation cover types and potential habitat for TE&C or plant species and communities of concern habitat (based on documented habitat information) were mapped using aerial photography interpretation. Some vegetation cover types may have changed or will change since mapping was conducted, especially in developing urban areas around Colorado Springs and Pueblo. The locations and size of plant species and communities of concern may change due to natural population fluctuations, loss from disturbance, and loss of habitat. Noxious weed populations change over time due to expansion into new areas and reduction due to implemented weed-control measures.

The Colorado Department of Agriculture is actively developing weed management plans for List B species and periodically revises the list of noxious weeds. Therefore, the species that require control plans could change by the time construction begins on the proposed project.

3.12.4 Affected Environment

3.12.4.1 Vegetation Cover Types

The following is a summary of the vegetation cover types found in the study area. More detailed information including plant lists are in the Vegetation Resources Technical Report (ERO 2007e) and Vegetation and Wildlife Resources Administrative Record Documentation (ERO 2008c).

Grasslands

Upland Native Grasslands

Upland Native Grasslands—the largest cover type in the study area—occur on the dry plains and rolling hills throughout the study area. Native species, such as blue grama and western wheatgrass, dominate this cover type. Some nonnative species, such as kochia, also occur within the Upland Native Grasslands, but are not dominant.

Mesic Native Grasslands

Mesic Native Grasslands occur in and adjacent to drainages and on vegetated swales. Generally, this cover type is found in relatively undisturbed drainages throughout the study area. Western wheatgrass, salt grass, and vine mesquite grass dominate this cover type with scattered shrubs such as western snowberry and Woods' rose. Palustrine emergent wetlands, as described in more detail in the Wetland, Waters, and Riparian Resources Technical Report (ERO 2007f), are included in this cover type.

Upland Mixed Grasslands

The Upland Mixed Grasslands cover type typically occurs near urban areas and along roadsides and are found throughout the study area except at the Jimmy Camp Creek and Williams Creek Reservoir sites. These grasslands are dominated by a mixture of native grasses, such as blue grama and introduced species such as smooth brome.

Mesic Mixed Grasslands

Mesic Mixed Grasslands is a mixture of native and nonnative graminoids (e.g., grasses, sedges, and rushes) and forbs that occur sporadically in drainages and along ditches in many of the pipeline alignments throughout the study area. Wetlands dominated by a mixture of introduced and native species are included in this cover type.

Upland Introduced Grasslands

Upland Introduced Grasslands are dominated by nonnative species such as kochia and crested wheatgrass. This cover type occurs in recently disturbed areas along existing pipelines and roads, and within or near urban areas. This vegetation cover type is found along all pipeline alignments and at the Williams Creek Reservoir site.

Mesic Introduced Grasslands

Mesic Introduced Grasslands dominated by smooth brome and other introduced species occur within the floodplain of Fountain Creek and other areas receiving more moisture than the surrounding uplands. This cover type is found throughout the study area, except at the Upper Williams Creek Reservoir site. Included in this cover type are wetlands along ditches dominated by reed canarygrass.

Shrublands

Upland Native Shrublands
A variety of native shrubs including mountain mahogany in the Jimmy Camp Creek Reservoir site and Highway 115 pipeline alignment, sagebrush in Chaffee County, and fourwing saltbush-shadscale saltbush in Pueblo County dominate the Upland Native Shrublands cover type. This common cover type is found throughout the study area except in the Chilcotte Ditch Return Flow Conveyance corridor.

Mesic Native Shrublands
Mesic Native Shrublands occur within drainages throughout the study area. The native dominant shrubs range from western snowberry and skunkbush sumac in drier drainages to sandbar willow shrub-dominated wetlands.

Upland Mixed Shrublands
The Upland Mixed Shrublands cover type is similar to the Upland Native Shrublands cover type except for the prevalence of kochia and other introduced species. This cover type occurs along the western and eastern water pipeline alignments and the Denver Basin Ground Water System.

Mesic Mixed Shrublands
The Mesic Mixed Shrublands cover type occurs in Pueblo and Fremont counties along the broad floodplain of the Arkansas River and other streams. A mixture of native species such as rubber rabbitbrush and sandbar willow, and introduced shrubs such as saltcedar are composed of the Mesic Mixed Shrublands. This cover type includes shrub-dominated wetlands.

Mesic Introduced Shrublands
Mesic Introduced Shrublands are dominated by saltcedar and occur in riparian areas along many of the major drainages and at the Williams Creek Reservoir site. This cover type occurs in both wetlands and uplands.

Woodlands

Upland Native Woodlands
Upland Native Woodlands are found throughout the study area. This cover type includes native ponderosa pine woodlands at the Jimmy Camp Creek Reservoir site and Rocky Mountain juniper woodlands in Pueblo County. Below the trees, a variety of native shrubs and herbaceous species dominate the understory.

Mesic Native Woodlands
Mesic Native Woodlands dominated by plains cottonwood and peachleaf willow occur mostly along the major drainages within the study area. Narrowleaf cottonwood woodlands also are found along the Highway 115 Pipeline alignment. The understory vegetation varies from dense sandbar willow in wetlands to scattered western snowberry and Woods' rose in drier drainages.

Upland Mixed Woodlands
The Upland Mixed Woodlands cover type occurs in scattered locations, including the Jimmy Camp Creek Reservoir site, and is similar to the Upland Native Woodlands cover type except for the dominance of introduced

species such as smooth brome in the understory.

Mesic Mixed Woodlands
Mesic Mixed Woodlands occur along the drainages in all alternatives. Along Fountain Creek, the Arkansas River, and some of their tributaries, this cover type is similar to Mesic Native Woodlands except that an introduced shrub, saltcedar, is codominant with native species. Along Colorado 115, woodlands dominated by a mixture of native species, such as plains cottonwood, and nonnative species, such as Siberian elm, occur along the creeks. This cover type also includes wetland plant communities, especially on the fringes of waterbodies.

Other Vegetated and Unvegetated Areas
The Agricultural Lands cover type occurs throughout the study area in farmed or fallow fields and disturbed areas associated with agriculture. Landscaped areas around buildings with lawns and ornamental trees such as Siberian elm and other nonnative trees are classified as Urban cover type. Waterbodies are streams and creeks including the Arkansas River, Fountain Creek, Jimmy Camp Creek, and Williams Creek, ditches, lakes, ponds, reservoirs, and dry, unvegetated drainages where water flows periodically. Roads and Other Disturbed Areas occur throughout the study area and consist of existing roads and pavement, lands disturbed by recent construction of roads and residential development.

3.12.4.2 Plant Species and Plant Communities of Concern
Four plant species and two plant communities of state concern were found within the study area.

Species of State Concern

Dwarf Milkweed
An estimated 500 individuals of dwarf milkweed have been found mostly on private land in nine counties in Colorado (not including the population found in the SDS Project study area). This Colorado critically imperiled (S1) species appears to be in decline throughout its range (Anderson 2006).

Dwarf milkweed was found on the lower slopes of the piñon/juniper woodland-covered bluffs north of Lake Pueblo State Park on the Western Untreated Water Pipeline alignment. Three small subpopulations totaling fewer than 30 plants were found in the study area on the sparsely vegetated lower slopes of hills underlain by shale.

Rocky Mountain Bladderpod
Rocky Mountain bladderpod, a state imperiled species (S2), has been found at 28 sites in six counties in Colorado, mostly on private land. In two of these occurrences, the population is estimated to be about 2,000 plants. In the study area, Rocky Mountain bladderpod was found on the hillsides north of Lake Pueblo State Park on the Western Untreated Water Pipeline alignment. The total population was more than 100 plants within the study area.

Golden Blazingstar
Twenty-six occurrences of the state imperiled golden blazingstar (S2) are currently known. About 4,100 individuals are estimated to occur in 14 of these occurrences. Within the study area, four populations of golden blazingstar were found. Two populations were found in Fremont County on the Highway 115 Pipeline alignment and two populations were found in Pueblo County north of Pueblo Reservoir on the Western Untreated Water Pipeline

alignment. Each of these populations within the study area had fewer than 10 individuals.

Crandall's Rock-cress

Crandall's rock-cress, a state imperiled species, occurs in west-central Colorado and southwest Wyoming. In Colorado, 32 occurrences have been found in the last decade. About half of the occurrences were found on National Forest System land and the other half on private or BLM land (Ladyman 2005). Crandall's rock-cress was found in ponderosa pine woodlands on the Ark-Otero Powerline alignment and Pump Station in Chaffee County. The majority of the plants were found on hills and slopes next to the Arkansas River terrace; some plants were found in sagebrush shrublands on the terrace.

Plant Communities of State Concern

Needle and Threadgrass – Blue Grama Grassland

The Needle and Threadgrass – Blue Grama Grassland community occurs on the flat prairie north of the Jimmy Camp Creek Reservoir site. Because of the presence of this community, the northernmost portion of the Jimmy Camp Creek Reservoir site is included in the Sand Creek Ridge Potential Conservation Area by the CNHP. This occurrence is rated by the CNHP as good (B-ranked) because of the size and quality of this occurrence. The proximity of urban areas and its location along U.S. 24 fragments the community and reduces its value as a biological resource (Doyle et al. 2001).

Softstem and Hardstem Bulrush Wetlands

The Softstem and Hardstem Bulrush Wetland community was found on Williams Creek about 3 miles below the reservoir site, but was not located in the analysis area. Bulrush, spikerush, and reed canarygrass grow in slow-moving water along Williams Creek. The CNHP has ranked this community as vulnerable to imperiled in Colorado because it is threatened by various human activities (Carsey et al. 2003).

3.12.4.3 Noxious Weeds

Noxious weeds were noted during vegetation surveys. The following species on the State of Colorado Noxious Weed List were found.

- **Canada thistle** – This noxious weed was found throughout the study area mostly along drainages and other mesic areas. Canada thistle is on the State B list and on the noxious weed lists for all the counties within the study area.
- **Field bindweed** – Field bindweed is widespread throughout the study area, especially in disturbed areas. This noxious weed is on the State C and Pueblo County lists.
- **Kochia** – Kochia is widespread in disturbed areas throughout the study area. Although not on the State Noxious Weed List, Pueblo County has kochia on its noxious weed list.
- **Musk thistle** – Musk thistle occurs in patches in many of the moist grasslands throughout the study area. It is listed on the State B list and on the Fremont and Chaffee County Noxious Weed lists.
- **Saltcedar** – Saltcedar is common along the drainages within the study area. This noxious weed is listed on the State B list and on the Pueblo County Noxious Weed list.

3.12.5 Environmental Consequences

3.12.5.1 Direct and Indirect Effects

No Action Alternative

Vegetative Cover Types

The No Action Alternative would have major effects to existing Native Grasslands (both Upland and Mesic) (Table 114). Most of these effects would be to shortgrass prairie dominated by blue grama grass, although midgrass prairie, including the state imperiled community Needle and Threadgrass – Blue Grama Grassland, also would be affected. Additionally, 1,038 acres of Upland and Mesic Native Grasslands would be temporarily affected by the No Action Alternative. The recovery time for the temporarily disturbed native grasslands may be lengthy because many of these species are slow growing and depend on certain soil and moisture conditions.

The permanent effects on Mesic and Upland Native Shrublands (156 acres) and Woodlands (201 acres) would be minor. Additionally, 78 acres of Native Shrublands and 155 acres of Native Woodlands would be temporarily affected by the No Action Alternative. Because woody vegetation takes a relatively long time to mature, restoring Native Shrublands and Woodlands to existing conditions may take up to 150 years. For example, to restore mature native ponderosa pine communities to the same level of maturity and species composition would take 100 to 150 years, depending on the growth stage of the existing community. To restore mountain mahogany and other Upland Native Shrublands to the same level of maturity and species composition may take 50 years or more.

Ground water pumping by Security and Fountain as part of the No Action Alternative may have major indirect effects on Mesic Native cover types associated with Fountain Creek. Security and Fountain have not designed their wellfields, and the ground water pumping effects were analyzed assuming a worst-case scenario of pumping from only one well for each Participant (MWH 2008a). Under the worst-case ground water pumping scenario, the combined pumping of Security and Fountain may result in 50 acres of indirect adverse effects on wetland and riparian vegetation, including high quality cottonwood woodlands. The No Action Alternative would have negligible to minor indirect effects on Mesic Native cover types along Jimmy Camp Creek, Fountain Creek, Williams Creek, and Arkansas River. These indirect effects are described in more detail in the Wetlands, Waters, and Riparian Vegetation section (Section 3.11).

Plant Species and Communities of Concern

The No Action Alternative would directly affect two CNHP-listed plant species of concern, Crandall's rock-cress (state imperiled) and golden blazingstar (state imperiled); and one plant community of concern, Needle and Threadgrass – Blue Grama Grassland (state imperiled or vulnerable) (Table 115).

About 1 acre (up to 500 individuals) of Crandall's rock-cress habitat would be permanently affected by the construction of the Ark-Otero Powerline and Pump Station. Another 1 acre (up to 250 individuals) of habitat would be temporarily affected by the construction of the pipeline. The species may re-establish in the 1 acre of temporarily affected areas; although, how long it may take to re-establish is not known.

Table 114. Permanent (P) and Temporary (T) Direct Effects on Vegetation Cover Types for Each Alternative.

Resource	No Action Alternative		Participants' Proposed Action		Wetland Alternative		Arkansas River Alternative		Fountain Creek Alternative		Downstream Intake Alternative		Highway 115 Alternative	
	P	T	P	T	P	T	P	T	P	T	P	T	P	T
Grasslands														
Upland Native Grasslands	1,655	978	2,301	589	1,310	751	802	918	1,787	933	1,720	777	1,654	794
Mesic Native Grasslands	137	60	83	53	27	51	84	47	150	56	140	49	137	43
Upland Mixed Grasslands	70	212	68	88	52	150	22	110	59	90	38	48	70	118
Mesic Mixed Grasslands	9	9	9	5	2	11	2	13	8	7	10	7	9	7
Upland Introduced Grasslands	18	29	22	42	7	45	22	61	32	61	32	58	18	24
Mesic Introduced Grasslands	32	10	32	15	2	5	3	1	30	5	32	11	32	10
Subtotal	1,921	1298	2,515	792	1,400	1013	935	1150	2,066	1152	1,972	950	1,920	996
Shrublands														
Upland Native Shrublands	154	75	17	34	23	65	181	181	175	182	175	146	154	65
Mesic Native Shrublands	2	3	30	8	30	8	<1	1	9	9	<1	1	2	1
Upland Mixed Shrublands	<1	1	16	31	16	31	<1	4	16	34	<1	3	<1	1
Mesic Mixed Shrublands	<1	<1	3	<1	3	1	1	2	3	1	9	1	<1	<1
Mesic Introduced Shrublands	29	2	29	3	1	3	3	2	29	3	29	2	29	2
Subtotal	185	81	95	76	73	108	185	190	232	229	213	153	185	69
Woodlands														
Upland Native Woodlands	195	147	3	5	55	141	150	142	102	9	99	4	195	137

Resource	No Action Alternative		Participants' Proposed Action		Wetland Alternative		Arkansas River Alternative		Fountain Creek Alternative		Downstream Intake Alternative		Highway 115 Alternative	
	P	**T**	**P**	**T**	**P**	**T**	**P**	**T**	**P**	**T**	**P**	**T**	**P**	**T**
Mesic Native Woodland	6	8	7	6	9	17	5	13	7	7	5	4	6	8
Upland Mixed Woodlands	1	2	<1	0	0	0	1	0	1	0	1	0	1	1
Mesic Mixed Woodlands	14	3	12	0	<1	2	1	3	12	<1	17	1	14	2
Subtotal	216	160	22	11	64	160	157	158	122	16	122	9	216	148
Other Types														
Agricultural Lands	6	15	0	0	0	0	0	19	0	0	0	0	6	15
Urban	1	82	<1	11	0	18	2	20	2	13	2	13	<1	7
Roads and other disturbed areas	47	120	21	70	24	123	17	108	16	75	12	61	47	80
Waterbodies	23	8	31	5	21	7	14	8	20	6	20	7	23	8
Subtotal	77	225	52	86	45	148	33	136	38	94	34	80	76	112
Total	2399	1,764	2,684	965	1,582	1.,429	1,310	1,634	2,458	1,491	2,342	1,192	2,397	1,324

All units are in acres and are rounded to the nearest whole number.

Source: GIS analysis for analysis area.

Table 115. Permanent (P) and Temporary (T) Direct Effects on Plant Species and Plant Communities of Concern for each Alternative.

Resource	No Action Alternative		Participants' Proposed Action		Wetland Alternative		Arkansas River Alternative		Fountain Creek Alternative		Downstream Intake Alternative		Highway 115 Alternative	
	P	T	P	T	P	T	P	T	P	T	P	T	P	T
Plant Species of Concern														
Crandall's rock-cress	1 (up to 500 individuals)	1 (up to 250 individuals)	0	0	0	0	0	0	0	0	0	0	1 (up to 500 individuals)	1 (up to 250 individuals)
Dwarf milkweed	0	0	< 1 (10 to 25 individuals)	0	< 1 (10 to 25 individuals)	< 1 (10 to 25 individuals)	0	0	< 1 < 1 (10 to 25 individuals)	0	0	0	0	0
Golden blazingstar	<1 (fewer than 20 individuals)	0	< 1 (fewer than 20 individuals)	< 1 (fewer than 5 individuals)	< 1 (fewer than 20 individuals)	< 1 (fewer than 20 individuals)	0	0	<1	< 1 < 1 (fewer than 5 individuals)	0	0	< 1< 1 (fewer than 25 individuals)	0
Rocky Mountain bladderpod	0	0	1	4	1	4	0	0	1	4	0	0	0	0
Plant Communities of Concern														
Needle and threadgrass – blue grama grasslands	15	68	114	1	114	1	15	22	15	22	15	22	15	22

All units are in acres are rounded to the nearest whole number or in number of individuals where appropriate.

Source: GIS analysis for analysis area

Thirty-two populations of Crandall's rock-cress are recorded in nearby upper Arkansas River Basin and Gunnison Basin (Ladyman 2005). Therefore, direct effects from the No Action Alternative would likely have a moderate effect on the sustainability and continued survival of Crandall's rock-cress because this alternative would likely affect about 3 percent of the total west-central Colorado population. No indirect effects on this species are expected from the No Action Alternative.

Under the No Action Alternative, the Highway 115 Untreated Water Pipeline and Pump Station No. 2 are likely to permanently affect fewer than 20 golden blazingstar individuals and temporarily affect a few (1 to 10) more individuals. The small loss of individuals would have minor effects on the survivability of this species, which has an estimated known population of more than 4,100 individuals (Anderson 2006). No indirect effects on this species are expected from the No Action Alternative.

The No Action Alternative would not directly affect the Bulrush Wetland community along Williams Creek downstream from the proposed Williams Creek Reservoir. Additionally, it is not likely to indirectly affect the Bulrush Wetland community that is 3 miles downstream from the reservoir because average flows would not change and this project is not likely to affect the ground water that appears to be the major hydrological support for this community (Section 3.6).

Under the No Action Alternative, the proposed Jimmy Camp Creek Reservoir and associated structures are estimated to permanently affect 15 acres of the Needle and Threadgrass – Blue Grama Grassland. Jimmy Camp Creek Reservoir and its associated structures likely would have a minor effect on Needle and Threadgrass – Blue Grama Grasslands because less than 25 percent of the local populations of this community are likely to be permanently affected.

Construction of the Jimmy Camp Creek Treated Water Pipeline and the Denver Basin Ground Water System under the No Action Alternative would likely temporarily affect about 68 acres of the Needle and Threadgrass – Blue Grama Grasslands. The effects would be relatively minor when compared to the total amount of the existing community. Restoring this plant community to existing conditions may take many years because many of the species are relatively slow growing. Also, indirect effects may occur from the introduction of noxious weeds and other invasive species during construction that would hinder the re-establishment of this plant community and invade the surrounding undisturbed Needle and Threadgrass – Blue Grama Grasslands.

Noxious Weeds

The No Action Alternative may increase the amount of noxious weeds—Canada thistle, field bindweed, kochia, musk thistle, and saltcedar—because areas recently disturbed by construction activities would be vulnerable to invasion by these aggressive species. Additionally, other noxious weeds not currently found in the analysis area may invade the sites disturbed during construction.

Participants' Proposed Action

Vegetation Cover Types

The Participants' Proposed Action would have major effects on Upland and Mesic Native Grasslands by permanently affecting 2,384 acres (Table 114). These effects would be similar to the effects of the No Action (1,792 acres). The Participants' Proposed Action would have minor permanent effects on Native

Shrublands (46 acres) and Woodlands (10 acres). Compared to the No Action Alternative, the Participants' Proposed Action would permanently affect more Mesic Native Shrublands than the No Action Alternative (30 acres compared to 2 acres), although, both of these alternatives would affect relatively small areas of this cover type. The Participants' Proposed Action would affect less Upland Native Shrublands (17 compared to 154 acres), and less Upland and Mesic Native Woodlands (10 compared to 201 acres) than the No Action Alternative. Restoration of all native vegetation cover types may occur slowly as described in the No Action Alternative section.

The Participants' Proposed Action would have negligible to minor indirect effects on Mesic Native cover types associated with stream systems as described in the Wetlands, Waters, and Riparian Vegetation section (Section 3.11). Compared to the No Action Alternative, major indirect effects on Mesic vegetation cover types along Fountain Creek would not occur because the Participants' Proposed Action does not include ground water pumping by Security and Fountain.

Plant Species and Communities of Concern

The Participants' Proposed Action would directly affect three plant species of concern and one plant community of concern. Construction of the Western Untreated Water Pipeline and associated structures would directly affect dwarf milkweed, golden blazingstar, and Rocky Mountain bladderpod in the shale hills northeast of Pueblo Reservoir. About 10 to 25 individuals of dwarf milkweed, which is critically imperiled to imperiled in Colorado, would be permanently affected by the Western Untreated Water Pipeline. The Participants' Proposed Action would have moderate effect on the survivability of this species because about 5 percent of the total number of individuals known may be lost. Additionally, because there are only nine other known occurrences, the loss of the plants from this project may result in the loss of genetic diversity of this species. Genetic diversity is considered advantageous to survival of a species.

Fewer than 25 golden blazingstar individuals, less than 1 percent of the over 4,000 individuals known from 14 occurrences are likely to be affected by the Participants' Proposed Action. The effects would be minor and similar to those described for the No Action Alternative.

About 1 acre of Rocky Mountain bladderpod habitat would be permanently affected and 4 acres would be temporarily affected by the Western Untreated Water Pipeline and associated structures. Surrounding the analysis area, 17 acres containing Rocky Mountain bladderpod were found within the study area (ERO 2007e), which would not be affected by this alternative.

The Participants' Proposed Action would likely have a minor effect on the survivability of this species because it is found at 28 other locations, two of which have more than 2,000 individuals, and less than a third of the plants found within the study area would be disturbed. No indirect effects on these native plant species are expected from the Participants' Proposed Action.

The Participants' Proposed Action would have more permanent effects (114 acres) and less temporary effects (1 acre) on the Needle and Threadgrass – Blue Grama Grasslands than the No Action Alternative (15 acres of permanent effects and 68 acres of temporary effects). The larger permanent effects would be from the Upper Williams Creek Water Treatment Plant site of the Participants' Proposed Action. There would be less temporary effects (1 acre) in the Participants' Proposed Action than the No Action Alternative (68 acres) because the Participants' Proposed Action does not contain the Denver Basin Ground Water System component.

The Williams Creek Reservoir would not directly or indirectly affect the Bulrush Wetland community as described under the No Action Alternative.

Noxious Weeds
The Participants' Proposed Action would have similar likelihood of spreading noxious weeds as the No Action Alternative.

Wetland Alternative

Vegetation Cover Types
The Wetland Alternative would have major effects on Native Grasslands (Upland and Mesic); 1,336 acres would be permanently affected. Compared to the No Action Alternative, the Wetland Alternative would have more permanent effects on Mesic Native Grasslands (137 acres compared to 83 acres) and less permanent effects on Upland Native Grasslands (1, 310 acres compared to 1,655 acres).

Effects on Native Shrublands (53 acres) and Native Woodlands (64 acres) would be minor. Less permanent effects on Upland Native Shrublands (23 acres) and Upland Native Woodlands (55 acres) would occur compared to the No Action Alternative (Table 114). Conversely, the Wetland Alternative would have greater permanent effects on Mesic Native Shrublands (30 acres) than the No Action Alternative (2 acres). Restoration of all native vegetation cover types would take time compared to introduced vegetation cover types, which tend to be dominated by relatively fast growing species.

The Wetland Alternative would have similar negligible to minor indirect effects on Mesic Native cover types associated with stream systems as all other Action Alternatives.

Plant Species and Communities of Concern
The Wetland Alternative would affect three plant species of concern—dwarf milkweed, golden blazingstar, and Rocky Mountain bladderpod; and one plant community of concern, Needle and Threadgrass – Blue Grama Grasslands. Construction of the Western Untreated Water Pipeline would have similar moderate effect on dwarf milkweed Rocky Mountain bladderpod as the Participants' Proposed Action. Construction of the Highway 115 Return Flow Pipeline in the Wetland Alternative would have similar minor effects on golden blazingstar as the Highway 115 Untreated Water Pipeline in the No Action Alternative. Construction of the Upper Williams Creek Water Treatment Plant in the Wetland Alternative would have similar minor effects on the Needle and Threadgrass – Blue Grama Grasslands as the Participants' Proposed Action but would have more permanent effects and less temporary effects compared to the No Action Alternative.

Noxious Weeds
The Wetland Alternative would have similar likelihood of spreading noxious weeds as the No Action Alternative.

Arkansas River Alternative

Vegetation Cover Types
The Arkansas River Alternative would have the fewest effects on Native Grasslands compared to the other alternatives. About 886 acres would be permanently affected and the effects would be moderate compared to major effects for the other alternatives. The effects

on Native Shrublands and Native Woodlands would be similar to the No Action Alternative. Restoration of all native vegetation cover types would take time, although the amount of time is difficult to estimate due to variable factors such as growth rate of species and climate conditions.

The Arkansas River Alternative would have similar negligible to minor indirect effects on Mesic Native cover types associated with stream systems as all other Action Alternatives.

Plant Species and Communities of Concern

The Arkansas River Alternative would directly affect Needle and Threadgrass – Blue Grama Grasslands. The proposed Jimmy Camp Creek Reservoir and associated structures would have similar minor effects on this plant community as the Participants' Proposed Action. The Arkansas River Alternative would have no effects on Crandall's rock-cress and golden blazingstar compared to the moderate effects on Crandall's rock-cress and minor effects on golden blazingstar under the No Action Alternative.

Noxious Weeds

The Arkansas River Alternative would have similar likelihood of spreading noxious weeds as the No Action Alternative.

Fountain Creek Alternative

Vegetation Cover Types

The Fountain Creek Alternative would have major permanent effects on Upland and Mesic Native Grasslands (1,937 acres), which is similar to the effects described for the No Action Alternative. Effects on Upland Native Grasslands would be slightly greater. Effects on Native Shrublands (184 acres) and Native Woodlands (109 acres) would be similar to the No Action Alternative.

Temporary effects from this alternative would be similar to No Action, except for Native Shrublands (191 acres compared to 78 acres for No Action). Restoration of all native vegetation cover types would take time, although the amount of time is difficult to estimate due to variable factors such as growth rate of species and climate conditions.

The Fountain Creek Alternative would have similar negligible to minor indirect effects on Mesic Native cover types associated with stream systems as for all other Action Alternatives.

Plant Species and Communities of Concern

The Fountain Creek Alternative would directly affect Needle and Threadgrass – Blue Grama Grasslands, dwarf milkweed, golden blazingstar, and Rocky Mountain bladderpod similar to the Participants' Proposed Action.

The Fountain Creek Alternative would have no effect on Crandall's rock-cress and the effects from this alternative to golden blazingstar would be less than the No Action Alternative. The Fountain Creek Alternative would have minor effects on Rocky Mountain bladderpod compared to no effects for the No Action Alternative. The Williams Creek Reservoir would not directly or indirectly affect the Bulrush Wetland community as described under the No Action Alternative.

Noxious Weeds

The Fountain Creek Alternative would have similar likelihood of spreading noxious weeds as the No Action Alternative.

Downstream Intake Alternative

Vegetation Cover Types

The Downstream Intake Alternative would have major effects on Native Grasslands (1,860 acres permanently affected), which is similar to the effects of the No Action Alternative. This alternative would have similar minor effects on Native Shrublands (175 acres of permanent effects) and Native Woodlands (104 acres of permanent effects) as the No Action Alternative. Restoration of all native vegetation cover types would take time, although the amount of time is difficult to estimate due to variable factors such as growth rate of species and climate conditions.

The Downstream Intake Alternative would have similar negligible to minor indirect effects on Mesic Native cover types associated with stream systems as all other Action Alternatives.

Plant Species and Communities of Concern

No plant species of concern would be affected by the Downstream Intake Alternative. Jimmy Camp Creek Reservoir and associated structures would have similar permanent effects on the Needle and Threadgrass – Blue Grama Grasslands as the No Action Alternative with less temporary effects. The Williams Creek Reservoir would not directly or indirectly affect the Bulrush Wetland community as described under the No Action Alternative.

The Downstream Intake Alternative would have no effect on Crandall's rock-cress or golden blazingstar compared to the moderate effects on Crandall's rock-cress and minor effects on golden blazingstar associated with the No Action Alternative. Also, the Downstream Intake Alternative would have fewer temporary effects on Needle and Threadgrass – Blue Grama Grasslands (22 acres) compared to the No Action Alternative (68 acres).

Noxious Weeds

The Downstream Intake Alternative would have similar likelihood of spreading noxious weeds as the No Action Alternative.

Highway 115 Alternative

Vegetation Cover Types

Permanent effects on Native Grasslands associated with the Highway 115 Alternative would be major (1,791 acres), similar to the effects described for the No Action Alternative. Effects on Native Shrublands (156 acres) and Native Woodlands (201 acres) would be similar to the No Action Alternative. Restoration of all native vegetation cover types would occur slowly although the amount of time is difficult to estimate due to variable factors such as growth rate of species and climate conditions.

The Highway 115 Alternative would have similar negligible to minor indirect effects on Mesic Native cover types associated with stream systems as all other Action Alternatives.

Plant Species and Communities of Concern

The Highway 115 Alternative would directly affect two plant species of concern, Crandall's rock-cress and golden blazingstar; and one plant community of concern, Needle and Threadgrass – Blue Grama Grasslands. Effects on Crandall's rock-cress from the Ark-Otero Powerline would be the same as the No Action Alternative. Permanent effects on golden blazingstar would be less than 1 acre. There would be no temporary effects on golden blazingstar. Jimmy Camp Creek Reservoir and associated structures would have similar permanent effects on the Needle and

Threadgrass – Blue Grama Grasslands as the No Action Alternative with greater temporary impacts to these grasslands than the No Action Alternative. The Williams Creek Reservoir would not directly or indirectly affect the Bulrush Wetland community as described under the No Action Alternative.

Noxious Weeds

The Highway 115 Alternative would have similar likelihood of spreading noxious weeds as the No Action Alternative.

3.12.5.2 Cumulative Effects

Reasonably foreseeable future actions that would result in cumulative effects, when combined with the effects of the proposed project, include urban development, other construction projects that disturb vegetation resources, and climate change.

Cumulative Effects Common to All Alternatives

For all alternatives, rapidly growing development around Colorado Springs, construction of new roads, widening of roads in previously undisturbed areas, and construction of the utility facilities, may cause major cumulative effects on Native Grasslands. Urban development, road construction, and construction of utility facilities would have moderate to major effects on Native Shrublands and Woodlands. Although the Needle and Threadgrass – Blue Grama Grassland community is globally secure, development and road construction around the Jimmy Camp Creek area would have major cumulative effects on the population of this state threatened or vulnerable plant community found in the area.

Climate change, a reasonable foreseeable action, may cause cumulative effects on native vegetation within the analysis area. These changes are difficult to assess precisely because global weather models do not have the level of detail necessary to predict effects on individual localities. As more studies are conducted, the effects of global warming on the plant communities in the analysis area may be more predictable.

Cumulative Effects for Each Alternative

The No Action Alternative

In addition to the cumulative effects that would be the same for all alternatives (described above), urban development around Fremont and Pueblo counties would likely increase the cumulative loss of golden blazingstar (S2) if found in areas identified for development. However, this species also occurs on public lands where urban development would not occur. Cumulative effects on Crandall's rock-cress are likely to be negligible because many populations occur on National Forest System and other public lands.

Participants' Proposed Action

Development around Pueblo may have cumulative effects on three species of concern (dwarf milkweed, golden blazingstar, and Rocky Mountain bladderpod). The exact acreage of effects from development is not known because many future development sites have not been surveyed for these species. Known populations in Lake Pueblo State Park and other public lands would not be cumulatively affected by these developments because public lands would not be developed.

Wetland Alternative

Three species of concern (dwarf milkweed, golden blazingstar, and Rocky Mountain bladderpod) may be cumulatively affected by this alternative. These effects are described in more detail in the Participants' Proposed Action section.

Arkansas River Alternative
There would be no cumulative effects on vegetative resources unique to the Arkansas River Alternative.

Fountain Creek Alternative
Three species of concern (dwarf milkweed, golden blazingstar, and Rocky Mountain bladderpod) may be cumulatively affected by this alternative, as described under the Participants' Proposed Action.

Downstream Intake Alternative
There would be no cumulative effects on vegetative resources unique to the Downstream Intake Alternative.

Highway 115 Alternative
Cumulative effects on two species of concern (Crandall's rock-cress and golden blazingstar) would be similar to the cumulative effects on these species described for the No Action Alternative.

3.12.5.3 Resource Commitments

Permanent effects from construction of reservoirs and associated structures to critically imperiled and imperiled plant species would be irreversible because the loss of genetic diversity of the individual plants removed. This loss of genetic diversity likely would be minor for golden blazingstar, Rocky Mountain bladderpod, and Crandall's rock-cress because only a small percentage of the total estimated population would be affected by the proposed project. The effect to the genetic diversity of dwarf milkweed likely would be greater than the other species because there are only nine other known occurrences of dwarf milkweed.

Permanent and temporary effects would cause an irretrievable commitment of resources for native vegetative cover types. Native Grasslands, Shrublands, and Woodlands currently found at Jimmy Camp Creek Reservoir, Williams Creek Reservoir, Upper Williams Creek Reservoir and other aboveground structures that would be lost during the time the reservoirs and structures are in existence. If the reservoirs cease to operate, these areas of native vegetation would continue to be lost until native vegetation has re-established. Temporary effects from pipeline and other construction activities would cause an irretrievable commitment of resources until after construction is complete and the native vegetation has re-established. Re-establishment of some vegetation types, especially native woodlands, may take decades.

The loss of the plant community of concern, Needle and Threadgrass – Blue Grama Grasslands would be similar to the loss described for native vegetation.

3.12.5.4 Mitigation

Proposed Measures
To increase the likelihood that Native Grasslands, Shrublands, and Woodlands would be restored, the following mitigation measures, some of which have been proposed by the Participants, would be implemented during construction, where practicable.

- Prior to final design, review locations of Needle and Threadgrass – Blue Grama Grasslands, high quality shrublands and woodlands, and other areas with desirable vegetation to determine design changes within the current study area that would avoid and minimize impacts

- Reseed with the appropriate native species
- Replace mature trees (diameter at breast height of 12 inches or greater) at a 1:1 ratio with the same or similar native species with available nursery container stock or pole plantings
- For 1 year after construction, monitor the site to determine if appropriate native vegetation is establishing. If native vegetation is not establishing, the site would be reseeded with appropriate species.

The following measures would mitigate for effects on plant species of concern:

- In the appropriate season prior to construction, survey the areas with known populations of dwarf milkweed and other plant species of concern, to locate areas where impacts can be avoided and minimized to the extent practicable with design changes within the current study area. After identifying populations to avoid, mark populations within or nearby the construction easement as environmentally sensitive so that workers avoid inadvertent impacts.

The following measures would reduce the spread of noxious weeds:

- During construction, wash major construction equipment before it enters the site so that noxious weeds are not spread from other construction sites Use certified weed-free mulch after seeding
- Reseed with comparable native vegetation as soon as practicable after disturbance
- Use only seed that does not contain any noxious weed seed
- Monitor the construction areas 3 years after construction to assess if noxious weeds have invaded the site. If noxious weeds were present, weed control plans would be formulated and completed.
- Because the project may indirectly increase the spread of tamarisk, the Participants would work with the Colorado Department of Agriculture's Colorado Noxious Weed Management Team on tamarisk issues in the Arkansas Valley including submitting a request for partnership evaluation.

Mitigated Effects

Impacts to plant species and communities of concern and other sensitive vegetation areas can be avoided and minimized during final design and implementation. Because mitigation measures such as transplanting individuals are often unsuccessful, avoidance and minimization would ensure the survival, especially of plant species of concern. Seeding disturbed areas, replacing mature trees, and controlling noxious weeds would replace existing vegetation types and structural diversity and would ensure that high quality habitat remained.

3.13 Wildlife

Wildlife resources are being assessed because components of the SDS Project may affect them. The resources that are addressed include federally threatened and endangered species, Colorado threatened and endangered species and species of special concern, sensitive species tracked by the CNHP, raptors and herons, large game, and other wildlife and migratory birds. USFS and BLM sensitive species were analyzed but are not discussed because of a lack of suitable habitat, primarily forested areas, needed to support viable populations of these species. None of the proposed alternatives would likely adversely affect USFS or BLM sensitive species.

3.13.1 Summary of Effects

The Participants' Proposed Action, Fountain Creek, and Downstream Intake alternatives would not affect threatened or endangered species. Threatened and endangered species would be affected by the permanent and temporary loss of habitat, displacement of individuals or populations, or disturbance of normal breeding, feeding, or sheltering behavior in the No Action, Wetland, Arkansas River and Highway 115 alternatives. Potential habitat exists within the analysis area for three federally listed species, Canada lynx, Preble's meadow jumping mouse (Preble's), and Mexican spotted owl. The No Action and Highway 115 alternatives would have minor, temporary effects on 5 to 6 miles of a Canada lynx movement corridor within low-use habitat associated with the Ark-Otero facilities. The No Action Alternative would temporarily affect 50 acres of known occupied Preble's habitat. None of the Action Alternatives would affect occupied Preble's habitat.

Short segments of pipeline alignments along Colorado 115 in the No Action, Wetland, Arkansas River, and Highway 115 alternatives would be within winter range and designated critical habitat for the Mexican spotted owl. Most activities associated with these alternatives would occur in areas that lack the Primary Constituent Elements (PCEs) of critical habitat for this species. Short segments of the alignment west of Colorado 115 would be in suitable winter habitat for the Mexican spotted owl. Construction activities in these areas would be restricted between November 15 and February 28, avoiding any impacts to owl winter range. Because of these temporal restrictions and the lack of PCEs along Colorado 115, the effects of all alternatives on the Mexican spotted owl and its critical habitat would be negligible.

Potential habitat exists within the analysis area for two Colorado-listed threatened and endangered species, 10 species of special concern, and six butterfly species listed as sensitive by CNHP. Hydrological changes at Lake Meredith, Lake Henry, and Holbrook Reservoir would not have any direct adverse effects on listed shorebird species (piping plover, least tern, or snowy plover). Indirect effects of fluctuating water levels at these reservoirs are highly variable and depend on multiple, unpredictable factors, including seasonal and daily changes in water levels, local and regional weather, and increasing and decreasing shorelines as vegetation is inundated or becomes established in extended dry periods. In general, these reservoirs would fluctuate within existing ranges resulting in a shifting mosaic of suitable and unsuitable shorebird habitat.

All alternatives would have minor adverse effects on species associated with prairie dog towns and cliff and canyon habitats because impacts on their habitat would be small on a regional scale. The No Action Alternative would have moderate adverse effects on widespread grassland species and wetland/riparian associated species. Effects on grassland species would be moderate because of the overall extent (>2,000 acres) of permanent or temporary effects on native grasslands. Wetland and riparian habitats are biologically diverse, and the No Action Alternative would have major adverse effects on state- and CNHP-sensitive species associated with these habitats. The effects of most of the Action Alternatives on state- and CNHP-sensitive species would be similar in magnitude to the No Action Alternative. The exceptions would be the Wetland Alternative, which would have negligible direct effects on wetland/riparian species, and minor effects on widespread upland species, and the Arkansas River Alternative, which would have minor effects on wetland, riparian and widespread upland wildlife species.

All alternatives would permanently affect between 1,200 and 2,700 acres of vegetation communities, which would generally contribute to moderate to major overall adverse effects on wildlife and migratory birds. Effects on migratory birds and wildlife were based on the overall quantity of vegetated habitat affected. Except for the Wetland Alternative, all alternatives would permanently displace three or more active raptor nest sites.

The effects of permanent and temporary loss of habitat for all large game species were evaluated at regional (percentage of seasonal habitats available within the region) and local (percentage of seasonal habitat available within a 820-foot buffer from the edge of project components) scales. All impacts to large game at the regional scale are negligible (<1 percent of habitat available). All alternatives would have minor (<10 percent of local habitat available) adverse effects on elk and white-tailed deer. The Participants' Proposed Action, Wetland, and Arkansas River alternatives would have moderate (10 to 25 percent of local habitat affected) permanent or temporary adverse effects to mule deer winter range. The Fountain Creek and Downstream Intake alternatives would have moderate permanent local adverse effects to mule deer winter range and major (>25 percent of local habitat available) temporary local adverse affects to mule deer winter range. The Participants' Proposed Action, Downstream Intake, and Highway 115 alternatives would have moderate adverse effects on pronghorn overall range.

The construction and operation of terminal storage and return flow reservoirs within 5-miles of an airport can potentially attract waterbirds and increase the Bird Aircraft Strike Hazard (BASH). None of the alternatives would affect potential bird concentration areas within the flight paths of Butts Army Airfield, Meadow Lake Airport, or the Air Force Academy (AFA). A minor increase in potential bird concentration areas within the flight paths of Colorado Springs Airport/ Peterson Air Force Base (COS/Peterson) would occur under all alternatives. The Participants Proposed Action and the Wetland alternatives would redistribute the relative concentration of waterbirds away from COS/Peterson and decrease the BASH compared to the No Action Alternative.

Changes to streamflows in segments of Fountain Creek, Williams Creek, and the Arkansas River would indirectly affect wildlife species associated with wetland and riparian habitats. Effects on riparian vegetation would vary. Increased streamflows or ground water levels below new reservoirs would benefit wetland and shrub riparian species such as song sparrow and red-winged blackbird. A long-term reduction in woody riparian vegetation from reduced peak flows below Williams Creek Reservoir (for all alternatives except the Wetland and Arkansas River Alternatives) likely would reduce breeding and roosting habitat available for warblers, herons, nesting raptors, and wintering bald eagles. The No Action Alternative may result in major adverse effects on riparian wildlife species from proposed ground water pumping along Monument and Fountain Creeks. The indirect effects on wildlife for the Action Alternatives would be less than for the No Action Alternative due to the lack of alluvial ground water pumping. Other indirect adverse effects such as increased noise, traffic, and human encroachment activity during construction would be common for all alternatives.

3.13.2 Regulatory Framework

Reclamation projects must comply with federal and state laws and regulations protecting wildlife species including:

- Endangered Species Act of 1973 (16 USC 1531 et seq.)
- Bald and Golden Eagle Protection Act of 1940, as amended (16 USC 668-668d)
- Fish and Wildlife Coordination Act of 1934, as amended (16 USC §§ 661-667e)
- Migratory Bird Treaty Act of 1918, as amended (16 USC §§ 703-712)
- Executive Order 13186 Responsibilities of Federal Agencies To Protect Migratory Birds
- Colorado wildlife statutes concerning non-game and endangered species conservation (Title 33, Article 2, C.R.S. (2007)

Federally listed threatened and endangered species are protected under the Endangered Species Act of 1973, as amended. Potential effects from a project on a federally listed species or its habitat resulting from a project with a federal action require consultation with the Service under Section 7 of the Endangered Species Act. Modification of designated critical habitat for a federally listed species also requires consultation with the Service.

The Bald and Golden Eagle Protection Act (16 USC §§ 668-668d) includes several prohibitions not found in the Migratory Bird Treaty Act (MBTA), such as molestation or disturbance. In 1962, the MBTA was amended to include the golden eagle. In 2007, the term “disturb” was defined to mean “to agitate or bother a bald or golden eagle to a degree that causes injury to an eagle, a decrease in productivity, or nest abandonment, by substantially interfering with normal breeding, feeding, or sheltering behavior (72 Fed. Reg. 31332, June 5, 2007).

The Fish and Wildlife Coordination Act requires the federal action agency to consult with the Service and CDOW on issues related to conservation of wildlife resources for federal projects resulting in modifications to waters or channels of a body of water (16 USC §§ 661-667e).

Migratory birds, including raptors and active nests, are protected under the MBTA. The MBTA prohibits activities that may harm or harass migratory birds during the nesting and breeding season. Removal of active nests that results in the loss of eggs or young is also prohibited (16 USC §§ 703-712). Executive Order 13186 directs federal agencies to take certain actions to implement the MBTA (66 Fed. Reg. 3853, January 10, 2001).

As directed by Colorado Revised Statute 33 [(Title 33, Article 2, C.R.S. (2007)], the Colorado Wildlife Commission issues regulations and develops management programs implemented by CDOW for wildlife species not federally listed as threatened or endangered. This includes maintaining a list of state threatened and endangered species. CDOW also maintains a list of species of special concern but these are not protected under Colorado wildlife statutes concerning non-game and endangered species conservation (Title 33, Article 2, C.R.S. (2007)). Although this Statute prohibits the take, possession, and sale of a state-listed species, it does not include protection of their habitat.

3.13.3 Analysis Area and Methods

3.13.3.1 Analysis Area

Existing wildlife resources were assessed and described for the study area (ERO 2007g, ERO 2008c). The analysis area was used to assess direct effects on wildlife resources. The analysis area also includes wildlife habitat along streams potentially affected by altered flow regimes (Section 3.5). Because wildlife are mobile and can be affected by disturbance outside the project footprint, the analysis area for indirect effects extended to areas that may potentially affect individual species or the wildlife community as a whole. Because the effects of the project vary among species, the analysis area also varied among species. For example, effects to sensitive shorebirds extended to several downstream reservoirs on the Arkansas River, whereas the analysis area for large game covered two scales; regional effects within the overall mapped range of the species, and local effects within an 820 foot buffer, a typical disturbance zone described in the literature. More detail on analysis area is provided in the Wildlife Resources Technical Report (ERO 2007g, 2008c).

3.13.3.2 Methods

Existing information was reviewed and special concerns related to the project were identified through coordination and consultation with the Service, CDOW, CNHP, and Colorado State Parks (CSP). TE&C wildlife species as potentially occurring in the analysis area were identified from Service (2008). Wildlife habitat was determined by site reconnaissance, vegetation mapping, aerial photography interpretation, and database review. Specific methods used for data collection are described in the Wildlife Resources Technical Report (ERO 2007g).

To determine direct effects, boundaries of habitat were digitized to GIS polygons and then intersected with analysis area shapefiles (CH2M HILL 2007h). The direct effects on large game winter range were calculated as a percentage of the total acreage of each affected range as mapped by CDOW (CNDIS 2007).

Indirect effects, including displacement of wildlife outside the project footprint due to increased noise, construction traffic, and other human disturbance, were evaluated qualitatively. Potential hydrologic changes of each alternative and the associated effect on riparian vegetation discussed in the Wetlands, Waters, and Riparian Vegetation section (Section 3.11) were used as an indicator of indirect effects on riparian wildlife species. The potential effects of construction and operation of Jimmy Camp Creek, Williams Creek, and Upper Williams Creek reservoirs on BASH at four local airports, as well as the cumulative effects on projected bird concentrations at the end of the project-planning period in 2046, were modeled and analyzed (ERO 2007a, 2008a).

Federal- and State-listed Threatened and Species Endangered and Species of Special Concern

Effects on federal- and state-listed threatened and endangered species and species of special concern were rated as negligible, minor, moderate, or major, based on the direct effects on suitable habitat as mapped in the field. The ratings are generally qualitative, based on professional knowledge of the species' habitat and behavioral requirements, seasonal use patterns, the quantity and quality of habitat affected, and discussions with state and federal agency biologists. Effects on bald eagle habitat were calculated as a percentage of available habitat. Available habitat was defined as all habitat mapped by CDOW that exists within 5 miles of any alternative component. Because the Botta's pocket gopher is restricted to Fremont County, effects on this subspecies were calculated as the total acres of impacts from each alternative within Fremont County, although actual effects probably would be restricted to a much smaller area within suitable soils near the Arkansas River.

Migratory Birds and General Wildlife

Effects on migratory birds and wildlife were based on the overall quantity of vegetated habitat affected and are based on the criteria used in the Vegetation section (Section 3.12).

Raptors and Herons

To determine the direct effects on raptors and herons from each of the alternatives, the following criteria were used:

- Negligible – no active nest sites or heron rookeries, including CDOW-recommended nest buffers (Craig 2002), within the analysis area would be affected. CDOW has no established guidelines for buffers around great blue heron nests; however, other states have buffers of 820 to 1,200 feet from the peripheries of colonies. A standard 1,000-foot buffer was established around heron rookeries for the analysis.
- Minor – fewer than three active nest sites or one heron rookery present within the analysis area would be affected.
- Moderate – between three and five active nest sites or more than one heron rookeries within the analysis area would be affected.
- Major – more than five active nest sites or heron rookeries within the analysis area would be affected.

Large Game

To determine the direct effects on large game from each of the alternatives, the following criteria were used:

- Negligible – no measurable (<1.0 percent) or perceptible consequence to the seasonal (winter/summer/ breeding) ranges.
- Minor – effects are localized, with impacts to winter/summer/breeding ranges between 1 and 10 percent of the seasonal ranges.
- Moderate – effects are localized, with impacts to winter/summer/ breeding ranges between 10 and 20 percent of the seasonal ranges.
- Major – effects are regional, or if a localized impact to winter/summer/ breeding ranges is greater than 20 percent of the seasonal ranges.

3.13.3.3 Limitations

Less than 1 percent of the study area was inaccessible for field studies. Identification of potential habitat for those properties was based on vegetation cover types mapped using aerial photography interpretation and/or aerial reconnaissance. Additionally, since field studies were conducted between 2003 and 2007, some areas of potential wildlife habitat may have changed or will change, especially in rapidly developing urban areas around Colorado Springs and Pueblo.

3.13.4 Affected Environment

Wildlife in the study area generally consists of species adapted to human-altered environments, such as suburban areas and agricultural lands. A greater diversity of species is found in aquatic and riparian habitats in the analysis area, even though these habitats have typically been disturbed by human activity.

3.13.4.1 Federally Listed Threatened and Endangered Species

Potential habitat exists within the analysis area for four federally listed species protected by the ESA: Canada lynx (lynx), Gunnison's prairie dog, Preble's, and Mexican spotted owl (Service 2008; ERO 2007g). Surveys were conducted for the Gunnison's prairie dog and none were found within the analysis area. Consequently, the Gunnison's prairie dog is not discussed further. Two other federally listed species, the Uncompahgre fritillary butterfly and black-footed ferret, were eliminated from further analysis because the analysis area lacks suitable habitat for these species. Additionally, the analysis area is within a black-footed ferret block clearance area (Service 2007). Note that the bald eagle was removed from the list of species protected under the ESA and is discussed as a state-listed species.

Canada Lynx

The Ark-Otero facilities would be located within the overall range of the Canada lynx, and telemetry data from the CDOW (Shenk 2007) indicate that areas both east and west of the facilities are low use lynx habitat. The area potentially affected by these facilities consists of sagebrush and open piñon-juniper woodlands with some willow riparian vegetation along the river. The area does not contain habitat components associated with denning, foraging, or wintering habitat of the lynx. The lynx may use the area when traversing between the east and west sides of the Arkansas River.

Preble's Meadow Jumping Mouse

The northwest portion of the Denver Basin Ground Water System (No Action Alternative) is the only component that contains Preble's known occupied range (ERO 2007g; CNDIS 2007). Although potential Preble's habitat (habitat that has vegetative components suitable for Preble's) occurs along Fountain Creek and its tributaries in El Paso County, Preble's is not known to occur south or west of Colorado Springs despite extensive survey efforts (ERO 2007g).

Mexican Spotted Owl

The Mexican spotted owl nests in rugged mountainous-forested canyons generally between 6,500 and 9,500 feet in elevation west of Colorado 115. The canyons are typically 1.5 to 2.0 miles long, and more deep than wide, with rock cliffs and/or rocky outcrops. Canyon bottoms have mature mixed conifers, Gambel oak, riparian cottonwoods, or piñon/juniper habitats (Stout and Associates 2002). The southern half of Fort Carson and much of Colorado 115 between Colorado Springs and Penrose is considered Mexican spotted owl winter range (Elwood 2008; Stout and Associates 2002). Winter roost sites have been identified in the south central portion of Fort Carson (Stout and Associates 2002;

CNHP 2006b). Occupied spotted owl habitat and two Primary Activity Areas (PAC) are present west of the analysis area near the Teller County line (Tapia 2006). No other PAC occurs near the study area.

Colorado 115 forms the eastern boundary of spotted owl critical habitat designated in the Pike National Forest in western El Paso and northern Fremont counties (69 Fed. Reg. 53182 (August 31, 2004)). Much of the Highway 115 Return Flow Pipeline and the Highway 115 Untreated Water Pipeline alignments are located within spotted owl overall range and critical habitat. However, these project components would be on the eastern edge of designated critical habitat in areas that lack the PCEs for both canyon and forested areas. Because these areas lack PCEs required by the species, they may not be considered critical habitat.

3.13.4.2 State Threatened and Endangered Species and Species of Special Concern

Potential habitat exists within the analysis area for two Colorado-listed threatened species (bald eagle and western burrowing owl) and 10 species of special concern (black-tailed prairie dog, mountain plover, ferruginous hawk, swift fox, triploid checkered whiptail lizard, Townsend's big-eared bat, peregrine falcon, plains leopard frog, northern leopard frog, and Botta's pocket gopher). Although each of these species has a unique set of habitat requirements, they can be placed into three broad categories based on their habitat affinities: upland species; rock outcrop/cliff/canyon-associated species; and riparian/wetland species. The bald eagle, a wide-ranging species that will use several vegetation communities depending on seasonal requirements and activities, and the Botta's pocket gopher, a species that is restricted in overall range, do not fall under these categories and are discussed separately. Complete descriptions of state threatened and endangered species and species of special concern occurring in Chaffee, Pueblo, Fremont, and El Paso counties are provided in the Wildlife Resources Technical Report (ERO 2007g).

Upland Species

State listed upland species include the black-tailed prairie dog, western burrowing owl, mountain plover, ferruginous hawk, swift fox, and triploid checkered whiptail. Burrowing owl and mountain plover are closely associated with the habitat provided by active prairie dog colonies and collectively are called Prairie Dog Associates. The ferruginous hawk preys on prairie dogs; however, ferruginous hawk, as well as swift fox and triploid checkered whiptail, are wide-ranging grassland species.

Prairie Dog Associates

Active prairie dog colonies are found throughout the analysis area. Large colonies exist along the Central Untreated Water Pipeline, the Eastern Untreated Water Pipeline, Eastern Return Flow Pipeline, Western Untreated Water Pipeline, and along the Highway 115 Return Flow and Untreated Water pipeline alignments. More than 5,000 acres of prairie dog colonies are found adjacent to the analysis area with 538 acres within the analysis area (ERO 2007g).

Additional suitable habitat for the mountain plover exists in extensively grazed or shortgrass prairie in Pueblo County and eastern El Paso County. Because this species inhabits low growing vegetation (<6 inches) with extensive bare ground and minimal shrubs (Knopf 1996), suitable habitat for this species declines west of I-25 and within the Jimmy Camp Creek Reservoir site.

Wide-ranging Upland Species
Suitable breeding and/or wintering habitat for ferruginous hawk and swift fox exists within or near all reservoir sites, pipeline alignments, and associated pump stations. Habitat for the triploid checkered whiptail (a lizard) is also found within all alternatives in Pueblo and Fremont counties near Fountain Creek or the Arkansas River. All three species generally avoid urbanized areas and are not found in Chaffee County (CNDIS 2007).

Rock Outcrop/Cliff/Canyon Species
Suitable habitat for the Townsend's big-eared bat and peregrine falcon exists west of the Highway 115 Return Flow Pipeline and Untreated Water Pipeline alignments (CNHP 2006b). Roosting habitat for Townsend's big-eared bat occurs in rocky areas in western portions of the analysis area, and suitable breeding habitat for the peregrine falcon exists in canyon areas in western El Paso and Fremont counties.

Riparian/Wetland Species
Riparian and wetland areas throughout the analysis area provide suitable habitat for plains and northern leopard frogs. The range of the plains leopard frog in Colorado includes the eastern edge and southwest corner of the state. Habitat for this species occurs along the Arkansas River in Pueblo and Fremont counties, and Fountain Creek in Pueblo and southern El Paso counties (Hammerson 1999). Suitable northern leopard frog habitat includes wetland areas containing a permanent water source and this species has been observed in several wetland areas and at the Jimmy Camp Creek and Williams Creek Reservoir sites within the analysis area (ERO 2007g; Stout and Associates 2003).

Bald Eagle
Although the bald eagle was officially removed from the federal list of threatened and endangered species in 2007, it remains listed as a Colorado threatened species and continues to be federally protected under the MBTA and the Bald and Golden Eagle Protection Act. The nearest active bald eagle nests are about 10 miles north of Cañon City and 10 miles east of Pueblo (CNDIS 2007). Most of Fountain Creek south of Colorado Springs, the lower reaches of Jimmy Camp Creek, and the Upper Arkansas River are mapped as bald eagle winter range (CNDIS 2007). Both the Arkansas River upstream of Pueblo Reservoir Dam and downstream of the Fountain Creek confluence are bald eagle winter concentration areas. Additionally, the upper end of Pueblo Reservoir and the area immediately downstream of the dam are mapped as winter roost sites (CNDIS 2007). The upper end of Pueblo Reservoir is an important winter use area with up to 30 bald eagles communally roosting in winter (ERO 2007g). None of the reservoir sites or the Ark-Otero Powerline or Intake are located within bald eagle winter or roosting areas (CNDIS 2007).

Botta's Pocket Gopher
The Botta's pocket gopher is likely to occur in riparian and prairie habitat dominated by sandy soils near the Arkansas River between Florence and Cañon City. Potential habitat for this species within the analysis area occurs along the Colorado 115 corridor in Fremont County.

3.13.4.3 CNHP Species
Several butterfly species considered imperiled, rare, or vulnerable in the state (CNHP 2007) potentially occur within the analysis area. The dusted skipper, Ottoe skipper, and regal fritillary inhabit mid- to tallgrass prairies that

support an abundance of big and/or little bluestem. The Rhesus skipper inhabits blue grama grasslands. Isolated patches of suitable upland habitat for these four species may occur throughout the analysis area (ERO 2007g, 2008c).

The Moss' elfin and mottled duskywing inhabit foothill/canyon areas and open woodlands. The Moss' elfin prefers cliffs, canyons, and thin-soiled or rocky north-facing slopes dominated by yellow stonecrop. The mottled duskywing occurs in foothill woodlands (ERO 2007g). Suitable habitat for these two species occurs along Colorado 115.

Several species, including common hog-nosed skunk, hops feeding azure, and ovenbird, are not discussed further because the analysis area lacks any suitable habitat or is outside of the known distribution of the species (ERO 2007g).

3.13.4.4 Raptors, Herons and Other Migratory Birds

Raptors

Raptors commonly occurring in and near the analysis area year round include red-tailed hawk, great horned owl, and American kestrel. Other raptors likely to occur near the analysis area are Cooper's hawk and Swainson's hawk in summer, and ferruginous hawk, northern harrier, and rough-legged hawk in winter.

Active raptor nests are found within the analysis area at the Jimmy Camp Creek, Williams Creek, and Upper Williams Creek Reservoir sites (ERO 2007g). Other potential raptor nests and tree cavities containing breeding American kestrels occur throughout the analysis area. An active golden eagle nest is located along the Bradley Road Realignment north of the Upper Williams Creek Reservoir site.

Herons

Great blue heron rookeries are found at five locations within or near the analysis area (ERO 2007g). Active rookeries exist on Fountain Creek northwest of the City of Fountain and south of the Western Untreated Water Pipeline alignment. Rookeries also occur on the Arkansas River near the upper end of Pueblo Reservoir and at two locations between Cañon City and Pueblo Reservoir (ERO 2007g).

Other Migratory Birds

Nearly all bird species present in the analysis area are protected under the MBTA. Bird species use different habitat types in the analysis area for shelter, breeding, wintering, and foraging at various times during the year. All of the SDS Project components in the analysis area contain habitat for migratory birds.

3.13.4.5 Large Game and Other Wildlife

Overall range for large game wildlife species such as elk, mule deer, pronghorn, and wild turkey occurs throughout the analysis area. Overall range, winter range, winter concentration areas, and severe winter range for several large game species have been identified within the study area (CNDIS 2007) and are described in the Wildlife Resources Technical Report (ERO 2007g).

The effects of permanent and temporary loss of habitat for all large game species were evaluated at a regional (percentage of seasonal habitats available within the region) and local (percentage of seasonal habitat available within a 820-foot buffer from the edge of project components) scales. The CDOW has not identified any large game migration corridors within the analysis area; however, permanent and temporary disturbance within large game winter ranges could effect movements between and within important seasonal habitats. Most permanent facilities would be located outside of any large game winter range, winter concentration area, or severe winter range, but several pipelines would traverse important large game seasonal ranges. All pipelines would be underground and installation of these pipelines is considered a temporary impact.

3.13.5 Environmental Consequences

3.13.5.1 Direct and Indirect Effects

Federal Threatened and Endangered Species

The No Action Alternative would have a moderate adverse effect on Preble's occupied habitat (Table 116). This alternative would result in 0.2 acre of permanent habitat loss and temporary disturbance to about 50 acres of occupied Preble's habitat from construction of the Denver Basin Ground Water System. This alternative may also result in minor temporary displacement of lynx and Mexican spotted owl from low density/low use habitats.

The No Action Alternative would have negligible effects on designated Mexican spotted owl critical habitat because the Colorado 115 corridor lacks essential PCEs and would not likely result in adverse modification of habitat (Table 116). The Highway 115 Alternative would have the same effects on the lynx and Mexican spotted owl as the No Action Alternative. The Participants' Proposed Action, Wetland, Arkansas River, Fountain Creek, and Downstream Intake alternatives would have negligible effects on federally listed species or critical habitat (Table 116).

State Threatened and Endangered Species and Species of Special Concern

Uplands – Prairie Dog Associates

The No Action Alternative would have minor effects on black-tailed prairie dogs and species closely associated with prairie dog colonies (burrowing owl and mountain plover), including prairie dog colonies and suitable burrowing owl habitat on Fort Carson.. About 16 acres of existing prairie dog colonies would be permanently affected by the No Action Alternative and 41 acres would be temporarily affected, the total of which is about 0.8 percent of the 5,000 acres of prairie dog colonies within or adjacent to the analysis area (Table 117). The Action Alternatives would range from 12 acres of permanent effects on prairie dog colonies and 41 acres of temporary effects in the Downstream Intake Alternative to 27 acres of permanent effects and 90 acres of temporary effects in the Wetland Alternative (Table 117). Compared to the No Action Alternative, effects on prairie dog colonies would be comparable in extent and magnitude for the Action Alternatives.

Uplands – Wide-ranging Species

The No Action Alternative would have a moderate adverse effect on ferruginous hawk and swift fox from permanent and temporary effects on native upland habitat (Table 117). Most of the project components would be on the western edge of the range of these species, and overall permanent and temporary habitat loss would be a small percentage of the habitat available.

Table 116. Permanent (P) and Temporary (T) Effects on Habitat for Federally Listed Threatened and Endangered Species by Alternative.

Resource	No Action Alternative		Participants' Proposed Action		Wetland Alternative		Arkansas River Alternative		Fountain Creek Alternative		Downstream Intake Alternative		Highway 115 Alternative	
	P	T	P	T	P	T	P	T	P	T	P	T	P	T
Canada Lynx	No effect	Temporary displace-ment from about 6 miles of movement corridors in low-use areas	No effect	No effect	No effect	No effect	No effect	No effect	No effect	No effect	No effect	No effect	No effect	Temporary displace-ment from about 6 miles of movement corridors in low-use areas
Preble's occupied habitat	<1	50	0	0	0	0	0	0	0	0	0	0	0	0
Mexican Spotted Owl critical habitat†	45	77	0	0	45	93	45	96	0	0	0	0	45	77

Effects are in acres (rounded to the nearest whole number).

†Although this analysis calculates impacts to designated critical habitat, the area to be permanently and temporarily affected is on the extreme edge of critical habitat adjacent to Colorado 115 in areas that lack adequate PCEs.

Table 117. Permanent (P) and Temporary (T) Direct Effects on Habitat for State Threatened and Endangered Wildlife Species and Wildlife Species of Special Concern by Alternative.

Resource	No Action Alternative		Participants' Proposed Action		Wetland Alternative		Arkansas River Alternative		Fountain Creek Alternative		Downstream Intake Alternative		Highway 115 Alternative	
	P	T	P	T	P	T	P	T	P	T	P	T	P	T
Uplands – Prairie Dog Associates														
Black-tailed Prairie Dog	16	41	23	69	27	90	17	59	24	70	12	41	16	48
Western Burrowing Owl	16	41	23	69	27	90	17	59	24	70	12	41	16	48
Mountain Plover														
High Potential (prairie dog colonies)	16	41	23	69	27	90	17	59	24	70	12	41	16	48
Low Potential (grasslands)	1,743	1,219	2,391	720	1,369	945	846	1,088	1,878	1,084	1,790	883	1,742	937
Uplands – Wide-ranging Species														
Ferruginous Hawk	2,093	1,444	2,426	790	1,462	1,183	1,179	1,415	2,173	1,309	2,066	1,036	2,092	1,142
Swift Fox	1,897	1,296	2,424	784	1,408	1,041	1,027	1,273	2,070	1,300	1,965	1,032	1,896	1,003
Triploid Checkered Whiptail	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Dusted Skipper	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Ottoe Skipper	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Rhesus Skipper	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Regal Fritillary	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Rock Outcrop/Cliff/Canyon Species														
Townsend's Big-eared Bat		X				X		X						X
Peregrine Falcon		X				X		X						X
Moss' Elfin	X	X			X	X	X	X					X	X
Mottled Duskywing	X	X			X	X	X	X					X	X
Riparian/Wetland Species														
Plains Leopard Frog	108	5	103	11	5	11	14	7	112	11	112	7	108	1
Northern Leopard Frog	108	5	103	11	5	11	14	7	112	11	112	7	108	1
Other														
Bald Eagle														
Winter Roost	1	0	12	29	12	0	0	0	29	12	0	0	0	0
Winter Concentration	14	2	6	7	7	10	1	4	6	7	6	2	13	2
Winter Range	59	52	19	17	10	18	17	12	18	16	23	16	58	52
Botta's Pocket Gopher	140	212	0	0	83	218	83	218	0	0	0	0	140	212

Effects are in acres (rounded to the nearest whole number). X = Potential habitat for the species present within the analysis area, but not quantified due to limited data on species range and patchy distribution

Overall, the Participants' Proposed Action, Fountain Creek, Downstream Intake, and Highway 115 alternatives would have similar moderate effects on wide-ranging upland species as the No Action Alternative. Although the overall acres of disturbance (permanent and temporary) would be less under these alternatives, effects would be moderate because of the loss of large contiguous blocks of habitat associated with any of the reservoirs. The Participants' Proposed Action would have the highest permanent disturbance and lowest temporary disturbance to grassland habitat, because of the construction of two reservoirs in grassland habitat and fewer miles of pipelines.

The Wetland and Arkansas River alternatives would have minor effects on wide-ranging upland species. The overall acreage of permanent and temporary disturbed habitat would be about 25 percent less than the No Action Alternative (Table 117). All alternatives would have similar effects on habitat for the triploid checkered whiptail.

Rock Outcrop/Cliff/Canyon Species

The No Action Alternative would have minor effects on sensitive species associated with rock outcrop, cliff, and canyon habitats. Potential habitat for these species is present, but more extensive habitat is available farther west of the analysis area on National Forest land or in less disturbed areas. No breeding or roosting habitat for the peregrine falcon and Townsend's big-eared bat exists within the analysis area, and the area would only occasionally be used for foraging or during migration.

The Wetland, Arkansas River, and Highway 115 alternatives would affect species associated with rock outcrop, cliff, and canyon habitats, similar to the No Action Alternative. The Participants' Proposed Action, Fountain Creek, and Downstream Intake alternatives would have no effect on species associated with these habitats, which compared to the No Action Alternative would be a beneficial effect.

Riparian/Wetland Species

The No Action Alternative would have moderate adverse direct effects on habitat for wetland and riparian species (leopard frogs). This alternative would permanently affect 108 acres and temporarily disturb 5 acres of wetland and riparian habitat (Table 117). Although this alternative would affect a small percentage of the suitable riparian and wetland habitat available along the Arkansas River and Fountain Creek, the overall effect would be moderate because riparian and wetland habitats are important habitats in Colorado.

The Participants' Proposed Action, Fountain Creek, Downstream Intake, and Highway 115 alternatives would permanently affect wetland and riparian associated species similar in magnitude as the No Action Alternative (Table 117). The Wetland and Arkansas River alternatives would permanently affect substantially less wetland and riparian habitat (5 and 14 acre, respectively) compared to the No Action Alternative. The Wetland and Arkansas River alternatives would have major beneficial effects on wetland and riparian species habitat compared to the No Action Alternative.

Bald Eagle

The No Action Alternative would have negligible effects on bald eagle winter roost sites and minor effects on winter range and winter concentration areas. This alternative would permanently affect less than 1 acre of winter roost below the Pueblo Reservoir dam. Effects on bald eagle winter habitat would include about 59 acres of permanent habitat loss of winter range 14 acres of permanent loss of winter concentration area, 52 acres of temporary disturbance to winter range, and 2 acres of temporary disturbance to winter concentration area) (Table 117). Effects of the Highway 115 Alternative on eagle winter range and winter concentration areas would be essentially identical to the No Action Alternative. All other Action Alternatives would permanently and temporarily affect substantially less bald eagle winter range than the No Action Alternative (range: 10 to 23 acres of permanent effects). The effects of these alternatives on eagle winter range and winter concentration areas would be less than 1 percent of the available habitat.

The Participants' Proposed Action, Wetland, and Fountain Creek alternatives would have minor effects on bald eagle winter roost sites. The permanent effects to winter roost areas below Pueblo Reservoir dam would be greater (Between 12 and 29 acres vs. 1 acre) for these three alternatives compared to No Action Alternative; however, the permanent loss of winter roosting habitat would be less than 3 percent of the overall available habitat. The Arkansas River and Downstream Intake alternatives would have no effects on bald eagle winter roost sites.

Botta's Pocket Gopher

The No Action Alternative would have minor effects on potential habitat for the Botta's pocket gopher. The No Action Alternative would result in 140 acres of permanent habitat loss and 212 acres of temporary habitat disturbance (Table 117). The Highway 115 Alternative would have the same effects as the No Action Alternative. The remaining Action Alternatives would have less disturbance of Botta's pocket gopher habitat and would be beneficial compared to the No Action Alternative. The Participants' Proposed Action, Fountain Creek, and Downstream Intake alternatives would not permanently affect habitat for the species, and the Wetland and Arkansas River alternatives would permanently disturb 83 acres of potential habitat, 57 acres less than the No Action Alternative.

CNHP Species

Permanent and temporary effects on native upland habitat would have a potential moderate adverse effect on the dusted skipper, Ottoe skipper, Rhesus skipper, and regal fritillary. Construction and operation of Jimmy Camp Creek and Williams Creek reservoirs under the No Action Alternative would result in the greatest permanent loss of native upland habitat (Section 3.12). Habitat, more specifically host plants, for the CNHP-listed upland butterfly species, is limited and patchy within the analysis area; however, individuals and local populations may be permanently lost or displaced by reservoir construction and operations. More suitable canyon habitat for the Moss' elfin and mottled duskywing occurs outside of analysis area, and all alternatives would have negligible effects on these species.

Raptors and Herons

The No Action Alternative would have a major effect on raptors. Construction and inundation of Jimmy Camp Creek and Williams Creek reservoirs would permanently displace five active raptor nests located within 0.25 mile of the edge of the study area during surveys in 2005 and 2006. Construction activity for the Highway 115 Powerline may displace an additional two active nest sites (Table 118). No heron rookeries would be directly affected by the No Action Alternative.

Table 118. Permanent (P) and Temporary (T) Effects on Terrestrial Wildlife Habitat by Alternative.

Resource	No Action Alternative		Participants' Proposed Action		Wetland Alternative		Arkansas River Alternative		Fountain Creek Alternative		Downstream Intake Alternative		Highway 115 Alternative	
	P	T*	P	T*	P	T*	P	T*	P	T*	P	T*	P	T*
Migratory Birds – Raptors (Number of known nests displaced)[†]														
Jimmy Camp Creek	3	NA	NA	NA	NA	NA	3	NA	3	NA	3	NA	3	NA
Williams Creek	2	NA	2	NA	NA	NA	NA	NA	2	NA	2	NA	2	NA
Upper Williams Creek	NA	NA	1	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA
Pipelines and permanent facilities	2	NA	1	NA	2	NA	2	NA	1	NA	1	NA	2	NA
Migratory Birds – Herons (Number of known rookeries disturbed)[†, ‡]														
	0	0	1	1	1	1	0	0	1	1	0	0	0	0
Migratory Birds and Wildlife – General (Acres disturbed)														
	2,329	1,635	2,632	890	1,535	1,290	1,279	1,516	2,424	1,409	2,310	1,125	2,327	1,236
Total (P + T)	3,964		3,522		2,835		2,795		3,833		3,435		3,563	
Waterbirds (Shorebirds/Waterfowl)[§]														
Turquoise Lake	NA / 0		NA / 0		NA / 0		NA / 0		NA / 0		NA / 0		NA / 0	
Twin Lakes	NA / -		NA / +		NA / +		NA / +		NA / +		NA / 0		NA / 0	
Pueblo Reservoir	NA / +		NA / -		NA / +		NA / +		NA / -		NA / -		NA / -	
Plains Reservoirs	+ / -		+ / -		+ / -		+ / -		+ / -		+ / - (Meredith +)		+ / -	
Proposed Reservoirs	NA /+		NA /+		NA /+		NA /+		NA /+		NA /+		NA /+	
Large Game Seasonal Ranges (Acres disturbed)[‡]														
Elk														
Severe	15	23	0	0	0	0	0	0	0	0	0	0	15	23
Winter	160	307	9	25	87	208	80	197	6	18	2	7	160	295
Overall	190	379	20	27	102	281	122	307	31	57	48	52	190	349
Mule Deer														
Severe	154	221	0	0	78	211	78	208	0	0	0	0	154	221
Winter	286	547	72	130	222	624	194	578	102	211	44	80	285	505
Overall	2,398	1,774	2,534	773	1,506	1,241	1,215	1,468	2,333	1,125	2,248	1,018	2,397	1,326
White-tailed Deer														
Overall	90	172	19	16	31	67	62	101	33	54	56	54	90	154
Pronghorn														
Winter	1	0	117	246	117	246	26	0	117	246	26	0	0	0

Resource	No Action Alternative		Participants' Proposed Action		Wetland Alternative		Arkansas River Alternative		Fountain Creek Alternative		Downstream Intake Alternative		Highway 115 Alternative	
	P	T*	P	T*	P	T*	P	T*	P	T*	P	T*	P	T*
Overall	2,179	1,342	2,249	1,062	1,400	1,073	1,120	1,040	2,333	1,318	2,238	980	2,178	906
Large Game Movement Corridors (Miles of underground pipeline creating a potential temporary barrier during construction and restoration)														
Miles of pipeline within winter ranges	0	71	0	30	0	87	0	63	0	36	0	7	0	71
Wild Turkey Seasonal Ranges (Merriam's and Rio Grande)‡														
Winter Concentration	67	155	1	3	73	210	74	216	1	2	2	2	66	152
Overall	189	377	7	18	131	390	145	406	4	28	26	33	189	375

* Only permanent effects of alternatives on raptors nests were evaluated; temporary effects would be avoided by adhering to CDOW guidelines.
† Source: field studies
‡ Source: CNDIS 2007.
§ 0 = Negligible, + = Benefit, - = Adverse.
NA = Not Applicable

The Participants' Proposed Action would contribute to major permanent direct effects on raptors similar to the No Action Alternative. In addition to the effects on raptor nests at the Jimmy Camp Creek and Williams Creek Reservoir sites, this alternative could permanently displace an active nest site along the Western Untreated Water Pipeline (Table 118). The Western Untreated Water Pipeline alignment would be within the standard buffer zone of an active heron rookery and may directly affect nesting herons if construction of this alternative were to occur during nesting.

The Wetland Alternative would have moderate direct effects on breeding raptors, less than the No Action Alternative. This alternative would permanently displace an active raptor nest within Upper Williams Creek Reservoir and along the Western Untreated Water Pipeline alignment (Table 118). The realignment of Bradley Road would be south of the reservoir and more than the recommended 0.5-mile buffer distance from an active golden eagle nest. An active heron rookery south of the Western Untreated Water Pipeline alignment crossing on Fountain Creek could also be directly affected if construction were to occur during nesting (Table 118).

The Arkansas River Alternative would have less effect on raptors than the No Action Alternative. It would permanently displace four active raptor nests, resulting in moderate direct effects on raptors (Table 118). This alternative would not impact any heron rookeries.

The Fountain Creek Alternative would have major direct effects on raptors, similar to the No Action Alternative. This alternative could permanently displace raptors from nests in the Jimmy Camp Creek and Williams Creek reservoirs and along the Western Untreated Water Pipeline alignment (Table 118). The Western Untreated Water Pipeline alignment would be within the standard buffer zone of an active heron rookery and may directly affect nesting herons if construction of this alternative were to occur during nesting.

The Downstream Intake Alternative could permanently displace raptors from nests in the Jimmy Camp Creek and Williams Creek reservoirs and near the Arkansas River Downstream of the Confluence Pump Station. This alternative would not directly affect herons. The effects of the Highway 115 Alternative on raptors and herons would be the same as the No Action Alternative (Table 118).

Waterbirds (Waterfowl and Shorebirds)

Hydrological changes from the operation of the proposed project could have both beneficial and adverse effects on aquatic wildlife, including waterfowl and shorebirds. Six reservoirs (Turquoise, Twin Lakes, Pueblo, Lake Henry, Lake Meredith, and Holbrook) and the waterbird habitat they provide would be potentially affected by the proposed project (Section 3.5). In general, reservoir operations that result in delayed spring filling, with relatively stable water levels through early to mid-summer benefit nesting shorebirds; however, daily or weekly fluctuations in water levels during nesting could inundate nest sites or expose nests to predation. Conversely, overall lower reservoir levels decrease aquatic insects, fish populations, and foraging habitat for waterfowl. Hydrological effects on the Lower Arkansas River from the Colorado Canal to the inlet of John Martin Reservoir would be negligible (GEI 2008a, 2008b); thus, any effects to waterbirds at John Martin Reservoir also would be negligible. The following analysis is based on the Supplemental Hydrology Administrative Record Documentation (2008d), Surface Water Hydrology Effect Administrative Record Documentation (MWH 2008d), Aquatic

Resources Effects Analysis (GEI 2008a), and Aquatic Resources Administrative Record Documentation (GEI 2008b).

Shorebirds

Three shorebird species—piping plover, interior least tern, and snowy plover—are either state and/or federally listed species. In Colorado, all three species nest on sandy beaches and islands of manmade reservoirs in eastern Colorado (Kingery 1998), most notably John Martin, Adobe Creek, Neenoshe, and Neegrande Reservoirs (Nelson 2005). Nesting habitat for these species is unpredictable and the distribution and abundance of all three species varies annually with reservoir water levels. None of the reservoirs potentially affected by the project currently provide any known nesting habitat for listed shorebirds; however, changing hydrological conditions would alter the amount of suitable habitat available to these, and other shorebird species at the three plains reservoirs, Lake Henry, Lake Meredith, and Holbrook Reservoir.

Generally, the No Action Alternative would result in the three plains reservoirs being lower for a longer period through spring and summer, benefiting shorebirds (Table 118). Water levels at Lake Henry between April and May would be within the range of variability compared to the No Action Alternative, and any effects to shorebirds would be negligible. Water levels at Lake Meredith are similar in April among all alternatives and decline within the range of variability compared to the No Action Alternative through mid June. Water levels in Lake Meredith continue to recede into August under the No Action Alternative, while the other alternatives would begin to fill in late June and July, possibly flooding late nesting shorebirds resulting in minor to moderate adverse effects compared to the No Action Alternative. At Holbrook Reservoir, all alternatives would have a steady drawdown in April, remain stable in May and June, and then experience a second drawdown in July. All Alternatives, including the No Action Alternative, would be equally beneficial for shorebirds.

Waterfowl

Effects on waterfowl (Table 118) closely reflect the effects of altered water levels on aquatic vegetation, invertebrates, and forage fish described in the Aquatic Resources Effects Analysis Report (GEI 2008a) and Aquatic Resources Administrative Record Documentation (GEI 2008b). Effects on waterfowl at Turquoise Lake would be negligible under all alternatives. The No Action Alternative would have minor adverse effects on waterfowl at Twin Lakes, Lake Henry, and Lake Meredith, and minor to moderate beneficial effects at Pueblo Reservoir and Holbrook Reservoir. All Action Alternatives would have negligible to slightly beneficial effects on waterfowl at Twin Lakes compared to the No Action Alternative. The Participants' Proposed Action, Fountain Creek, Downstream Intake, and Highway 115 alternatives would have minor to moderate adverse effects on waterfowl; the Wetland and Arkansas River alternatives would have slightly beneficial effects compared to the No Action Alternative. The Downstream Intake Alternative would have a slight beneficial effect on waterfowl at Lake Meredith; all other Action Alternatives would have negligible to moderate adverse effects resulting from lower water levels for longer.

All alternatives, including the No Action Alternative, would include the construction of at least one new reservoir. Once constructed, these reservoirs would provide a net benefit to waterfowl by providing new aquatic habitat to be inhabited by breeding, migrating, and wintering waterfowl. The indirect adverse effects of potentially attracting waterfowl near airports are described in the BASH report and BASH Administrative Record Documentation (ERO 2007a, 2008a).

Other Wildlife and Migratory Birds

Effects on general wildlife and migratory birds would include habitat loss, disruption of migration, dispersal, and other movements, especially along riparian corridors, increased habitat fragmentation, and possible destruction of nests or dens during construction. Effects from permanent habitat loss or temporary disturbance on wildlife and migratory birds would be closely tied to the effects on the vegetation communities that support terrestrial wildlife habitat. The No Action Alternative would result in major direct effects on wildlife habitat that include permanent loss of 2,329 acres of habitat and displacement from 1,635 acres during construction (Table 118). Some of the adverse impacts would be offset by shoreline and open water habitat created by construction and operation of two new reservoirs. A negligible amount of wetland and riparian habitat may establish downstream of the dams.

The Participants' Proposed Action, Fountain Creek, Downstream Intake, and Highway 115 alternatives would result in major permanent direct effects on wildlife and migratory bird habitat similar to the No Action Alternative. Permanent effects of these alternatives range between 2,310 acres for the Fountain Creek Alternative and 2,632 acres for the Participants' Proposed Action, although temporary effects of the Participants Proposed Action (890 acres) would be substantially less than the No Action Alternative (Table 118).

The effects on wildlife and migratory bird habitat from the Wetland and Arkansas River alternatives would be less than the No Action Alternative. The Wetland Alternative would have 1,535 acres of permanent effects and 1,290 acres of temporary effects on wildlife and migratory bird habitat; the Arkansas River Alternative would have 1,279 acres of permanent effects and 1,516 acres of temporary effects on wildlife and migratory bird habitat (Table 118).

Large Game Habitat

Overall range for large game wildlife species such as elk, mule deer, and pronghorn occurs throughout the analysis area. Overall range, winter range, winter concentration areas, and severe winter range for several large game species have been identified within the analysis area (Table 118) (CNDIS 2007) and are described in the Wildlife Resources Technical Report (ERO 2007g). The effects of permanent and temporary loss of habitat for all large game species under all alternatives would be negligible at the regional level (<1 percent of habitat available (ERO 2007g).

The effects of permanent and temporary loss of habitat for all large game species were also evaluated at a local scale (percentage of seasonal habitat available within a 820-foot buffer from the edge of project components, or 820 feet on both sides of a pipeline for a total 1,640-foot buffer, Table 119 and Table 120). All alternatives, including the No Action Alternative, would have negligible to minor (<10 percent of local habitat available) temporary effects across all seasonal ranges for elk, mule and white-tailed deer and pronghorn (Table 120).

Table 119. Acreage and Percentage of Permanent Impact to Big Game Seasonal Ranges at the Local Scale.

Resource–seasonal range	No Action Alternative		Participants' Proposed Action		Wetland Alternative		Arkansas River Alternative		Fountain Creek Alternative		Downstream Intake Alternative		Highway 115 Alternative	
	Acres	% of range within 500 m buffer (total acres)	Acres	% of range within 500 m buffer (total acres)	Acres	% of range within 500 m buffer (total acres)	Acres	% of range within 500 m buffer (total acres)	Acres	% of range within 500 m buffer (total acres)	Acres	% of range within 500 m buffer (total acres)	Acres	% of range within 500 m buffer (total acres)
Elk														
Severe	15	1.6 (925)	0	0	0	0	0	0	0	0	0	0	15	1.6 (925)
Winter	160	2.6 (6208)	9	2.1 (425)	87	2.3 3831)	80	2.3 (3552)	6	2.2 (291)	2	1.8 (139)	160	2.7 (6005)
Overall	190	2.5 (7488)	20	2.7 (719)	102	2.1 (4824)	132	2.2 (6105)	45	2.8 (1607)	60	4.0 (1511)	202	2.8 (7240)
Mule Deer														
Severe	154	3.4 (4579)	0	0	78	2.2 (3498)	78	2.2 (3498)	0	0	0	0	154	3.4 (4579)
Winter	286	2.9 (10031)	72	2.7 (2675)	222	1.9 (11433)	194	1.9 (10336)	102	2.5 (4028)	44	2.8 (1567)	285	2.8 (10025)
Overall	2398	7.7 (31162)	2534	14.8 (17103)	15.6	7.2 (20873)	1215	5.6 (21742)	2323	11.3 (20529)	2248	12.5 (17962)	2397	9.8 (24467)
White-tailed Deer														
Overall	90	2.9 (3070)	19	3.8 (504)	31	2.6 (1189)	62	3.0 (2050)	33	2.7 (1204)	56	4.0 (1408)	90	3.2 (2847)
Pronghorn														
Winter	1	1.8 (34)	117	2.6 (4526)	117	2.6 (4526)	26	2.9 (889)	117	2.6 (4526)	26	2.6 (889)	0	0
Overall	2165	9.8 (22147)	2565	14.0 (18384)	1468	8.7 (16667)	1128	6.7 (16736)	2323	10.3 (22876)	2224	12.2 (18241)	2164	13.6 (15966)

Table 120. Acreage and Percentage of Temporary Impact to Big Game Seasonal Ranges at the Local Scale.

Resource–seasonal range	No Action Alternative		Participants' Proposed Action		Wetland Alternative		Arkansas River Alternative		Fountain Creek Alternative		Downstream Intake Alternative		Highway 115 Alternative	
	Acres	% of range within 500 m buffer (total acres)	Acres	% of range within 500 m buffer (total acres)	Acres	% of range within 500 m buffer (total acres)	Acres	% of range within 500 m buffer (total acres)	Acres	% of range within 500 m buffer (total acres)	Acres	% of range within 500 m buffer (total acres)	Acres	% of range within 500 m buffer (total acres)
Elk														
Severe	23	2.5 (925)	0	0	0	0	0	0	0	0	0	0	23	2.5 (925)
Winter	307	4.9 (6208)	25	5.8 (425)	208	5.4 (3831)	197	5.5 (3552)	18	6.1 (291)	7	4.8 (139)	295	4.9 (6005)
Overall	379	5.1 (7488)	27	3.8 (719)	281	5.8 (4824)	307	5.7 (5436)	57	4.3 (1349)	52	3.7 (1402)	349	4.9 (7150)
Mule Deer														
Severe	221	4.8 (4579)	0	0	221	6.0 (3498)	208	5.9 (3498)	0	0	0	0	221	4.8 (4579)
Winter	504	5.0 (10031)	130	4.9 (2675)	624	5.5 (11433)	578	5.6 (10336)	211	5.2 (4028)	80	5.1 (1567)	505	5.0 10025)
Overall	1774	5.7 (31162)	773	4.5 (17103)	1241	6.0 (20873)	1468	6.8 (21742)	1124	5.5 (20529)	1018	5.7 (17996)	1325	5.4 (24467)
White-tailed Deer														
Overall	173	5.6 (3070)	16	3.3 (504)	67	5.7 (1189)	101	4.9 (2050)	54	4.5 (1204)	54	3.8 (1408)	154	5.4 (2847)
Pronghorn														
Winter	0	0	246	5.4 (4526)	246	5.4 (4526)	0	0	246	5.4 (4526)	0	0	0	0
Overall	1296	5.6 (22147)	866	4.7 (18384)	972	5.8 (16867)	1054	6.3 (16736)	1255	5.5 (22876)	969	5.3 (18241)	860	5.4 (15966)

The No Action and Highway 115 alternatives would have very similar minor permanent effects on elk, mule deer and white tailed deer seasonal ranges (Table 119). The Participants' Proposed Action, Wetland, Arkansas River, Fountain Creek, and Downstream Intake Alternatives would have negligible effects on elk severe winter range.

All Action Alternatives would have similar (minor) adverse effects on elk winter and overall ranges and mule deer winter range, and white-tailed deer overall range as the No Action Alternative.

All Action Alternatives would have similar (minor) adverse effects on mule deer winter range. The No Action, Wetland, and Arkansas River alternatives would have minor (< 10 percent) permanent local adverse effects to mule deer overall range.

The Participants' Proposed Action, Fountain Creek and Downstream Intake alternatives would have would have negligible permanent effects on mule deer severe winter range. The Participants' Proposed Action, Fountain Creek, and Downstream Intake alternatives would have moderate (10 to 25 percent of local habitat affected) permanent adverse effects to mule deer overall range, with effects from the Highway 115 Alternative approaching moderate (9.8 percent).

Effects on pronghorn winter range would be negligible for the Highway 115 alternative and minor for all other alternatives, including the No Action Alternative. The Participants' Proposed Action, Fountain Creek, Downstream Intake, and Highway 115 alternatives would have moderate adverse permanent effects on pronghorn overall range, with effects from the No Action Alternative approaching moderate (9.8 percent).

Large Game Movement Corridors

Impacts on large game movement corridors can have many potential effects on wildlife, including habitat fragmentation, reduced access to habitat, population fragmentation and isolation, and disruption of dispersal patterns. No large game migration corridors as defined by CDOW have been identified in El Paso, Pueblo and eastern Fremont counties. However, large game movements to and from or within winter ranges may be temporarily obstructed during construction of pipelines within winter range, severe winter range and winter concentration areas. The effects of all alternatives on large game movements within the various winter ranges of elk, mule deer, and pronghorn combined would be temporary and minor (Table 118).

Wild Turkey (Merriam's and Rio Grande)

The No Action Alternative would have permanent adverse effects on 189 acres of overall wild turkey range, including 67 acres of winter concentration area (Table 118). This alternative would also have temporary adverse effects on 377 acres of overall turkey range, including 155 acres of winter concentration area. The Wetland, Arkansas River, and Highway 115 alternatives would have adverse effects similar in magnitude as the No Action Alternative. The Participants' Proposed Action, Fountain Creek, and Downstream Intake alternatives would have adverse effects much lower than the No Action Alternative, permanently impacting less than 26 acres of overall wild turkey range and 3 acres of winter concentration area (Table 118).

Bird/Wildlife Aircraft Strike Hazard

None of the reservoir configurations would affect potential bird concentration areas within the flight paths of Butts Army Airfield, Meadow Lake Airport, or the AFA (ERO

2007a, 2008a). The No Action Alternative would result in a minor increase in BASH risk at COS/Peterson compared to existing conditions.

The increased BASH risk at local airports from the Action Alternatives except the Participants' Proposed Action and Wetland alternatives would be the same or similar to the No Action Alternative. The Arkansas River Alternative would have a slight shift of waterbirds away from flight paths at COS/Peterson. Effects of the Participants' Proposed Action and the Wetland alternatives would be negligible to slightly beneficial compared to the No Action Alternative as waterbirds would shift away from flight paths at COS/Peterson.

Indirect Effects on Riparian Species

Indirect effects on wetland and riparian habitat from hydrologic changes from the No Action Alternative would be variable and include the beneficial effects of increased wetland/riparian habitat from increased flows and ground water levels below Jimmy Camp Creek and Williams Creek reservoirs, and possible newly established vegetation along Fountain Creek and the Arkansas River from increased sedimentation. Long-term adverse effects from this alternative may include reduced woody vegetation establishment from reduced peak flows. Newly established vegetation resulting from seepage and increased sediments likely would benefit wetland and riparian shrub species such as song sparrow and red-winged blackbird; whereas, a long-term reduction in woody vegetation likely would result in less breeding and roosting habitat available for warblers, herons, nesting raptors and wintering bald eagles. Security's and Fountain's ground water pumping may have major adverse effects on riparian vegetation and thus on associated wildlife.

Other indirect effects such as increased noise, traffic, and human encroachment during construction would be common for all alternatives. Indirect effects on migratory birds and other wildlife would include displacement of individuals or local populations outside the project footprint.

Indirect effects on riparian and wetland wildlife species from the Participants' Proposed Action, Arkansas River, Downstream Intake, Highway 115 alternatives would be negligible compared to the No Action Alternative. Indirect effects of hydrologic changes on riparian and wetland wildlife species from the Wetland Alternative would be negligible for most stream locations and beneficial below Upper Williams Creek Reservoir.

Indirect effects of hydrologic changes on riparian and wetland wildlife species from the Fountain Creek Alternative would be negligible for most stream locations and beneficial below Williams Creek Reservoir. Overall, indirect effects on wildlife and migratory birds from the Action Alternatives would be beneficial compared to the No Action Alternative.

Homestake Reservoir and Western Slope streams within the study area provide potential boreal toad habitat. Homestake Reservoir is a steep-sided reservoir, generally unsuitable for toads. Although the upper end of the reservoir and wetlands below the dam and along the streams may provide suitable habitat for boreal toads, changes in stream flow in Western Slope streams and reservoir water levels are expected to have a negligible effect on boreal toad habitat.

3.13.5.2 Cumulative Effects

As discussed in Section 3.1.3.1, reasonably foreseeable future actions that would contribute to cumulative effects, when combined with the effects of the proposed project, include urban development in El Paso and Pueblo counties, transportation projects, the Eastern Plains Transmission Project, and climate change that would directly impact wildlife through habitat loss, habitat alteration, and displacement of individuals or populations. Additionally, projects that would affect the hydrology of Fountain Creek, Jimmy Camp Creek, Williams Creek, and the Arkansas River would indirectly affect wetlands and riparian communities as described in the Wetlands, Waters, and Riparian Vegetation section (Section 3.11), and the terrestrial wildlife dependant on those communities. Because terrestrial wildlife is dependant on the vegetation communities that provide essential habitat components (food, cover, and water) the cumulative effects on wildlife closely mirrors those described in the Wetlands, Waters, and Riparian Vegetation section (Section 3.11). The cumulative effects on wildlife for each alternative and for actions that affect all alternatives are described below.

Cumulative Effects Common to All Alternatives

For all alternatives, rapidly growing development around Colorado Springs, Pueblo and Pueblo West, construction of new roads, and construction of the utility facilities, may cause moderate to major cumulative effects to native vegetation and wildlife habitat, including habitat for State and CNHP species, large game, migratory birds, and raptors. Hydrologic changes within streams and watershed from urban development may have major cumulative effects on wetlands and riparian vegetation and species such as bald eagle and great blue heron. Proposed transportation projects may contribute to cumulative loss of habitat within native upland, wetland, and riparian wildlife communities. Transportation projects would also further fragment habitat and create barriers to wildlife movement. Continued residential and commercial development in El Paso, Pueblo, and Fremont counties, would contribute to the loss and degradation of habitat for state-listed species, particularly grassland species such as the burrowing owl, mountain plover, and ferruginous hawk.

Climate change would affect all alternatives similarly. These changes are difficult to assess because global weather models do not have the level of detail necessary to predict effects on individual localities. Predicted higher temperatures, changes in precipitation, and earlier spring runoff could lead to a decrease in wetland and riparian areas or change vegetation community species composition and a subsequent change in wildlife communities.

No Action Alternative

The No Action Alternative would contribute to major adverse cumulative effects on wildlife habitat in general and wetland and riparian habitat along the upper reach of Fountain Creek. The No Action Alternative would incrementally increase disturbance to occupied Preble's habitat in the rapidly growing northern El Paso County. This alternative also would incrementally increase disturbance to occupied Botta's pocket gopher habitat in Fremont County.

The BASH assessment model was run with land use information projected to 2046 to provide an estimate of cumulative effects of alternatives and future development of bird concentration areas. Based on potential future roosting and feeding locations, very high potential bird concentration areas (on a regional scale) would increase by 13 square miles within the aircraft paths at COS/Peterson for the No Action Alternative in 2046, thereby, increasing BASH risk to COS/Peterson.

Action Alternatives

The Action Alternatives would contribute to cumulative effects on most wildlife species and wildlife habitat similar to the No Action Alternative. The primary exception would be that the Participants' Proposed Action, Fountain Creek, and Downstream Intake alternatives would not incrementally increase cumulative effects on the Botta's pocket gopher.

For the BASH assessment, the cumulative effects projected to 2046 would be similar under the No Action and all Action Alternatives. The Participants' Proposed Action would result in a 5 square-mile reduction in moderately high potential, and a 4.3 square mile increase in moderately low potential, resulting in a slight reduction in BASH risk compared to the No Action Alternative. Compared to No Action, the Wetland Alternative would result in a 4.3-square mile reduction of very high potential bird concentration area but a 4.3-square mile increase in moderately high potential, resulting in only a slight reduction in BASH risk. The Arkansas River Alternative would result in a slight reduction of moderately high potential bird concentration area compared to the No Action Alternative. The BASH risk of the Fountain Creek, Downstream Intake, and Highway 115 alternatives in 2046 would be similar to the No Action Alternative.

3.13.5.3 Resource Commitments

There would be no irreversible commitment of wildlife resources. Irretrievable commitment of resources would include all wildlife habitat, including Preble's habitat, permanently or temporarily disturbed by construction and operation of project components. Permanent and temporary effects on habitat from construction of Jimmy Camp Creek Reservoir, Williams Creek Reservoir, Upper Williams Creek Reservoir, and other aboveground structures would cause an irretrievable commitment of resources while the reservoirs and structures are in place. If the reservoirs or structures are removed, these resources would continue to be lost until habitat is replaced and wildlife species return. Temporary effects from pipeline and other construction activities would cause an irretrievable commitment of wildlife resources until after construction is complete and habitat is replaced.

3.13.5.4 Mitigation

Proposed Measures

The Participants would implement the following measures to minimize wildlife impacts:

- Submit a proposed wildlife mitigation plan to the Colorado Wildlife Commission pursuant to C.R.S. § 37-60-122.2
- Conform to best management practices and state and federal guidelines to minimize short- and long-term effects on wildlife
- Promptly revegetate all disturbed areas with native species that provide species diversity and food and cover for large game and wildlife habitat
- Avoid or minimize effects on Mexican spotted owl habitat. Effects on Mexican spotted owl habitat along Colorado 115 may require consultation with the Service and a detailed mitigation plan
- Restrict construction activities in areas with suitable winter habitat for the Mexican spotted owl between November 15 and February 28 to avoid any impacts to owl winter range

- Conduct clearance surveys for state-listed species following standard protocols, as available, prior to construction (e.g., CDOW n.d.)
- Conduct raptor nest surveys prior to construction and impose seasonal restrictions to surface activity within recommended buffers (generally ¼ to ½ mile) (CDOW 2008; Service 2002) around active raptor nest sites and heron rookeries during construction
- Consult with CDOW and U.S. Migratory Bird Office to develop mitigation for unavoidable loss of raptor nests. Options may include constructing artificial nests in suitable habitat or enhancing prey habitat
- Develop construction schedules to avoid impacts to nesting migratory birds. If construction is scheduled to occur during the nesting season (April 1 through August 31) in areas where migratory birds may nest, a qualified biologist would conduct a nesting bird survey prior to the commencement of construction activities to determine the presence of migratory birds and their nests. If an active nest is detected, a buffer zone between the nest and the limit of construction would be flagged and avoided, or construction would be scheduled outside of the nesting season
- Conduct pre-construction surveys for Botta's pocket gopher
- Conduct pre-construction surveys for swift fox den sites within appropriate habitat along the pipeline corridor and proposed reservoir sites. Avoid surface disturbance within ¼ mile of active den sites while young are den dependent (March 15 through June 15)
- Restrict pesticides for rodent control within swift fox overall range
- Mitigate impacts to state-listed amphibian species by avoiding, minimizing, and mitigating wetland effects as proposed under Section 3.11.5.4
- Impose seasonal restrictions on construction to avoid sensitive large game winter habitat (from first large snowfall to summer green-up (CNDIS 2007 metadata)
- Install wildlife crossovers (trench plugs) during pipeline construction with ramps on each side at a maximum of ¼ mile intervals and at well-defined game trails
- Create additional nesting habitat or next boxes in nearby trees for the Lewis' woodpecker when nest trees are destroyed

Mitigated Effects

By replacing vegetation including structural diversity, the long–term effects on wildlife would be reduced by allowing wildlife to return to disturbed areas. Pre-construction surveys would identify wildlife use at the time of construction and allow for planning for avoidance and minimization. Imposing seasonal and/or daily restrictions on construction will enable wildlife to use important habitat, especially during breeding and other critical periods. Wildlife crossovers installed within the pipeline trench will facilitate wildlife passage and provide escape routes for wildlife trapped within the trench, thereby reducing mortality.

3.14 Recreation

This section describes recreation resources in the SDS Project analysis area and the anticipated effects of the alternatives on those resources. Recreation resources in the analysis area primarily consist of boating and angling on lakes and rivers, and the use and enjoyment of parks, trails, and open space areas. Because some of these resources are important amenities and economic generators for communities in the analysis area, it is important that effects to these resources are identified and considered in the EIS process. Primary indicators for recreation resources include:

- Changes in Arkansas River flows
- Changes in reservoir water surface elevation
- Changes in water quality and fisheries
- Physical impacts to parks and trails
- Physical impediments to recreation access

3.14.1 Summary of Effects

Recreational boating on the Arkansas River downstream of Pueblo Dam is limited to kayaks, canoes, and inner tubes. The No Action Alternative would have a minor adverse effect on boating opportunities through Pueblo. Compared to the No Action Alternative, all Action Alternatives except for the Highway 115 Alternative would result in minor to moderate benefits to boating opportunities through Pueblo, because PFMP targets would be met more frequently. The Highway 115 Alternative would result in minor adverse effects to those opportunities (the effect would be greater than that of the No Action Alternative).

The Arkansas River Alternative would result in moderate benefits to angling downstream of Pueblo Dam, due to favorable changes to flows and fish habitat, while changes under the Highway 115 Alternative would result in moderate adverse effects to angling in this area. The effects of the remaining alternatives, including No Action, would be negligible.

The development and operation of Jimmy Camp Creek Reservoir and Park (included in the No Action Alternative and all Action Alternatives except the Participants' Proposed Action and Wetland alternatives) would result in major benefits to recreation opportunities in the Colorado Springs region. The Upper Williams Creek Reservoir proposed in the Participants' Proposed Action and Wetland alternatives would have similar benefits.

All alternatives except for the Wetland and Arkansas River alternatives would result in minor adverse effects to Fountain Creek Regional Park, while all alternatives would result in negligible to minor adverse effects to Clear Spring Ranch Park.

Upstream of Florence, none of the alternatives would result in noticeable changes to Arkansas River streamflow; additionally, none of the alternatives would substantially affect how frequently flow targets were met for boating and angling. Downstream of Florence, the No Action Alternative would result in minor adverse effects to boating opportunities (primarily kayak and canoe use) in this area compared to Existing Conditions. Compared to the No Action Alternative, substantial increases in fall (September and October) streamflow from Florence to Pueblo Reservoir under the Participants' Proposed Action, Wetland, Arkansas River, Fountain Creek, and Downstream Intake alternatives would result in moderate to major benefits to boating. Changes in flows and their resulting improvements to fish habitat in the Wetland and Arkansas River Alternatives would result in moderate benefits to angling in this area.

Construction of project facilities along the Arkansas River at Colorado 115 in the No Action, Wetland, Arkansas River, and Highway 115 alternatives would result in minor short-term adverse effects to boating access from the BLM's Blue Heron Property, and minor long-term adverse effects to the property itself.

All alternatives (in average years) except for the No Action and Highway 115 alternatives would result in moderate adverse effects on fish habitat and angling opportunities in Lake Henry. The Wetland and Arkansas River alternatives would result in moderate adverse effects on water-based recreation at Lake Meredith in average years, and moderate to major adverse effects in dry years, while the remaining alternatives would have minor effects. Effects of the No Action Alternative on recreation at Lake Henry, Lake Meredith, and Holbrook Reservoir, when compared to Existing Conditions, would be negligible.

Hydrological changes on the Western Slope would result in negligible effects on recreation along the Roaring Fork River, negligible effects to recreation at Homestake Reservoir, and negligible to minor effects to recreation on various small streams.

None of the alternatives or their effects are anticipated to conflict with existing recreational plans or policies. The relationship of the alternatives to existing flow management programs are described below.

3.14.2 Regulatory Framework

No regulatory requirements pertain to this resource.

3.14.3 Analysis Area and Methods

3.14.3.1 Analysis Area

The analysis area for recreation is located in Pueblo, El Paso, Fremont, Chaffee, Lake, and Crowley counties and encompasses areas potentially affected by project activities (ERO 2007c). In this section, four areas comprise the analysis area. These four areas are identified on Figure 91.

Pueblo Area

The Pueblo Area analysis area includes water- and land-based recreation within Pueblo County and along the Arkansas River between Colorado 115 and a location about 500 feet downstream of the confluence with Fountain Creek, and the Fountain Creek corridor within Pueblo County.

El Paso County Area

Water- and land-based recreation within El Paso County that may be affected by the alternatives includes parks and trails along the Fountain Creek and Colorado 115 corridors, existing and proposed trails along pipeline corridors, and proposed park and reservoir sites at Jimmy Camp Creek and upper Williams Creek.

Upper Arkansas River

The Upper Arkansas River analysis area is the Arkansas River between Turquoise Lake and the Portland Gage (near Florence), as well as visitor use facilities near the Ark-Otero Powerline alignment. This portion of the analysis area also includes Twin Lakes and the short reach of Lake Creek between the reservoir and the Arkansas River. Recreation at Turquoise Lake is excluded from this analysis because the hydrological changes resulting from the project alternatives would be negligible (Section 3.5) and would not affect Turquoise Lake recreation.

Lower Arkansas River

This portion of the analysis area includes the Arkansas River between the Fountain Creek confluence and Rocky Ford Gage, as well as three off-channel reservoirs near Rocky Ford—Lake Meredith, Lake Henry, and Holbrook Reservoir. Areas downstream of Rocky Ford are excluded from this analysis area because the hydrological changes resulting from the project alternatives would be negligible (Section 3.5) and would not affect the limited recreation in that area.

Western Slope Study Area

The Western Slope analysis area includes the headwaters region of the Colorado River Basin in eastern Pitkin County and southeastern Eagle County.

3.14.3.2 Methods

Water-Based Recreation

Reservoir Recreation

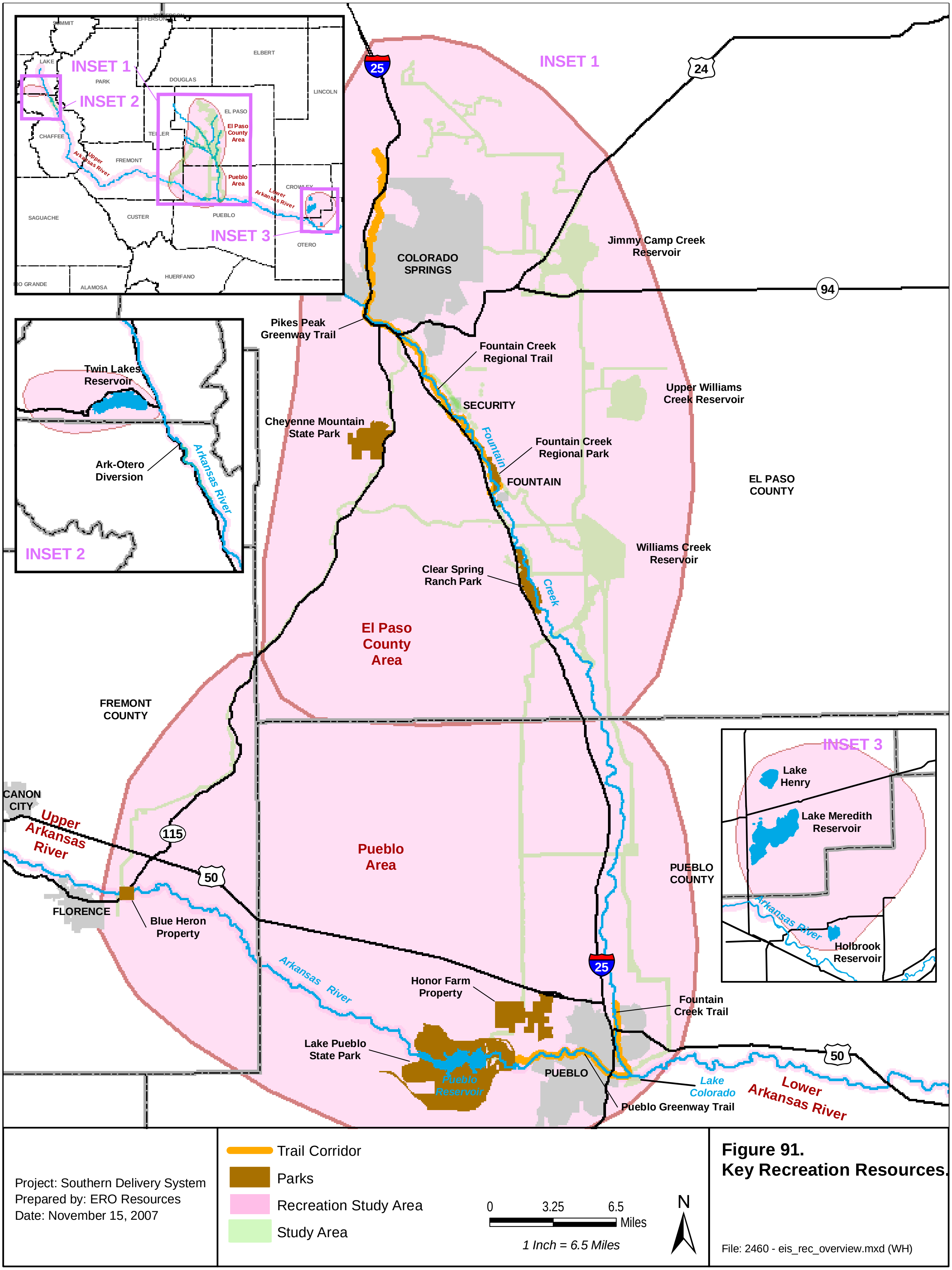
Predicted surface water elevations based on hydrological modeling (Section 3.5) were evaluated to determine effects on recreation facilities and opportunities at Pueblo Reservoir, Twin Lakes, Lake Meredith, Lake Henry, and Holbrook Reservoir. Changes to surface water elevations, along with other factors such as effects to fisheries, were used to assess potential effects on boating and angling opportunities.

Arkansas River Recreation

Anticipated river flow changes (measured in cfs) were used to determine effects on water-based recreation opportunities along the Arkansas River corridor upstream of Pueblo Reservoir and downstream of Fountain Creek. Changes to river flow for average, wet, and dry years were considered and evaluated for both direct and cumulative effects. These changes are documented in Section 3.5. In general, reduced river flows were considered to adversely affect recreation, while higher flows are considered to benefit recreation.

Effects on river recreation (boating and angling) throughout the upper Arkansas River area were identified based on recreation flow targets in the Upper Arkansas Voluntary Flow Management Program (Section 3.2) using measurements from the Wellsville Gage located downstream of Salida.

Effects on river recreation through the City of Pueblo were estimated based on the relationship of anticipated flow changes to the PFMP targets. For purposes of this analysis, the PFMP flows were used as an agreed-upon standard by which effects to recreation opportunities would be measured. Using hydrological modeling data, the analysis quantified the number of days that the PFMP flow targets would be met for each alternative, and then evaluated the changes in the number of days that each alternative would meet those targets in each month. Increases in the percentage of days that PFMP flow targets would be met were considered a benefit to recreation opportunities, while decreases in the percentage of days were considered an adverse effect.



Project: Southern Delivery System
Prepared by: ERO Resources
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Figure 91.
Key Recreation Resources.

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Lake Recreation Adjacent to the Arkansas River

Downstream of Pueblo Reservoir, several recreation areas are located on small lakes (usually former gravel mining pits) immediately adjacent to the Arkansas River. Water levels in these lakes are typically influenced by river stage elevation and alluvial ground water levels. Potential effects on water-based recreation in these areas were evaluated based on effects to alluvial ground water, which were estimated for each alternative (Section 3.6). Decreases in alluvial ground water levels were considered to adversely affect recreation in these areas, while increases would be beneficial to recreation.

Angling

Effects to angling opportunities were based on two factors: effects on the fishery due to hydrological changes, and physical effects or impediments to areas used for angling access. The aquatic life evaluation (Section 3.10), which takes changes in hydrology and water quality into account, was used to identify effects to the fishery. Physical effects to angling access areas were determined using GIS mapping of the alternatives. In areas where pipelines, pump stations, or other facilities (and their buffers) intersect angling access locations (within an assumed 300-foot buffer), the footprint of those effects is expressed in acres.

Land-Based Recreation

Trails

Effects to existing and proposed trails, expressed in linear feet, were based on GIS analysis of the length of trail intersected by the temporary and permanent effects of facility corridors for each alternative. All trail effects were considered temporary, with the assumption that trails would be closed for a short time during pipeline construction, or would be rerouted around any permanent aboveground structures. The magnitude of trail effects was based on the length of trail within a specified complex or grouping of affected trails. Impact calculations are inclusive of all construction activities. Table 121 describes the general trail groupings used for the analysis.

Table 121. General Trail Groupings Used for Effects Analysis.

Trail Complex/Grouping	Location	Miles
Lake Pueblo State Park	Pueblo County	17
Pueblo Greenway Trails	City of Pueblo	8
Fountain Creek Trail (Pueblo)	City of Pueblo	4
Proposed Honor Farm Trails	City of Pueblo	11
Pikes Peak Greenway	Colorado Springs	14
Fountain Creek Regional Trail	El Paso County	16
Proposed NE Colorado Springs Trails	North of U.S. 24	34
Proposed SE Colorado Springs Trails	South of U.S. 24	69
Proposed Fort Carson Area Trails	West of I-25	49

Parks and Other Recreation Sites

Effects on public parks, open space lands, or other areas used by the public for recreation were quantified in acres, based on the area of the temporary and permanent effects of the alignment corridors for each alternative intersecting those resources. Effect calculations are inclusive of all construction activities.

Proposed Reservoir Recreation
The beneficial effects of future recreation opportunities at the proposed Jimmy Camp Creek and Upper Williams Creek reservoirs were based on professional judgment and Colorado Springs staff (Lieber, pers. comm. 2006), as well as known or anticipated visitation to other similar recreation sites elsewhere on the Colorado Front Range.

Impact Thresholds
Effects on recreation resources (both land- and water-based) are classified into the following four categories based on effects analysis:

- Negligible – adverse or beneficial effects to recreation resources due to hydrological changes or physical disturbance are below the level of detection.
- Minor – adverse or beneficial effects to recreation resources due to hydrological changes or physical disturbance are less than 10 percent.
- Moderate – adverse or beneficial effects to recreation resources due to hydrological changes or physical disturbance are greater than 10 percent and less than 25 percent.
- Major – adverse or beneficial effects to recreation resources due to water level changes or physical disturbance are greater than 25 percent.

Resources with Negligible Effects
The effects of the alternatives on the following resources when evaluated in detail were found to be negligible and are not discussed further. These and other recreation resources are described in the Recreation Resources Technical Report (ERO 2007c).

Pueblo Area

- Rock Creek Swim Area
- Lake Colorado
- Pueblo Greenway Trail System
- Runyon/Fountain Lakes SWA
- Fountain Creek Trail
- Greenway Nature Center of Pueblo
- Historic Arkansas Riverwalk of Pueblo

El Paso County Area

- Cheyenne Mountain State Park
- Aiken Canyon Preserve
- Turkey Creek Ranch Recreation Area

Upper Arkansas River

- Brush Hollow State Wildlife Area
- Turquoise Lake
- Upper Arkansas River
- Twin Lakes recreation
- Lake Fork Creek of the Arkansas River angling
- Lake Creek angling

Lower Arkansas River

- Arkansas River recreation

Cumulative Effects
The cumulative effects analysis considered the effects of the proposed alternatives along with other reasonably foreseeable actions that would occur in the analysis area. All of the reasonably foreseeable actions are described in Section 3.1.3.1. The analysis of cumulative effects to water-based resources was conducted in a similar manner as the direct and indirect effects, using cumulative hydrological effects values for rivers and lakes in the analysis area. Cumulative effects to land-based resources were evaluated based on the anticipated physical area and effects of the location-

specific reasonably foreseeable actions in the analysis area.

Limitations

While the physical effects of proposed alternatives on recreation facilities (i.e., trail and parks) can be quantified, it is more difficult to accurately measure how certain changes would affect each individual's use and enjoyment of a specific recreational resource. This is particularly true for resources such as boating, angling, hunting, and others where the resource commonly fluctuates, actual use by individuals is rarely measured, and individual enjoyment can be subjective.

An analysis approach based on recreation use numbers and recreation visitor days was not used for this analysis because uniform baseline data are not available. To avoid subjectivity, most of this analysis was based on specific measurable units whenever possible. For example, water flows were generally used to gage boating opportunities on rivers, while surface water elevations were used to measure boating opportunity on lakes. It is assumed that where there is greater opportunity, there is greater use and enjoyment of the resource. These hydrological factors, combined with the results of the aquatic resource analysis, were used to evaluate effects on angling. In some cases where specific studies or flow management programs have identified target flows for recreation, those units also were used to measure effects.

All adverse effects to existing trails would be mitigated through permanent trail reroutes or temporary detours, diminishing the adverse effect that construction impacts would have on recreational use. In some cases, effects to proposed trail corridors could result in long-term benefits if the construction of belowground pipelines or other facilities facilitated the establishment of future trail corridors. However, it is not possible to assess these potential benefits in this analysis.

3.14.4 Affected Environment

Recreation resources in the analysis area are summarized below and are described in detail in the Recreation Resources Technical Report (ERO 2007c). Key resources are identified on Figure 91.

3.14.4.1 Pueblo Area

Lake Pueblo State Park

Recreational use at Pueblo Reservoir is centered on boating, angling (shore and boat), personal watercraft, sailboarding, and water skiing (CSP 2004). Peak months for recreational use at Lake Pueblo State Park are June, July, and August, which account for over 50 percent of annual visitation (Smith and Hill 2000).

Boating

Two marinas, four boat ramps, and a sailboard launch area provide reservoir boating access. The sailboard launch also provides access for canoers and other non-motorized boaters.

Angling

The diversity of game fish species makes Pueblo Reservoir a popular destination for anglers. Popular game fish species include walleye, rainbow and brown trout, wiper, catfish, smallmouth and largemouth bass, and crappie. Because Pueblo Reservoir does not freeze over, shore and boat fishing are popular all year. About 67 percent of all angling use occurs between April and August (Smith and Hill 2000).

Other Water-Based Recreation
Sailboarding, personal watercraft, water skiing, and jet skiing are also popular water-based recreation activities that occur at Pueblo Reservoir during the summer. While swimming is not permitted in Pueblo Reservoir, the nearby Rock Canyon Swim Area accommodates swimmers.

Land-Based Recreation
About 17 miles of paved trails and 30 miles of unpaved trails are found in Lake Pueblo State Park (CSP 2004). The Pueblo River Trail, which is part of the 35-mile Greenway Trail System, connects Pueblo to Lake Pueblo State Park.

River Corridor Recreation

Angling
The portion of the Arkansas River within the Pueblo area is currently managed as a sport fishery (Corps 2001a). CDOW annually stocks the Arkansas River downstream of the Pueblo Dam with rainbow and brown trout. Other game fish species recorded in the area include walleye and perch (Corps 2001a). The area between the dam and Wildhorse Creek is popular, while the fishery is less productive downstream of Wildhorse Creek (Corps 2001a; Melby, pers. comm. 2004). Angling opportunities are also available at the "Chain of Lakes" ponds and at Runyon and Fountain lakes. No angling occurs along Fountain Creek.

Boating
Recreational boating on the Arkansas River downstream of Pueblo Dam is limited to kayaks, canoes, inner tubes, and inflatable mattresses. A recently completed (2004) whitewater park along the Arkansas River through downtown Pueblo is expected to eventually attract 25,000 users per year.

To provide for instream recreational uses, Arkansas River flows through the City of Pueblo are subject to the PFMP. The PFMP target flows are administered at a point downstream of the Above Pueblo Gage that includes fish hatchery discharge. Most of the river recreation on the Arkansas River flows through the City of Pueblo is expected to occur in the "nonwinter" season between March 16 and November 14 (244 days) when target flows are higher (Table 122).

Table 122. General PFMP Flow Targets.

Period	Average Year (cfs)	Below Average Year (cfs)
October 1 – October 15	250	150
October 16 – November 14	200	150
November 15 – March 15	100	100
March 16 – March 31	250	200
April 1 – April 15	350	250
April 16 – April 30	400	300
May 1 – May 22	450	350
May 23 – July 31	500	500
August 1 – August 15	450	350
August 16 – September 7	300	300
September 8 – September 30	250	150

Source: MWH 2007c.

Other Pueblo Area Recreation

Honor Farm Property
Located just northeast of Lake Pueblo State Park, the Honor Farm Property is a 2,300-acre area acquired by the City of Pueblo from CSP. Most of the Honor Farm Property is open space, and a Master Plan process is underway to determine types and locations of specific

uses of the property. Proposed long-term plans for the property include a designated off-highway vehicle area, a network of trails, a restored natural park area, and the extension of Joe Martinez Road/24th Street through the property (Pueblo 2007).

3.14.4.2 El Paso County Area

Much of the recreational use in the El Paso County portion of the analysis area occurs along the Fountain Creek corridor, which includes the Pikes Peak Greenway Trail in Colorado Springs and the Fountain Creek Regional Trail in the City of Fountain.

Pikes Peak Greenway

The Pikes Peak Greenway extends along Monument and Fountain creeks through Colorado Springs. About 14 miles of the Pikes Peak Greenway are within the analysis area.

Fountain Creek Regional Trail

The southern terminus of the Pikes Peak Greenway Trail is the starting point for the Fountain Creek Regional Trail. This includes about 16 miles of trail extending south to the Fountain Creek Regional Park. Hikers, joggers, bikers, horseback riders, and birders use the trail.

Fountain Creek Regional Park

The 465-acre Fountain Creek Regional Park includes about 6 miles of trails, an active use area with developed recreation facilities, fishing ponds, the Fountain Creek Nature Center, and Ceresa and Hanson Nature Parks.

Jimmy Camp Creek Park

Jimmy Camp Creek Park is a nearly 700-acre regional park site on the eastern edge of Colorado Springs. It is not yet open for public use. The property also serves as the juncture for the planned extension of the Rock Island Trail and Jimmy Camp Creek Trail. Colorado Springs currently envisions allowing angling and motorboat use on the proposed reservoir, and other uses such as hiking and picnicking along the shoreline. Motorboat use would be limited to electric trolling motors and modern petroleum-powered craft to minimize pollutant emissions. The proposed reservoir likely would be stocked with game fish by CDOW to support a recreational fishery (Section 3.10). Any public uses that would involve human contact with the water (such as swimming, water skiing, and wind surfing) would not be allowed (CSU and Colorado Springs 2004). A proposed open space park and reservoir at this location has been envisioned in the City's open space, parks, and recreation plans for over a decade (Colorado Springs 1997, 2000).

Clear Spring Ranch Park

Clear Spring Ranch Park consists of about 930 acres between Old Pueblo Road and Interstate 25 in the southern part of the county. The park provides access to 5.7 miles of trails.

Proposed Trails

Proposed trail alignments in El Paso County are scattered throughout the analysis area. El Paso County and Colorado Springs also are considering trail alignments along the pipeline corridors associated with the proposed project (Havel, pers. comm. 2004).

3.14.4.3 Upper Arkansas River

Recreation along the upper Arkansas River (upstream of Florence in Fremont, Chaffee, and Lake counties) consists primarily of boating and angling within the Arkansas Headwaters Recreation Area (AHRA).

Boating

About 90 percent of the total boating use on the upper Arkansas River is rafting, including both commercial and private trips. The remaining 10 percent of boaters are kayakers and canoers (Smith and Hill 2000). The upper Arkansas River comprises several nationally recognized whitewater boating sections including the Numbers, Browns Canyon, and Royal Gorge. Peak boating use occurs from mid-June to mid-August (ERO 2006). Other activities include fishing, private kayaking, and private rafting.

Several developed public use facilities along the river provide river access, parking, picnic facilities, and restrooms (BLM and CSP 2001). The existing Ark-Otero diversion structure has several exposed cables and metal pieces that are considered to be a hazard for rafters and kayakers (Banks and Eckardt 1999).

The Arkansas River from Cañon City to Florence lies within the easternmost portion of the AHRA. Unlike other portions of the AHRA, this segment of the Arkansas River is characterized as a plains river, dropping only 15 vertical feet per mile and offering Class I rapids. This segment is well suited for canoers and other boaters desiring a tranquil river experience. Wildlife viewing and angling from boat or shore also occur along this segment of river.

Angling

Next to whitewater rafting, angling is the most popular water-based recreation activity on the upper Arkansas River. Most angling occurs during the summer. The river is well known as an outstanding, self-sustaining brown trout fishery. Angling is best after late July when the flows are below 1,200 cfs and the water is clear. The period May through early July typically provides less desirable angling conditions due to higher streamflows created by snowmelt runoff and a larger concentration of boaters on the river (Colorado Resort Network 2007).

The Arkansas River upstream of Lake Pueblo State Park and Pueblo State Wildlife Area (SWA) offers angling opportunities for coldwater species such as brown trout, as well as warmwater species such as wiper and walleye, particularly during the early spring and summer spawning periods when these species migrate upstream. No recent estimates are available on angler use upstream of Lake Pueblo State Park (CDOW 2006b).

Recreation Flow Targets

The UAVFMP is designed to provide water for fisheries and recreation in the Upper Arkansas River. The program is primarily aimed at providing target flows for releases of Fry-Ark Project water from Twin Lakes and Turquoise Lake to Pueblo Reservoir. The flow recommendations are "intended to provide an annual flow regime that helps the state maintain the brown trout fishery, meet the demand for boating recreation, support the region's tourism industry, and allow managers of the AHRA to meet their obligation to manage recreation and natural resources within the area's boundaries" (Walcher 2003). In general, the UAVFMP flow recommendations set a target of 700 cfs between July 1 and August 15 and 250 cfs the remainder of the year. These recommendations are described in detail in the Hydrologic Model Documentation Report (MWH 2007c); while commonly accepted standards for recreation flows are discussed as follows.

The 2001 Arkansas River Water Needs Assessment (ARWNA) provides an evaluation of water needs for recreation on the Arkansas River and its associated reservoirs. River flow preferences for boating and angling documented in the ARWNA are summarized in Table 123.

Blue Heron Property

The BLM and CSP are developing a management plan for the 275-acre Blue Heron Property. Two BLM-owned parcels are located near the study area – the Blue Heron Acquisition, west of Colorado 115, and Blue Heron Recreation and Public Purposes Act Land east of Highway 115. BLM's management plan addresses both parcels, which are collectively referred to as the Blue Heron Property. The proposed SDS facilities in this area would be within the western "Blue Heron Acquisition" parcel. The portion of the Blue Heron Property adjacent to Colorado 115 is occasionally used as a boat launch on the Arkansas River. However, the City of Florence River Park on the south side of the river provides similar (and potentially better) river access opportunities than the Blue Heron Property. Preliminary plans for the Blue Heron Property include reclamation of the existing boat launch and the construction of a new boat launch elsewhere on the property (BLM 2003). Because the Blue Heron Property was acquired by BLM using funds appropriated by Congress, the BLM has an obligation to manage the property for recreation purposes. Any non-recreational uses of the property would need to be configured to minimize impacts to, and enhance if possible, recreational values.

3.14.4.4 Lower Arkansas River

Recreation along the lower Arkansas River (between Fountain Creek and Rocky Ford) consists primarily of boating and angling in off-channel reservoirs, and limited angling along the river.

Reservoir Recreation

Lake Meredith, Lake Henry, and Holbrook Reservoir are off-channel reservoirs in the easternmost portion of the analysis area. Power boating and sail boating are popular throughout the summer when water is available. Lake Meredith, Lake Henry, and Holbrook Reservoir are SWAs and historically have provided habitat for a number of warmwater game fish species such as saugeye, crappie, channel catfish, yellow perch, and wiper. In 2002, all of Lake Meredith's water was released from the reservoir resulting in a total loss of fish (GEI 2008a). Sail boarding, jet skiing, and water skiing are popular summer recreation activities at Lake Meredith, Lake Henry, and Holbrook Reservoir. Waterfowl hunting is available at the reservoirs from November through March.

3.14.4.5 Western Slope

Within the Western Slope study area, the Roaring Fork River provides angling and

Table 123. Upper Arkansas River Recreation Flow Targets.

Use	Acceptable Low Flow (cfs)	Optimum Low Flow (cfs)	Optimum High Flow (cfs)	Acceptable High Flow (cfs)
Rafting	750	1,500	2,000	2,500
Kayaking	650	1,300	1,500	2,500
Fly Fishing	250	400	500	800
Spin Fishing	500	700	1,200	2,000
Float Fishing	550	900	1,200	2,500

Source: Smith and Hill 2000.

boating opportunities, while the small streams and Homestake Reservoir are primarily used for angling.

3.14.5 Environmental Consequences

3.14.5.1 Direct and Indirect Effects

The direct and indirect effects of the alternatives on recreation are described below. The hydrological changes that determine most of the effects for water-based recreation are described in detail in the Supplemental Hydrology Administrative Record Documentation (2008d) and Surface Water Hydrology Effects Administrative Record Documentation (MWH 2008d).

Pueblo Area Recreation

Lake Pueblo State Park

Boating. The negligible to minor decreases in reservoir elevations under all alternatives would result in negligible effects to boating and other water-based recreation on Pueblo Reservoir. While minor changes in surface water elevation and surface water area would occur, the changes would be too small to measurably affect the quality of the recreation experience and the amount of visitation. This is supported by surveys conducted at Pueblo Reservoir that indicated there is little sensitivity to minor fluctuations in water levels and the quality of the recreation experience (Smith and Hill 2000).

Angling. Based on the results of the aquatic resources analysis, Section 3.9, and GEI (2008a, 2008b) the No Action Alternative would result in moderate benefits to angling opportunities, while the Downstream Intake and Highway 115 alternatives would result in moderate adverse effects. The effects of the remaining alternatives on angling opportunities would be negligible.

Land-Based Recreation. None of the alternatives are anticipated to affect the long-term quality and availability of land-based recreation at Lake Pueblo State Park, including camping, picnicking, walking, cycling, hunting, and wildlife observation. However, the construction of project infrastructure downstream of the Pueblo Reservoir dam in the No Action, Participants' Proposed Action, Wetland, and Fountain Creek alternatives would result in minor temporary adverse effects on existing trails in the area and access for angling. Specifically, the Pueblo West Intake in the No Action and the proposed Western Untreated Water Pipeline alignment in the Participants' Proposed Action, Wetland Alternative, and Fountain Creek Alternative would cross the Arkansas Point Trail and the Arkansas River Trail. In the No Action Alternative, 280 linear feet of trail would be affected and 400 linear feet of trail affected in the Proposed, Wetland, and Fountain Creek alternatives. These effects would be less than 1 percent of the 17 miles of trails in Lake Pueblo State Park. These trail connections likely would be closed or rerouted for several months during pipeline construction, which would result in minor short-term adverse effects to recreational use. While the Juniper Pump Station downstream of the dam could be considered to be visually obtrusive, it would be consistent with the existing character and use of the area as a water infrastructure facility (Section 3.19) and would not result in any direct long-term effects to recreational uses or facilities.

River Corridor Recreation–Downstream of Pueblo Reservoir

Pueblo Flow Management Program. Effects on river recreation along this reach of the Arkansas River are based on changes in the number of days that flows are anticipated to meet PFMP targets for each alternative, as presented in Section 3.5.

Compared to Existing Conditions, the No Action Alternative would result in a 0.6 percent (1.5 days annually) reduction in the number of non-winter days that PFMP targets would be met. Compared to the No Action Alternative, all alternatives except for the Highway 115 Alternative would increase the number of days PFMP targets would be met by between 1.1 percent (2.7 days) and 6.9 percent (17 days). The Highway 115 Alternative would result in a 9.2 percent (22.5 days) decrease in the number of days PFMP targets were met compared to No Action.

Summary of Effects on Arkansas River Alluvial Ground Water. Alluvial ground water effects at the Arkansas River Above Pueblo Gage are assumed to be representative of effects for the Arkansas River between Pueblo Reservoir and the Wildhorse Creek confluence. Channel levees downstream of Wildhorse Creek prevent hydrologic connections between streamflow and ground water. Effects on alluvial ground water levels from Pueblo Reservoir to the Wildhorse Creek confluence would result from changes in river stage, and are indicative of effects to water levels at water bodies adjacent to the Arkansas River channel (i.e., Lake Colorado, Chain of Lakes, and Runyon/Fountain Lakes SWA that are hydrologically connected to the alluvial ground water system (S. Smith, MWH, pers. comm. 2007) and that support recreational uses. Changes to water levels in these adjacent water bodies could affect water-based recreation at those sites.

As described in Section 3.6, direct effects of the Action Alternatives on alluvial ground water would range from a lowering of mean monthly water table elevations of about 0.14 feet to an increase of the water table elevations of about 0.36 feet. The greatest overall monthly mean reductions in alluvial ground water levels would be 0.14 feet, within 100 feet of the river, under the No Action Alternative. The largest magnitude of overall monthly mean effects on alluvial ground water levels would be a 0.36-foot increase at a location 100 feet from the Arkansas River under the Arkansas River Alternative. The effects of these hydrological changes on recreation resources are described as follows.

Boating. The anticipated hydrological changes and frequency at which PFMP targets are met would result in minor benefits to boating opportunities under the Participants' Proposed Action, the Wetland Alternative, Fountain Creek Alternative, and the Downstream Intake Alternative, while the Arkansas River Alternative would result in moderate benefits. The Highway 115 Alternative would result in minor adverse effects to boating opportunities. These effects would be similar in wet and dry years, except that in dry years, the Arkansas River Alternative would result in increased benefits, while the Highway 115 Alternative would result in a minor reduction in days.

Angling. The construction of water intake facilities downstream of the Pueblo Reservoir dam under the No Action, Participants' Proposed Action, Wetland, and Fountain Creek alternatives would result in minor temporary adverse effects to angling opportunities in that location by interrupting angling access (see *Land-based Recreation* under *Lake Pueblo State Park*). Likewise, the construction of similar facilities near the confluence with Fountain Creek under the Arkansas River, Fountain Creek, and Downstream Intake alternatives would permanently affect between 0.01 and 8.3 acres of land along the banks of the Arkansas River. These effects could result in minor temporary adverse effects to existing angling access in that area.

CDOW stocks and manages the fishery in this reach of the Arkansas River. The anticipated hydrological changes through this reach would result in moderate benefits to angling opportunities (Section 3.10) in the Arkansas River Alternative, and moderate adverse effects in the Highway 115 Alternative. The remaining alternatives would result in negligible to minor adverse effects to angling opportunities in this area.

Trails. None of the alternatives would affect existing or proposed trails in Pueblo County, with the exception of temporary effects to existing trails at Lake Pueblo State Park (see *Land-based Recreation* under *Lake Pueblo State Park*) and the Honor Farm Property (below under *Other Pueblo Area Recreation*).

Other Pueblo County Recreation

Honor Farm Property. The Western Untreated Water Pipeline in the Participants' Proposed Action, Wetland, and Fountain Creek alternatives would cross the Honor Farm Property, resulting in temporary effects to 24 acres of the property, and to 467 feet of proposed trails due to pipeline construction. This effect would be negligible.

El Paso County Area Recreation

Pikes Peak Greenway

The No Action, Participants' Proposed Action, Fountain Creek, Downstream Intake, and Highway 115 alternatives do not include facilities along Fountain Creek within the Colorado Springs, and would not affect the Pikes Peak Greenway Trail or any other associated parks or recreation facilities.

The Wetland and Arkansas River alternatives would result in temporary effects to about 640 feet of the Pikes Peak Greenway Trail. This minor short-term adverse effect would disturb less than 1 percent of the trail system during construction.

Other Colorado Springs Trails

All alternatives include pipeline alignments that cross proposed trail alignments, including the Rock Island Trail corridor in the eastern portion of Colorado Springs. Specific temporary effects to proposed trail corridors would be 1,100 feet of trail under the No Action Alternative, and 540 feet of trail in all remaining alternatives. These effects, encompassing less than 1 percent of the existing and proposed trails, would be negligible.

Fountain Creek Regional Trail

All alternatives except for the Wetland and Arkansas River alternatives include pipeline alignments that would affect the Fountain Creek Regional Trail. The length of Fountain Creek Regional Trail that would be affected by each alternative is 1,330 feet for No Action, Participants' Proposed Action, Fountain Creek, and Highway 115 alternatives, and 840 feet for the Downstream Intake Alternative.

All of these effects would result in temporary trail closures or rerouting during construction, resulting in minor short-term adverse effects to the Fountain Creek Regional Trail.

Other Fountain Area Trails

All alternatives include pipeline alignments that would cross proposed trail alignments to the east and west of the City of Fountain (including Clear Spring Ranch Park, southeast Colorado Springs area trails, and Fort Carson area trails). These effects would result in temporary trail closures or rerouting, provided that the trails are developed prior to pipeline construction. These short-term trail effects would have a negligible effect on trail access and use in the Fountain area. However, pipeline construction also may provide a benefit to trail construction by providing opportunities to locate proposed trail corridors with pipeline facilities.

Jimmy Camp Creek Park/Reservoir

Jimmy Camp Creek Park is not open for public use and does not include any amenities that would be adversely affected by the proposed reservoir and other facilities. All alternatives except the Participants' Proposed Action and Wetland alternatives include a new Jimmy Camp Creek Reservoir, a water treatment plant, and related water conveyance facilities at this location. Colorado Springs' past plans for a park facility at this location have been documented in various plans, including the Colorado Springs Open Space Plan (Colorado Springs 1997) and the Parks, Recreation and Trails 2000-2010 Master Plan (Colorado Springs 2000). In addition, Colorado Springs has envisioned using the park as a juncture for the planned extension of the Rock Island Trail and the proposed Jimmy Camp Creek Trail.

Few recreation areas in the Colorado Springs region provide the community with any opportunities for water-based recreation. Although some water-based uses would be restricted, a future Jimmy Camp Creek Park would be a major recreational asset for the community. Colorado Springs has not estimated public use levels at the future Jimmy Camp Creek Park (Lieber, pers. comm. 2006). Based on other existing reservoirs along the Front Range with similar public uses and restrictions (e.g., Barr Lake State Park near Brighton) (Roush, pers. comm. 2006), this park would be estimated to support between 50,000 and 80,000 visitors per year. The development and operation of this new facility would be a major benefit to both water- and land-based recreation opportunities in the Colorado Springs region, because it would offer recreation amenities that are currently not available.

Williams Creek Reservoirs

The No Action, Participants' Proposed Action, Fountain Creek, Downstream Intake, and Highway 115 alternatives include a new return flow storage reservoir on Williams Creek, southeast of the City of Fountain. The Participants' Proposed Action and Wetland alternatives would include a new terminal storage reservoir in upper Williams Creek. The development of a reservoir in either of these locations would not affect any existing or proposed recreation uses or facilities. No recreational use is proposed to occur at Williams Creek Reservoir; any incidental effects, such as wildlife observation, would be a negligible beneficial effect.

A new terminal storage reservoir in upper Williams Creek in the Participants' Proposed Action and Wetland alternatives would benefit water- and land-based recreation opportunities in the Colorado Springs region for reasons that are similar to those described above under *Jimmy Camp Creek Park/Reservoir* (which is proposed for the other alternatives). The area around Upper Williams Creek Reservoir is less scenic and recreational use would likely be less than at the proposed Jimmy Camp Creek Reservoir.

Fountain Creek Regional Park

All alternatives except for the Wetland and Arkansas River alternatives include water intake and return flow conveyance facilities in Fountain Creek Regional Park. Anticipated permanent effects to the park would be about 13 acres, which would comprise about 3 percent of the park area resulting in minor adverse effects.

Clear Spring Ranch Park

The No Action and Highway 115 alternatives include SDS Project facilities in Clear Spring Ranch Park, along Fountain Creek, south of the city of Fountain. The Participants' Proposed Action and Downstream Intake alternatives include a conveyance pipeline outlet on the edge of the park which would affect about 0.1 acre of park land. Anticipated permanent effects on Clear Spring Ranch Park for the No Action and Highway 115 alternatives would be about 6 acres. These permanent effects would be much less than one percent of the total park area (930 acres), and would result in negligible to minor adverse effects on Clear Spring Ranch Park. The effects of the outlet in the Participants' Proposed Action and Downstream Intake alternatives would be negligible.

Upper Arkansas River Recreation

Boating

Leadville to Florence. When compared to recreation flow targets for boating (Table 123) none of the alternatives would result in river flows that fall below the acceptable flow targets for boating and angling during the summer recreation season (under average conditions) (Table 124). Likewise, none of the alternatives would satisfy the preferred optimum flow of 1,500 cfs for rafting in July or August of average years, or the preferred optimum flow of 1,300 cfs for kayaking in August. (This target is not met under Existing Conditions.) While all alternatives would exceed the preferred optimum high flow of 1,500 cfs for kayaking in June, none of the alternatives would exceed the acceptable high flow of 2,500 cfs. This effect would occur for Existing Conditions and all alternatives. Overall, all alternatives would meet recreation flow targets (and UAVFMP targets) during the summer recreation season, and the difference between the proposed alternatives and Existing Conditions would be negligible to minor. BLM, State parks, and several municipal water suppliers coordinate efforts to provide boatable flows from July 1 to August 15.

In dry years, average flows for all alternatives would drop below the preferred optimum target for both rafting and kayaking throughout the summer recreation season, and acceptable low flows for both activities in August. None of the high flow targets for boating would be exceeded. In wet years, all alternatives would exceed the acceptable high flow target in June. These conditions (for both dry and wet years) are the same for the alternatives and Existing Conditions.

Florence to Pueblo Reservoir. The No Action Alternative would result in minor

Table 124. Upper Arkansas River Flows Compared to Recreation Flow Targets.

Flow Regime	Acceptable Flow Targets		UAVFMP Target*	Exist. Cond.	Alternative						
	Rafting/ Kayaking	Angling			1	2	3	4	5	6	7
High Flow	2,500	2,500	n/a	1,996	1,923	1,961	1,988	1,983	1,949	1,993	1,926
Low Flow	650	250	250/700*	791	791	802	790	791	806	794	824

All units are in cfs.

Direct and indirect effects presented are for average conditions during June, July, and August. All high flows occur in June, and all low flows occur in August.

* UAVFMP Targets are minimum flow recommendations of 250 cfs between August 15 and June 30, and 700 cfs between July 1 and August 14

Source: MWH 2008d.

adverse effects to boating along this reach of the Arkansas River compared to Existing Conditions. The Participants' Proposed Action, Wetland, Arkansas River, Fountain Creek, and Downstream Intake alternatives would result in minor to moderate increases (compared to No Action) in streamflow from Florence to Pueblo Reservoir on the Arkansas River during the summer months (Section 3.5). Compared to No Action, increased flows would result in minor to moderate benefits to boating. The effects of the Highway 115 Alternative on Arkansas River recreational flows would be negligible, and would have a negligible effect on boating in this area. The substantial increases in fall (September and October) streamflow under the Participants' Proposed Action, and the Wetland, Arkansas River, Fountain Creek, and Downstream Intake alternatives would result in moderate to major benefits to boating on this reach of the river by increasing boating opportunities in these months, which would effectively extend the boating season in this area. These effects and benefits would be more pronounced in dry years, and less apparent during wet years.

The No Action, Wetland, Arkansas River, and Highway 115 alternatives would result in short-term adverse effects to an existing boat launch near Colorado 115 (discussed further under *Blue Heron Property*).

Angling

Florence to Pueblo Reservoir. Under the Wetland and Arkansas River alternatives, the construction and operation of a return flow pipeline outfall near the Colorado 115 bridge near Florence could result in negligible adverse effects to angling access to the Arkansas River in this area. The disturbance footprint of these facilities would be about 1 acre. Under the No Action and Highway 115 alternatives, the disturbance footprint of project facilities would be about 6 acres. The Wetland and Arkansas River alternatives would result in moderate benefits to the sport fishery in this portion of the Arkansas River. The Participants' Proposed Action, Fountain Creek, and Downstream Intake alternatives would result in minor benefits to fisheries, while the effects of the Highway 115 and No Action alternatives would be minor (Section 3.10).

Blue Heron Property

The No Action, Wetland, Arkansas River, and Highway 115 alternatives include project facilities at the Arkansas River west of the Colorado 115 bridge. These facilities would be located on the BLM's Blue Heron Property. The permanent effects of these facilities would be 6.4 acres under No Action and the Highway 115 alternatives, and 0.3 acre under the Wetland and Arkansas River alternatives.

The No Action, Wetland, Arkansas River, and Highway 115 alternatives would result in minor short-term adverse effects to the existing boating access on the Blue Heron Property, and minor long-term adverse effects to the property itself. Effects of facility construction on boating access would be minimal because the City of Florence River Park property would continue to provide an alternative river access point. The inflatable rubber diversion dam that is proposed to replace the existing concrete rubble weir is not anticipated to adversely affect boating or angling opportunities in the area.

The Wetland and Arkansas River alternatives include a return flow outfall at this location, which could result in perceived or actual impacts to recreational use and experiences due to odors or perceptions associated with treated wastewater. Such use would be consistent with the nearby Fremont County Rainbow Park Wastewater Treatment Facility and outfall, located across the river to the south. The effect of the proposed SDS Project return flow point on recreation in the Wetland and Arkansas River alternatives is anticipated to be negligible to minor.

Lower Arkansas River Recreation

Reservoir Recreation

Lake Henry. Compared to Existing Conditions, reductions in Lake Henry water surface elevations under the No Action Alternative (less than 1 foot in average, wet, and dry years) would have a negligible effect on reservoir recreation during the summer season. In average conditions, compared to the No Action Alternative, the minor fluctuations in water levels during the summer months under all Action Alternatives would have negligible effects on recreation opportunities. All alternatives except for the No Action and Highway 115 alternatives would result in moderate adverse effects to the fishery and angling opportunities. The effects of the No Action and Highway 115 alternatives would be negligible (Section 3.10).

In dry years, the decreases in surface water elevation would result in moderate adverse effects on boating and additional effects to angling opportunities during the summer. The magnitude of effects would be less under the Highway 115 Alternative, which would result in negligible effects in June and August (compared to the No Action Alternative). During wet years, the small water level changes under all alternatives in June would have a negligible effect on recreation opportunities, while the more substantial water level increases in July and August would result in minor benefits to boating and angling opportunities on the lake.

Lake Meredith. Compared to Existing Conditions, reductions in Lake Meredith water surface elevations under the No Action Alternative (less than 1 foot in average, wet, and dry years) (MWH 2008d) would have a negligible effect on reservoir recreation during the summer season. In average conditions, compared to the No Action Alternative, the Wetland and Arkansas River alternatives would result in moderate adverse effects to recreation opportunities on Lake Meredith, while the Highway 115 alternative would result in minor benefits. The remaining alternatives would result in minor effects.

During dry years, the effects of the No Action Alternative compared to Existing Conditions would be negligible. Compared to No Action, the Wetland and Arkansas River alternatives would result in moderate to major decreases in recreation opportunities, while the Participants' Proposed Action and the Fountain Creek alternative would result in minor to moderate decreases in recreation opportunities during the summer recreation season. The Highway 115 Alternative would result in minor benefits during the months of July and August. During wet years, all alternatives would have negligible effects on boating and angling opportunities on Lake Meredith.

Holbrook Reservoir. All of the anticipated water level changes in average, wet, and dry years would have negligible effects on boating and angling opportunities at Holbrook Reservoir during the summer recreation season.

Western Slope Recreation

All alternatives would result in a combination of negligible, beneficial, and adverse effects on aquatic life throughout the Western Slope analysis area. The effects would be indirect effects through changes in streamflow or reservoir operation. In the smaller streams, the differences in hydrology among the alternatives would be small (less than 1 or 2 cfs) and would result in negligible or minor effects on angling opportunities.

The No Action Alternative would moderately decrease flows in the Roaring Fork River during the month of June. Compared to the No Action Alternative, all Action Alternatives would include a minor to moderate increase in streamflow during the month of June, with negligible to minor increases in flows during the remainder of the summer recreation season. These changes would result in negligible effects to angling and boating opportunities on the Roaring Fork River.

In Homestake Reservoir, the No Action Alternative would have a moderate adverse indirect effect with an average of 17 percent lower storage throughout the year compared to existing conditions. Compared to the No Action Alternative, all other alternatives would have negligible to minor fluctuations in water levels which would have negligible effects on recreation opportunities.

3.14.5.2 Cumulative Effects

The cumulative effects of the alternatives, when combined with the effects of other reasonably foreseeable activities are described below. Recreation resources with no cumulative effects are not discussed.

Pueblo Area Recreation

Lake Pueblo State Park

Water-Based Recreation. Compared to Existing Conditions, the cumulative effects of the No Action Alternative would result in moderate decreases in water surface elevation in Pueblo Reservoir. For all of the Action Alternatives, compared to the No Action Alternative, the decrease in surface water elevation during average, dry, and wet years (Section 3.5) would result in negligible to minor cumulative impacts to water-based recreation on Pueblo Reservoir. These projected changes would not measurably affect the quality of the recreation experience for boating or angling, or overall visitation levels (Smith and Hill 2000).

Long-term climate change may result in a longer recreation season or a shift in peak recreation from the summer months to the fall and spring. Higher temperatures may benefit warmwater fisheries and associated angling use.

River Corridor Recreation–Downstream of Pueblo Reservoir

Water-Based Recreation. Compared to Existing Conditions, the No Action Alternative would result in minor cumulative effects to river recreation opportunities through Pueblo, based on the number of days PFMP targets would be met (Section 3.5). Compared to No Action, the Participants' Proposed Action Fountain Creek, and Highway 115 alternatives would result in minor reductions in the number of days target flows would be met during the summer, while the remaining alternatives would result in minor increases in days. The cumulative effect of these changes (both adverse and beneficial) on boating and angling through Pueblo would be negligible to minor.

Long-term climate change may result in a reduction in days that PFMP flows are met, and/or a shift in peak recreation flows from the summer months to the spring. Depending on the overall hydrological changes, this may result in cumulative effects to river recreation opportunities through Pueblo, a change in peak recreation seasons, or both.

El Paso County Area Recreation

Trails

Several reasonably foreseeable actions within El Paso County may result in temporary closures or rerouting of trails, and are described as follows.

Pikes Peak Greenway Trail. Several reasonably foreseeable projects, including improvements to I-25 through Colorado Springs, the South Metro Accessibility Project (to improve east-west transportation mobility), and improvements to the existing Las Vegas Street Wastewater Treatment Facility, may result in minor cumulative effects under all alternatives. Cumulative effects would occur because an increased number of trail sections would be closed temporarily during project construction and the frequency of closures to portions of the Pikes Peak Greenway Trail system would increase.

Northeast Colorado Springs Trails. Proposed improvements to Marksheffel Road, as well as a variety of expected road improvements associated with additional development and population growth in eastern Colorado Springs, may result in additional minor cumulative effects if existing trails are temporarily closed during construction. However, many of these construction and road-improvement activities also may provide opportunities to develop proposed trails in the area, resulting in an overall benefit to trail connectivity in the region.

Upper Arkansas River Recreation

River Recreation

Compared to Existing Conditions, the cumulative effect of the No Action Alternative on upper Arkansas River recreation would range between minor adverse effects in June to minor benefits in August (due to changes in river flows) (Section 3.5).

Cumulative hydrology effects in average conditions would maintain river flows within the acceptable range for boating (650 to 2,500 cfs) during the summer recreation season. In dry years, flows in August would drop below the acceptable range, while in wet years, flows in July would be above what is considered acceptable. This is true for all proposed alternatives as well as Existing Conditions.

None of the alternatives would result in adverse cumulative effects on either boating or angling along the upper Arkansas River, while all alternatives would result in minor benefits to both activities in dry years due to higher June river flows.

Long-term climate change may result in an overall reduction in river flows and a shift in peak flows to earlier in the spring. Higher water temperatures could benefit coldwater fisheries in the upper Arkansas River. Higher ambient temperatures also could increase the demand for high altitude, water-based recreation. This may result in adverse cumulative effects to recreation along the upper Arkansas River by increasing the demand for river recreation while decreasing peak river flows. However, hydrological changes may benefit aquatic habitat and the overall quality of the fishery (Section 3.10).

Reservoir Recreation

Compared to Existing Conditions, the No Action Alternative would result in minor cumulative effects to recreation opportunities at Twin Lakes due to reductions in lake levels. Compared to the No Action Alternative, the minor cumulative changes in surface water elevations (between -2 and +4 percent) at Twin Lakes (in average conditions) would be similar among all alternatives, and would not result in cumulative effects on boating or angling.

Higher water temperatures in Twin Lakes due to long-term climate change could benefit coldwater fisheries in the reservoir. Higher ambient temperatures also could increase the demand for high-altitude, water-based recreation, while also extending the recreation season into the spring and fall. The effect of hydrological changes on reservoir levels is not known. The overall cumulative effect of these factors on reservoir recreation is not known.

Lower Arkansas River Recreation

Lake Henry

Compared to Existing Conditions, the cumulative effects of the No Action Alternative on recreation opportunities in Lake Henry would be negligible. Compared to the No Action Alternative, in average conditions, the changes in water level elevations on Lake Henry (Section 3.5) would result in minor effects to the availability and use of the reservoir for boating and angling throughout the summer recreation season. During dry years, the hydrological changes would result in minor to moderate cumulative adverse effects to recreation. In wet years, increased water levels would result in minor to moderate benefits to recreation.

Long-term climate change likely would increase the variability of water levels in Lake Henry, resulting in greater frequency of dry or very low water levels during the summer recreation season. Increased ambient temperatures and changes in runoff patterns also could shift the peak recreation season from the summer months to the spring and/or fall. In general, these factors would result in cumulative effects to reservoir recreation, although the actual effect of climate change on lake levels and their use is not known.

Lake Meredith

Compared to Existing Conditions, the cumulative effects of the No Action Alternative on recreation opportunities in Lake Meredith would be negligible to minor. Compared to the No Action Alternative, in average conditions, the changes in water level elevations on Lake Meredith (Section 3.5) would result in minor to moderate adverse effects to the availability and use of the reservoir for boating and angling throughout the summer recreation season, with the exception of the Highway 115 Alternative, which would result in minor benefits. During dry years, the anticipated hydrological changes would result in minor to moderate adverse effects for all alternatives except the Highway 115 Alternative, which would have minor adverse effects in June, and minor to moderate benefits in July and August. In wet years, all alternatives would result in minor adverse or beneficial effects during the summer recreation season.

The cumulative effects of long-term climate change on recreation at Lake Meredith would be similar to what is described above under Lake Henry.

Western Slope Recreation

The proposed alternatives would not result in any cumulative effects to Western Slope recreation resources.

3.14.5.3 Resource Commitments

None of the alternatives would result in irreversible commitments of recreation resources. Some of the effects described above would result in a short-term irretrievable loss of recreation access and opportunities at various sites and facilities that would be affected by proposed project facilities. These sites and resources include:

- Angling opportunities in Pueblo Reservoir (Downstream Intake and Highway 115 alternatives)

- Boating opportunities on the Arkansas River through Pueblo (Highway 115 Alternative)
- Angling access downstream of Pueblo Reservoir dam (No Action, Participants' Proposed Action, Wetland, and Fountain Creek alternatives)
- Proposed trails on the Honor Farm Property (Participants' Proposed Action, Wetland, and Fountain Creek alternatives)
- Pikes Peak Greenway Trail (Wetland and Arkansas River alternatives)
- Other Colorado Springs and Fountain area trails (all alternatives)
- Fountain Creek Regional Park (No Action, Participants' Proposed Action, Fountain Creek, Downstream Intake, and Highway 115 alternatives)
- Clear Spring Ranch Park (all alternatives)
- Boating and angling access at the Blue Heron Property (No Action, Wetland, Arkansas River, and Highway 115 alternatives)

3.14.5.4 Mitigation

Proposed Measures

The following measures, some of which have been proposed by the Participants, would be implemented. These proposed mitigation measures are described by the affected resource.

Trails

The following measures are proposed to mitigate trail effects during construction:

- During short-term construction activities that require trail closures, designate a safe and reasonable detour around the project site. Post signs directing trail users

The following is proposed to mitigate long-term trail effects:

- Work with the local municipality to establish alternate trails with consistent width, surfacing, and signage

Parks and Open Space

The following measures are proposed to mitigate effects to parks and open space areas during construction:

- Within developed parks with temporary effects, commit to full reclamation of the impact area by replacing turf, irrigation systems, and other facilities that could be affected. Provide follow-up monitoring and maintenance to ensure that reclamation efforts are successful

The following is proposed to mitigate long-term or permanent effects to parks and open space areas:

- In areas with permanent, aboveground project facilities, reconfigure park facilities that may be affected and visually screen facilities from other park uses with vegetation, berming, or attractive fencing

Upper Arkansas River Corridor

The following measures are proposed to mitigate general effects to recreation resources:

- In the Action Alternative that includes the Ark-Otero Untreated Water Pipeline (Highway 115 Alternative), reconstruct the Ark-Otero diversion dam and intake structure so that it is less hazardous to boaters

- In alternatives that include facilities at the Blue Heron Property (No Action, Wetland, Arkansas River, and Highway 115 alternatives), work with the BLM to establish new long-term river access points that are compatible with proposed facilities and management priorities at the site

Lower Arkansas River Reservoirs
The following is proposed to mitigate general effects to recreation resources (i.e., reservoirs):

- Seek opportunities to enhance angling, boating, or other recreation opportunities at affected reservoirs (Lake Henry, Lake Meredith, and Holbrook) so that they are less vulnerable to water level fluctuations. Work with the CDOW to identify priority projects

Mitigated Effects
The benefits (or effects) of implementing the proposed mitigation measures are described by affected resource as follows.

Trails
The proposed mitigation measures would reduce the impact of project facility construction on trail users under all alternatives.

Parks and Open Space
The proposed mitigation measures would reduce the short- and long-term impacts of project facilities on park infrastructure, vegetation, aesthetics, and recreation experiences. These benefits would apply to all alternatives.

Upper Arkansas River Corridor
A reconstructed Ark-Otero diversion dam/intake proposed as mitigation in the Highway 115 Alternative would improve safety and the recreational experience for many boaters. Collaboration with BLM at the Blue Heron Property (Wetland, Arkansas River, and Highway 115 alternatives) would provide the opportunity to implement SDS facilities while minimizing impacts to, or potentially improving, recreational facilities and uses at that location.

Lower Arkansas River Reservoirs
Collaboration with CDOW to enhance fishing and boating opportunities may result in such improvements to recreation at Lake Henry, Lake Meredith, and Holbrook Reservoir under any alternative.

3.15 Socioeconomics and Land Use

This section describes existing socioeconomic conditions in the study area and the anticipated effects of the alternatives on these conditions. For this analysis, socioeconomic effects include direct, indirect, and cumulative effects on recreation-related economic activity and benefits, agricultural production and employment, property values, household costs for water and wastewater services, construction-related employment, regional jobs and population, and quality of life due to project construction or operation.

This section also discusses the effects of alternatives on land use. Land use describes how a piece of land is managed or used by humans and reflects the degree of human activities on the land. Land use is being analyzed in this FEIS because construction of proposed SDS Project components may require changes to land use or the requisition of special land use permits. Changes to federal, state, and local land use plans that would result from the alternatives were used as an indicator of land use effects.

Some tables and figures in this section use the following numbers to identify the alternatives:

- Alternative 1 (No Action Alternative)
- Alternative 2 (Participants' Proposed Action)
- Alternative 3 (Wetland Alternative)
- Alternative 4 (Arkansas River Alternative)
- Alternative 5 (Fountain Creek Alternative)
- Alternative 6 (Downstream Intake Alternative)
- Alternative 7 (Highway 115 Alternative)

Further detail regarding existing socio-economic conditions can be found in the Socioeconomic Resources Technical Report (BBC 2007). More information on anticipated socioeconomic effects is provided in the Socioeconomic Effects Analysis (BBC 2008a) and Socioeconomic Resources Administrative Record Documentation (BBC 2008b).

3.15.1 Summary of Effects

None of the alternatives is anticipated to create long-term adverse effects for the recreation-related economy in Pueblo County or the upper Arkansas Valley. Under the Participants' Proposed Action, Wetland Alternative, and Fountain Creek Alternative, construction may cause minor, short-term adverse effects to visitation levels at Pueblo Reservoir as certain areas become inaccessible or enjoyment of the site is otherwise hampered by construction activities. This would cause corresponding short-term effects on the recreation-related economy in Pueblo County.

The direct effects of all alternatives, including the No Action Alternative, would be to reduce flood risk and damage along Fountain Creek because each alternative involves construction of one or more reservoirs in tributary basins above the creek.

The No Action Alternative would meet PFMP target flows slightly less often than under Existing Conditions. With the exception of the Highway 115 Alternative, the Action Alternatives would meet summer PFMP target flows more than under the No Action Alternative. The Arkansas River Alternative would meet target flows most frequently in summer and winter and might have small but beneficial effects on property values near the Arkansas River.

There would be substantial increases in the cost of water service for customers of

Colorado Springs Utilities and Security Water District under the No Action Alternative and all Action Alternatives. Despite these increases, water rates are projected to remain affordable (well below 2 percent of median household income levels) for customers of both of these Participants. For Colorado Springs customers, the Participants' Proposed Action would require the smallest increases in rates and connection charges and the Wetland Alternative, the Arkansas River Alternative, and the Downstream Intake Alternative would require the largest increases. The No Action Alternative would require the smallest rate increases for Security customers. None of the alternatives is anticipated to lead to noticeable cost changes for other water or wastewater providers in the analysis area, including Fountain and Pueblo West.

Construction of the No Action Alternative would support additional employment in the local construction industry relative to Existing Conditions. Increased construction employment and non-labor construction expenditures would generate additional economic activity. Construction of the Action Alternatives would provide similar benefits as the No Action Alternative. These effects would be negligible, however, relative to the overall size of the local construction industry and the regional economy.

None of the alternatives would have a noticeable, long-term effect on overall socioeconomic conditions in communities along the Arkansas River and Fountain Creek, or a perceptible effect on quality of life in those communities. Farming communities in the lower Arkansas Valley are struggling with a number of economic challenges including the recent departure of major employers, the transfer of agricultural water rights to municipalities and depressed agricultural production. The alternatives, however, are not expected to have a discernable effect on the socioeconomic conditions within these communities.

Existing land use would change in certain areas because of SDS Project aboveground infrastructure (e.g., pump stations, water treatment facilities, and reservoirs). The No Action Alternative would have the greatest effect on land use because it would have the greatest number of aboveground structures, including well systems, three untreated water intakes, six pump stations, one booster pump station, two reservoirs, and a treatment plant. The Highway 115 Alternative would have similar effects on land use because it would use the same aboveground structures as the No Action Alternative, with the exception of the well systems and one untreated water intake. The Wetland and Arkansas River alternatives would have the least effect on land use because they only have one new reservoir, and therefore have aboveground structures that would affect the least amount of land. The Participants' Proposed Action, Fountain Creek, and Downstream Intake alternatives would have similar, intermediate land use effects.

Changes to existing land use would require special variances, zoning changes, or permits from local, state, and federal government land use agencies.

3.15.2 Regulatory Framework

There is no overarching regulatory framework regarding socioeconomic effects. Examination of environmental justice issues, discussed in the Environmental Justice section (Section 3.16), is directed by an Executive Order.

Land use is regulated through land use planning, such as zoning, land use permitting, and land development guidelines. Multiple federal, state, county, municipal, and intergovernmental agencies manage or coordinate land use within the analysis area, including the Pikes Peak and Pueblo area councils of government, El Paso, Pueblo, Fremont, and Chaffee counties, the cities of Colorado Springs, Fountain, and Pueblo, the Colorado State Land Board, the CSP, the U.S. Forest Service, the U.S. Bureau of Reclamation, U.S. Army Fort Carson Military Reservation, and the U.S. Bureau of Land Management. Each of these agencies has its own plans, regulations, policies, or guidance about how land under its jurisdiction should be managed and developed. Special variances or permits may be required for proposed land uses that differ from what has been defined by each agency in its land use plan.

Because federal land would not be acquired by the Participants, use of federal lands would require a right-of-way grant or special use permit. A right-of-way grant is an authorization to use a specific piece of public land for a certain use, such as a road, pipeline, transmission line, or communication site. A right-of-way grant authorizes rights and privileges for a specific use of the land for a specific period of time, which is generally the life of the project. A special use permit is similar to a right-of-way, but is generally for temporary uses.

Counties within the analysis area that have 1041 regulations are Pueblo and Chaffee counties. 1041 Regulations are discussed in more detail in Section 2.4.4.3.

3.15.3 Analysis Area and Methods

Key socioeconomic concerns identified during scoping were (MWH 2004):

- Effects on tourism and the tourism-related economy in Pueblo and upstream communities
- Effects on agricultural production in the lower Arkansas Valley from changes in water quality
- Effects on residents and property located in proximity to the Arkansas River and Fountain Creek
- The cost of construction, operations and maintenance and water treatment by Project Participants and downstream water users
- Overall socioeconomic effects on Pueblo and other communities, especially those downstream along the Arkansas River
- Impact to overall quality of life

Proximate generally means located close enough to streams or SDS Project facilities to be potentially affected. For the Environmental Justice analysis, proximate communities were defined based on Census block group geography.

Effects on property values and property owners from SDS Project construction and construction-related economic activity were also analyzed.

3.15.3.1 Analysis Area

The analysis area was defined to include all areas that might incur socioeconomic effects due to either project construction or operation. The large geographic area encompassed in the socioeconomic analysis focuses primarily on eight Colorado counties divided into four sub-areas for purposes of describing the affected environment and evaluating economic effects. These sub-areas included: El Paso County, the upper Arkansas Valley, Pueblo County, and the lower Arkansas Valley. The upper Arkansas Valley includes Lake County, Chaffee County, and Fremont County. The lower Arkansas Valley includes Bent County, Crowley County, and Otero County.

Figure 92. shows the primary analysis area for socioeconomics. The potential for socioeconomic effects on the Western Slope, including the headwaters region of the Colorado River Basin in eastern Pitkin County and southeastern Eagle County, was also considered.. The analysis area for land use was counties in which SDS Project facilities would be constructed under one or more alternatives: El Paso, Pueblo, Fremont, and Chaffee counties.

3.15.3.2 Analysis Methods

Information to characterize the socioeconomic affected environment was assembled from local, state, and federal data sources and previous reports and publications. Existing, published data were used to describe current conditions and historic trends in measures such as total population, total households, household size, ethnic/minority population, total employment, employment by sector, earnings by sector, labor force, unemployment rates, household income, and other general economic and demographic metrics.

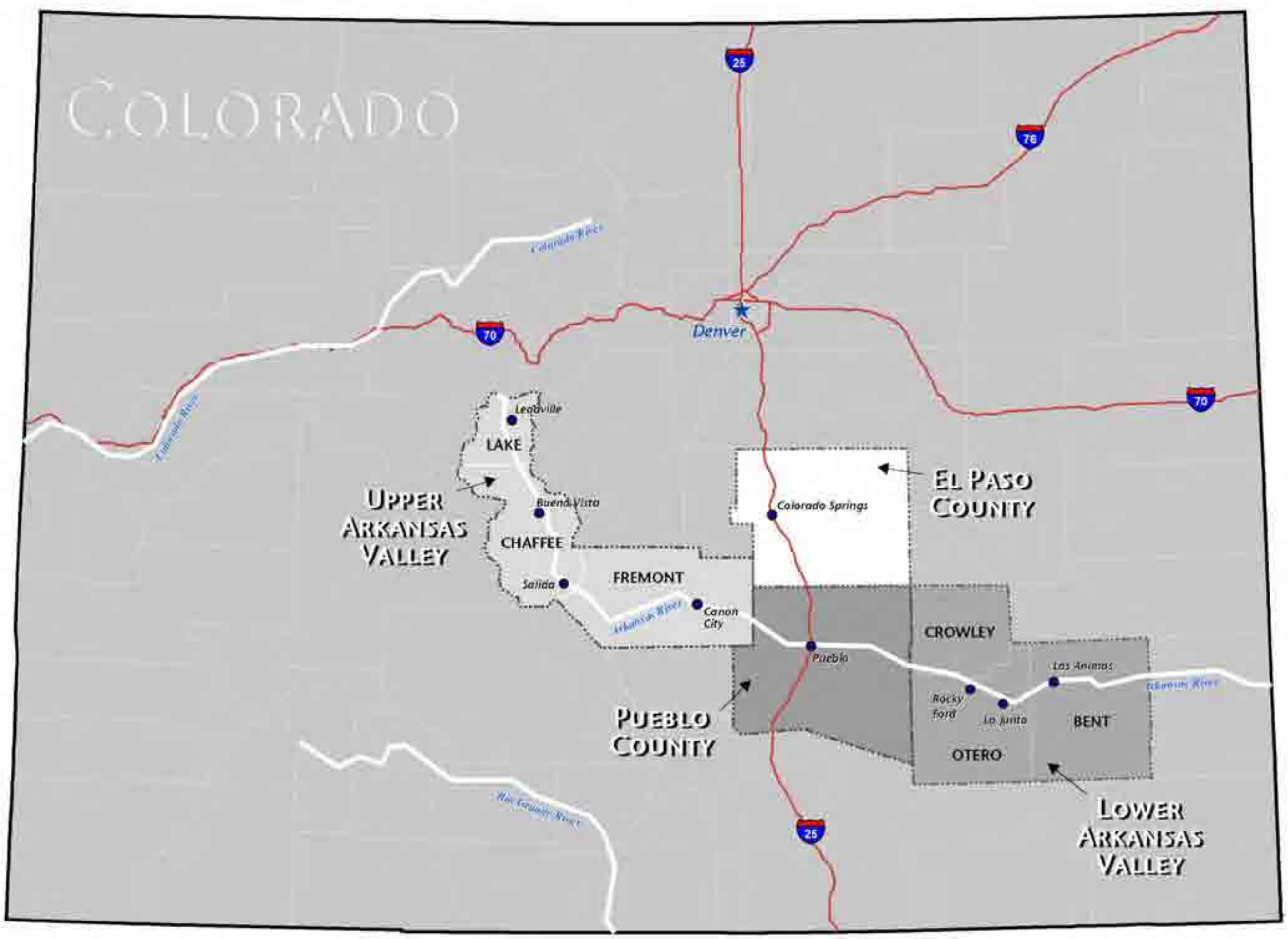


Figure 92. Primary Socioeconomic Analysis Area.

Additional data were collected and analyzed for economic sectors and activities that might be particularly affected by the alternatives. These areas included agriculture, recreation/tourism, downtown Pueblo business activity, water rates, and system development charges. Where additional information was required to characterize the affected environment or to develop data to help identify relationships between the potential effects of the alternatives and socioeconomic conditions, interviews were conducted with local information sources.

To evaluate the direct, indirect, and cumulative socioeconomic effects of the alternatives, Reclamation:

- Evaluated effects of each alternative potentially leading to socioeconomic consequences. The primary sources for this evaluation were information from other resource assessments conducted for this FEIS and information provided by the Participants. Other resource assessments critical to the socioeconomic analysis included the evaluations of surface water hydrologic effects, water quality, recreation, and flood hydrology and floodplains.
- Evaluated the economic changes associated with direct effects. The extent to which economic effects were quantified depended on the magnitude of the effects and the data available from existing sources and other resource assessments.
- Used a regional economic impact model to examine secondary economic impacts that could be associated with changes in crop yields in the lower Arkansas Valley and with project construction in El Paso County. IMPLAN, an input-output modeling and database package, was used for this purpose (IMPLAN 2006).
- Evaluated financial effects on households receiving water service from Participants based on cost estimates and rate models developed by the Participants. Annual water expenditures below 2.0 percent of household income were considered relatively affordable. This threshold was based on the 2.5 percent standard traditionally used by EPA. Recognizing that EPA has been advised to lower the affordability threshold (EPA 2006), a slightly lower threshold was used for this analysis.

No established, absolute thresholds are available for evaluating socioeconomic effects. Instead, the magnitude of effects may be best evaluated in relative terms. For example, a gain of 100 jobs in the U.S. economy would typically be considered insignificant or undetectable. However, 100 new jobs in a small, rural county could represent a relatively large socioeconomic effect.

Table 125 summarizes the socioeconomic indicators and thresholds used to categorize socioeconomic effects from the alternatives. In this evaluation, socioeconomic effects are classified into five potential categories: major adverse, minor adverse, none or negligible, minor benefit, and major benefit. Specific measures were assigned to each potentially affected sector or socioeconomic issue (e.g., agriculture or recreation) to help classify the magnitude of effects. The relevant metrics for recreation- and agriculture-related economic effects are annual measures of economic activity at the county level, such as visitor spending, total value of annual agricultural production and sector employment and income. Property value effects refer to projected changes in the sales value of affected

Table 125. Socioeconomic Effects Classification and Thresholds.

Effects Threshold	Recreational Spending/ Benefits†	Agricultural Production†	Property Values‡	Cost of Water/ Wastewater Services‡	Construction Employment†	Regional Jobs and Residents†	Social Character/ Quality of Life
Major Adverse	Decrease >5%	Decrease >5%	Decrease >10%	Increase >25%	Decrease >10%	Decrease >2%	Noticeable long-term effect
Minor Adverse	Decrease by 1%-5%	Decrease by 1%-5%	Decrease by 5%-10%	Increase by 10%-25%	Decrease by 5%-10%	Decrease by 1%-2%	Noticeable short-term effect
None/ Negligible	<1% change	<1% change	<5% change	<10% change	<5% change	<1% change	No detectable change
Minor Beneficial	Increase by 1%-5%	Increase by 1%-5%	Increase by 5%-10%	Decrease by 10%-25%	Increase by 5%-10%	Increase by 1%-2%	Noticeable short-term improvement
Major Beneficial	Increase >5%	Increase >5%	Increase >10%	Decrease >25%	Increase >10%	Increase >2%	Noticeable long-term improvement

† Relative effects measured against overall values for the county or region.

‡ Relative effects assessed only for affected parties (e.g., properties near SDS Project facilities or customers of participating water systems).

properties. Cost of water service is evaluated in terms of inflation-adjusted cumulative changes in the annual bill for a typical household served by water systems affected by the proposed alternatives. Construction employment refers to short-term effects during the construction of the proposed project.

More description regarding these indicators and thresholds is provided in the Socioeconomic Effects Analysis (BBC 2008a).

The analysis area for each alternative was assessed for land use effects. Existing federal, state, and local land use plans were reviewed and potential land use effects from the SDS Project were evaluated qualitatively. Alternatives with the greatest number of permanent structures and aboveground disturbances were assumed to have the greatest land use impacts.

Changes to existing land use may be required due to construction of SDS Project infrastructure. Any changes to land use would need to comply with applicable land use plans described below. Aboveground infrastructure, such as pump stations, diversion structures, water treatment plants, and access roads, would require industrial land use or a special use permit or right-of-way for federal land. Reservoir areas would be acquired by Colorado Springs and used for open space in addition to water storage. Buried pipelines or electric transmission lines would require an easement.

SDS Project – Land Use and Growth

The SDS Project will not increase **regional growth**. This statement is true for all the SDS Project alternatives analyzed in this EIS. Rather, regional growth in the areas served by the SDS Project is projected to occur regardless whether the SDS Project is built.

Consideration of the SDS Project began as a planning response by project participants to this growth that was projected to occur, as the projected growth originally was considered within Participants' resource planning and demand forecasting. As now proposed and considered in this EIS, the SDS Project is the Project Participants' effort to assure that adequate infrastructure, including water supply, is available to support the growth expected in their service areas.

Population estimates from the Colorado State Demography Office and the Pikes Peak Area Council of Governments have been calculated without regard to whether the SDS Project is built. These estimates indicate that the population in the Participants' planning areas is anticipated to grow at the following annual rates (between 2000 and 2030): Colorado Springs, 1.2 percent; Fountain, 4.0 percent; Security, 1.7 percent; and Pueblo West, 3.5 percent. In the next 20 years more than 40 percent of the population growth in El Paso County is expected to come from within the community (children and grandchildren of existing residents). People moving into the study area from outside of the counties, including 8,500 troops and their families arriving due to military base expansions, will make up the balance.

Banning Lewis Ranch consists of 24,000 acres, along the eastern edge of Colorado Springs planned as a multi-use development. Banning Lewis Ranch was annexed by Colorado Springs in the 1980s and has an approved master plan for residential, recreation and open space areas. The property is expected to develop in phases over several decades.

Direct growth is defined as growth that would result if a project constructs facilities to accommodate populations in excess of those projected by local or regional planning agencies. None of the alternatives would cause direct growth because the SDS Project is not expected to attract population growth in excess of the population growth already projected to occur independently of the SDS Project..

Indirect growth is defined as growth that would result if a project results in substantial new employment opportunities or construction effort that indirectly would cause the need for additional housing and services. None of the alternatives would cause indirect growth because the SDS Project is not expected to result in demand for additional housing or services.

The socioeconomic analysis indicates that none of the alternatives, including the No Action Alternative, would increase long-term employment opportunities or increase regional growth pressures. Planned population growth and development would likely continue whether or not any of the alternatives are constructed.

3.15.3.3 Limitations

The socioeconomic analysis begins, in some instances, from other resource assessments (such as changes in water quality or projected recreation effects). Limitations and uncertainties in those analyses carry over into the socioeconomic effects analysis.

Relationships between physical and economic effects are often less precise or less predictable than in some other disciplines.

The regional economic modeling method (input-output analysis) used to estimate indirect effects has certain limitations. For example, such models rely on a static model of existing economic relationships and may not accurately reflect changes in the structure of the economy that will occur in the future.

The financial analysis contained in this evaluation was conducted to provide consistent estimates of the general magnitude of financial effects on Participants. Some Participants have conducted more detailed analyses of financial impacts associated with the alternatives, but none of the Participants have developed and formally adopted final changes to their rates and charges to help pay for the SDS Project.

Data to describe the affected environment was largely collected in 2004 and 2005. Based on review of the most recent data, conditions have not changed substantially and these data are adequate for purposes of this analysis.

3.15.4 Affected Environment

The following sections summarize the affected socioeconomic environment in the study area. In addition to providing a general overview of socioeconomic conditions, the narrative identifies specific information relevant to socioeconomic concerns raised during scoping. For example, existing water bills and connection charges are described for Project Participants, but these issues are not discussed for other water districts throughout the study area. More detailed information and sources are provided in the Socioeconomic Resources Technical Report (BBC 2007).

Existing land uses in the study area include private and government owned-lands within El Paso, Pueblo, Fremont, and Chaffee counties. The No Action and Highway 115 alternatives would cross Fort Carson Military Reservation, BLM, and U.S. Forest Service lands. The Participants' Proposed Action, Wetland, and Fountain Creek alternatives would cross Reclamation and Colorado State Park land around Pueblo Reservoir. All alternatives would cross public roadways managed by state and local agencies. Stewardship trust lands are not within the study area of any alternative.

3.15.4.1 El Paso County

Socioeconomic Conditions

El Paso County's population was estimated to be about 555,000 people in 2004, an increase of about 38,000 residents from the 2000 Census. The Colorado State Demography Office population forecasts for El Paso County continue the trend of adding 100,000 or more residents each decade. By 2030, the State Demography Office projects that county population will exceed 860,000 people, making El Paso County the most populous county in Colorado. The City of Colorado Springs had a 2004 population of about 380,100 residents, 69 percent of the county total. Colorado Springs has grown almost as rapidly as the county as a whole over the past 20 years. The Widefield-Security area, with a 2000 population of nearly 30,000 people, has been growing slowly relative to other parts of the county. The City of Fountain had about 18,300 residents in 2004 and, since 1990, has been one of the fastest growing areas in the county.

The age, household size, income and race/ethnic profile of El Paso County residents is similar to that of Colorado as a whole, with a few exceptions. El Paso County and Colorado have relatively fewer people 65 years of age and older than the United States as a whole. Median income of El Paso County households in 1999, $46,800, was about the same as the state, and higher than the nation. Relatively fewer people live in poverty in El Paso County (and Colorado) than in the country as a whole. About 24 percent of El Paso County residents are members of a minority group. Eleven percent are Hispanic, less than the statewide average of 17 percent.

Some of the economic history of El Paso County is typical among Colorado communities: initial growth when the railroad came, an early boom as a mining supply and processing center, and development as a tourist destination. However, from the 1940s on, the role of the military and defense industries is much more important in El Paso County than in other regions of the state. Of the nearly 343,000 jobs in El Paso County in 2003, military jobs comprised about 10 percent. Manufacturing accounted for 6 percent of total jobs. Both of these sectors account for a greater share of El Paso County jobs than elsewhere in Colorado.

The five largest municipal water systems in the county are Colorado Springs Utilities (Colorado Springs), which accounts for over 80 percent of the county's municipal water supplies, Security Water District (Security), Cherokee Metro District, the City of Fountain (Fountain) and Widefield Water and Sanitation. Three of these systems (Colorado Springs, Fountain, and Security) are Participants in the proposed project.

Current average monthly water bills for single family residents vary among the El Paso County Participants from $16 per month for the Security Water District to $26 and $40 per month for Colorado Springs and the City of Fountain (respectively). Average charges for new residential connections also vary, from $4,400 within the Security Water District to $7,850 in Colorado Springs, and $13,560 in the City of Fountain.

Local Land Use Plans

Pikes Peak Area Council of Governments

The Pikes Peak Area Council of Governments (PPACG) is a voluntary organization of local governments. Member governments include the City of Colorado Springs, City of Fountain, City of Cripple Creek, City of Manitou Springs, City of Woodland Park, El Paso, Teller, and Park counties, and the Towns of Victor, Alma, Calhan, Fairplay, Green Mountain Falls, Monument, and Palmer Lake. In the area of land use, PPACG assists member governments by preparing socioeconomic projections and preparing regional water quality management, air quality management, and transportation plans. PPACG provides guidance only and has no direct regulatory authority over land uses.

El Paso County

The El Paso Board of County Commissioners is a policy-making and administrative body and the Planning Commission is advisory to the Board of County Commissioners on most land use requests. Land use planning applies directly to the unincorporated areas in the county where the county has jurisdiction and land use authority. El Paso County relies on land development requirements that are in place in the El Paso County Land Development Code to guide land use planning. These requirements implement directives contained in the County-Wide Policy Plan (Policy Plan) (El Paso County 1994). The Policy Plan is used as a guidance document to give direction regarding county-wide land use planning issues such as growth management, land use compatibility, property rights, and infrastructure and facility service standards. The Policy Plan is also intended to assist in cooperative planning related to local municipalities, federal installations, and adjacent counties.

City of Colorado Springs
The City of Colorado Springs has authority for land use planning and regulation within Colorado Springs city limits. City planners rely on a comprehensive planning document to effectively address planning issues. Comprehensive Plans (CPs) provide region-specific guidance by presenting options for establishing livable and socio-economically friendly communities (Colorado Springs 2001). The CPs outline specific neighborhood development, accessible and attractive retail shopping, and well-located schools, parks, and public places for a defined area. Opportunities for developing greenbelt areas and nature preserves are also identified.

The City of Colorado Springs presently owns portions of land that would be used for the Jimmy Camp Creek Reservoir and owns all land that would be used for the Williams Creek Reservoir.

City of Fountain
The City of Fountain has authority for land use planning and regulation within Fountain city limits. The City of Fountain uses the Fountain City Development Plan to guide municipal and citywide growth (Fountain 2005). The Fountain City Development Plan is based on the city's vision that growth and development in the city improves its citizen's quality of life. The Fountain City Development Plan also emphasizes the need to preserve the city's visual resources, parks, and significant features such as floodplains, wetland areas, historic places, and architectural features. One element of the city's vision is to encourage an appropriate mix of low-density and high-density residential development for the area.

Frost Ranch Conservation Easement
The Frost Ranch conservation easement was granted by Colorado Open Lands in 2007. Its purpose is to permanently protect the confluence of Williams Creek and Fountain Creek from development. Under the easement agreement, the land owner (and any subsequent owners) agrees to manage the land in accordance with the conservation easement, which generally protects the land from subdivision and development.

The Frost Livestock Company properties (Frost Ranch) lie east of Fountain Creek and include the southern-most portion of Williams Creek and its confluence with Fountain Creek. The conservation easement includes 915 acres of the Frost Livestock Company properties.

3.15.4.2 Upper Arkansas Valley

Socioeconomic Conditions
The upper Arkansas Valley portion of the analysis area includes the counties from the headwaters of the Arkansas River to the foothills west of Pueblo. Lake, Chaffee, and Fremont counties are within this region. The State of Colorado estimated the 2004 population of the upper Arkansas Valley to total about 72,000 residents. Nearly two-thirds of upper Arkansas Valley residents, over 47,000 people, live in Fremont County. The Colorado State Demography Office projects population in the three-county region to grow by over 70 percent between 2000 and 2030 to reach a total population of almost 120,000.

Rapid development of the upper Arkansas Valley began with the 1860 gold mining boom. Farming and cattle ranching in the upper Arkansas Valley developed in the 1860s to serve the growing mining communities. Railroad jobs were very important to the upper Arkansas Valley economy into the middle part of the 20th century. The Colorado Territorial Penitentiary opened in Fremont County in the 1870s and correctional facilities have been a major employer in the upper Arkansas Valley since then. The upper Arkansas Valley has a relatively high concentration of employment in the public sector. More than 25 percent of upper Arkansas Valley jobs are in government, compared with 13 percent for Colorado as a whole. This is attributable to the large number of jobs at correctional facilities near Buena Vista and Cañon City, plus a large amount of employment by local governments.

In more recent times, winter and summer tourism has grown into one of the largest industries in the upper Arkansas Valley. Activities include rafting, skiing, hiking, camping, touring historic sites and districts, and special events. In 2004, there were 204,000 user days of commercial rafting on the Arkansas River, producing an estimated total economic impact of $53 million. Jobs in the arts/entertainment/recreation, retail trade and accommodation/food services sectors (which include economic activities tied to river rafting, guided fishing, hotel, and food and drink establishments) account for 14 percent of total upper Arkansas Valley employment.

Economic activity in the upper Arkansas Valley also depends on income from employment outside the region and there is substantial out-commuting of residents of this region to jobs outside the region, especially among residents of Lake County.

Demographic data for the upper Arkansas Valley show relatively low incomes and educational attainment, and a relatively large population of older citizens. Of the total regional population in 2000, 15 percent lived in group quarters, reflecting the population housed in correctional facilities in the area. Estimated median household income in the upper Arkansas Valley was about $34,600 in 1999, roughly three-quarters of the median income for all households in Colorado.

Of upper Arkansas Valley residents, 12 percent were living below the poverty level in 1999, higher than average in Colorado and about the same as the United States average. About 20 percent of upper Arkansas Valley residents are members of a minority group; 13 percent are Hispanic, less than the statewide average of 17 percent. From 2001 through 2004, unemployment rates in the upper Arkansas Valley were typically about 1 percent higher than the statewide unemployment rate.

Local Land Use Plans

Fremont County

The Fremont County Planning Commission reviews land use proposals, such as subdivision, zone changes, and use permits, and makes recommendations to the Board of County Commissioners who render final decisions on land use proposals within unincorporated portions of Fremont County. The 2001 Fremont County Master Plan (URS 2002) is the official document for guiding land use decisions for the county. The plan outlines broad-based goals and objectives for growth in the county.

Chaffee County

The Chaffee County Board of Commissioners serves as the administrative and policy-making authority of the County, while the Planning Commission reviews Land Use applications and makes recommendations on those applications to the Board of Commissioners. The Comprehensive Plan for Chaffee County (CP) was adopted by the Board of Commissioners and Planning Commission (Consensus Planning 2000). The primary focus of the CP is land use and the impact growth will have on land use decisions. Some CP components are updating land use regulations to reflect the changing economy and values of the county, focusing residential and commercial growth around the municipalities of Salida, Buena Vista, and Poncha Springs, and adopting regulations to protect the county's water and other resources.

3.15.4.3 Pueblo County

Socioeconomic Conditions

The Pueblo County portion of the study area includes Pueblo Reservoir, the City of Pueblo, the southern portion of the Fountain Creek Valley, suburban communities including Pueblo West and Colorado City, rural communities such as Avondale, and areas of irrigated farming to the south and east of Pueblo.

Pueblo County population was about 150,000 people in 2004, an increase of nearly 9,000 people since the 2000 Census. The State Demography Office population forecasts for Pueblo County reflect growth rates for the county that are very similar to the growth rate projected statewide. Pueblo County population is projected to increase by about 50 percent to about 226,000 residents by 2030. The population of the City of Pueblo is projected to increase by almost 40,000 residents by 2030, to nearly 138,000. The most rapid growth rate, however, is projected for Pueblo West, with population growing from about 16,900 residents in 2000 to about 43,400 residents before 2030.

Pueblo was first settled in the 1840s around Fort Pueblo, which was abandoned in the 1850s. The Denver and Rio Grande Railroad came to Pueblo in the 1870s, followed by other railroads over the next decade. Pueblo was a smelting center for the gold, silver, lead, and zinc from nearby mines. Pueblo's proximity to coal and iron ore led to its subsequent development as a steel center.

In the 1950s, the three major employers—CF&I, Pueblo Depot, and Colorado State Hospital—accounted for more than one-third of local jobs and nearly one-half of local payroll. Pueblo suffered from job cuts at each of these major employers from the 1960s through the 1980s and the county unemployment rate approached 20 percent during parts of the 1980s. Before the local economic downturn began in the 1960s, Pueblo was the second-largest city in Colorado. By 2000, it was only the seventh largest.

From the mid-1980s to the present, Pueblo's economy has benefited from the addition of a variety of new employers, although periodic layoffs, closures and downsizing continue to present economic development challenges for the city. Pueblo wages remain lower than other Colorado urban centers and unemployment rates still exceed state averages. Relatively high-wage manufacturing employment has been replaced by lower-wage trade and services jobs.

Pueblo County has a relatively large population of older adults, and educational attainment and incomes are lower than state and national averages. In 2000, 15 percent of local residents lived below the poverty line compared with 9 percent of residents statewide. About 42 percent of Pueblo County residents are members of a minority group; 38 percent are Hispanic, more than double the statewide average of 17 percent.

Pueblo County produced $42 million of agricultural products in 2002, about twice as much as the upper Arkansas Valley and about one-sixth as much as the lower Arkansas Valley. The county had about 25,000 acres of irrigated cropland and 6,000 acres of irrigated pasture.

Pueblo Reservoir is a very important recreation resource to the City of Pueblo. As one of the top five statewide recreational attractions (based on visitation), the area receives as many as 1.6 million visitors per year. The City of Pueblo opened a whitewater recreation amenity on the Arkansas River in downtown Pueblo in spring 2005.

The largest municipal water systems in Pueblo County are the Pueblo Board of Water Works, which provides water to the City of Pueblo, the St. Charles Mesa Water District, and the Pueblo West Metropolitan District. Pueblo West is a Participant in the proposed project. The typical single-family residence within Pueblo West pays an average of about $34 per month for water service at present. The connection charge for new homes is $6,883 per home, which includes both a water tap fee and a plant investment fee.

Local Land Use Plans

Pueblo Area Council of Governments

The Pueblo Area Council of Governments (PACOG) is organized through an intergovernmental agreement and is considered the official planning organization for the Pueblo area. PACOG membership includes Pueblo County, City of Pueblo, Pueblo West Metropolitan District, Colorado City Metropolitan District, the towns of Beulah and Rye, School Districts 60 and 70, Pueblo Board of Water Works, and the Salt Creek Sanitation District. It is authorized to receive federal and state funding for planning programs related to land use, water quality, transportation, and senior citizen assistance.

The PACOG typically undertakes activities related to water quality planning, committee coordination such as the Environmental Policy Advisory Committee, Citizens Advisory Committee for Transportation, Intergovernmental Review Committee, and PACOG Administration. PACOG is the designated Clean Water Act Section 208 Water Quality Planning Agency for the Pueblo region. PPACG is the designated Clean Water Act Section 208 Water Quality Planning Agency for the Pikes Peak region.

Pueblo County

The Pueblo County Board of Commissioners serves as the administrative and policy-making authority of the County. The Pueblo County Planning Commission is responsible for long-range land use planning and administration of the County's land uses codes. The Pueblo Regional Development Plan, developed by the PACOG, was initially adopted by the Pueblo County Planning Commission and subsequently adopted by the Pueblo County Board of Commissioners (PACOG 2002).

The Pueblo Regional Development Plan is broad in scope and contains a planning horizon to 2030. It was developed to focus on key planning issues that affect the region's land use, economic development, recreation and public facilities, infrastructure development, traffic circulation, and growth areas in the region. Similar to the comprehensive plans for El Paso County, the Pueblo Regional Development Plan serves as an advisory document and is periodically updated. The Pueblo Regional Development Plan defines planning and development principles, policies, and strategies as they relate to land management decisions.

City of Pueblo

The City of Pueblo has authority for land use planning and regulation within Pueblo city limits. As part of the PACOG, City of Pueblo was involved in the development of the Pueblo Regional Development Plan. Adopted by the Pueblo City Council, the Pueblo Regional

Development Plan, ensures land use ordinances meet the diverse needs of the community, manages growth in a sustainable fashion that adds value to the community, provides technical planning assistance in support of neighborhood physical planning goals and ordinances that preserve neighborhood character, plans assistance in the development of special projects as identified by the City Administration, and develops intergovernmental cooperation in support of achieving the community's goals.

3.15.4.4 Lower Arkansas Valley

Socioeconomic Conditions

The lower Arkansas Valley study region includes Crowley, Otero, and Bent counties. There were about 32,000 residents in the region in 2004, an increase of about 3,000 people since 1980. Much of this growth is attributable to the development of correctional facilities in Crowley and Bent counties. The modest population growth this region has experienced over the past 25 years runs counter to population declines in earlier periods. Each of the counties and most of the major communities within them peaked in population prior to 1950. The State Demography Office, however, projects the more recent trend of modest growth to continue into the future with the region reaching a total population of 36,000 by 2030.

The lower Arkansas Valley was the site of new trading posts opening up the West in the 1800s. William Bent opened a number of forts and trading posts along this trade route including sites near present day La Junta. Many of today's towns in the Arkansas Valley were created when railroads came to the area in the 1870s.

Irrigation ditches supplying Arkansas River water were dug in the late 1800s and irrigated agriculture flourished by the early 1900s. The region has seen rapid expansion and decline of several agricultural industries based on weather, market conditions, and soil quality. Currently, crop-growing agriculture in the lower Arkansas Valley includes farmers growing grains and hay and vegetable farmers. Nine major feedlots are located in the Valley, ranging from 3,000 head to about 35,000 head of cattle. Overall, the lower Arkansas Valley is one of Colorado's major centers for irrigated agriculture and livestock, producing nearly $242 million in agricultural products in 2002.

Agriculture, government jobs, manufacturing, highway-related tourist facilities, and correctional facilities are the important components of the lower Arkansas Valley economic base. Government employment accounted for 25 percent of local jobs in 2003 compared to 13 percent of statewide jobs. Agriculture accounted for 14 percent of lower Arkansas Valley jobs versus a statewide average of only 2 percent. La Junta, in Otero County, is the primary manufacturing center in the region and accounts for most of the 600 regional manufacturing jobs in 2003.

The lower Arkansas Valley has relatively depressed incomes, low educational attainment, and a relatively large population of older citizens. Estimated median household income in the lower Arkansas Valley was about $29,100 in 1999, almost 40 percent lower than the median income for all households in Colorado. Average unemployment rates from 2001 through 2004 for the lower Arkansas Valley were typically 1 to 2 percent higher than statewide unemployment rates. About 39 percent of lower Arkansas Valley residents are members of a minority group; 34 percent are Hispanic, double the statewide average of 17 percent.

Water supplies for agricultural and municipal use in the lower Arkansas Valley suffer from relatively high levels of salinity. It is generally believed that existing salinity levels are affecting crop yields. Larger communities from La Junta downstream to the Kansas border have installed expensive, advanced treatment systems to improve water quality for their residents and businesses.

3.15.4.5 State and Federal Land Use Plans

Land use on public lands throughout the analysis area is managed in accordance with state and federal agency plans. The following summarizes the roles and responsibilities of state and federal agencies related to study area lands.

Colorado State Land Board

The State Board of Land Commissioners and staff manage lands given to the State by the federal government. Stewardship Trust Lands of the State Land Board (CSLB 2001) are a special designated trust of lands preserved for future use to support public schools and other trust beneficiaries. The Stewardship Trust Lands protect the natural values of land that provide long-term benefits and earnings to the state.

Colorado State Parks

CSP aims to provide a spectrum of safe, quality recreation experiences for visitors while effectively managing the natural resources under their authority. One of Colorado's 41 State Parks is Lake Pueblo State Park, which provides a natural resource base for a variety of recreational pursuits. The Lake Pueblo State Park Stewardship Plan focused on maintaining the natural resources of Lake Pueblo State Park in good condition (CSP 2002). The goals and objectives for Lake Pueblo are to maintain healthy native plant communities; preserve, protect, and maintain wildlife habitat and populations; preserve and protect the quality and quantity of water resources; and preserve scenic resources and mitigate natural and human-related disturbances.

Colorado Department of Transportation

The Colorado Department of Transportation (CDOT) is responsible for the state highway and bridge system. Portions of pipeline and power line alignments may be within the CDOT right-of-way and would require a special use permit from CDOT.

3.15.4.6 Federal Land Use Plans

Bureau of Reclamation

Reclamation manages, develops, and protects water and related resources in an environmentally and economically sound manner in the interest of the American public. Reclamation has adopted the Lake Pueblo State Park Stewardship Plan as a resource management plan for Pueblo Reservoir (Section 3.14.4.5).

Bureau of Land Management

The Bureau of Land Management (BLM) is responsible for carrying out a variety of programs for the management and conservation of resources on the surface and subsurface of public lands. Under the Federal Land Policy and Management Act of 1976 (BLM 2001), the BLM was to establish public land policy and guidelines to provide management, protection, and enhancement of the public land. The public lands are to be managed so they:

- Protect the quality of scientific, scenic, historical, ecological, environmental, air and atmospheric, water resource, and archeological values

- Preserve and protect public lands in their natural condition
- Provide food and habitat for fish and wildlife and domestic animals
- Provide outdoor recreation and human occupancy and use

In 1996, BLM released the Royal Gorge Resource Management Plan (BLM 1996), which guides management within the Royal Gorge Resource Area in accordance with the Federal Land Policy and Management Act of 1976.

USDA Forest Service

The Forest Service is an agency of the U.S. Department of Agriculture, and manages public lands in national forests and grasslands. The Pike and San Isabel National Forests and Land Resource Management Plan's (USDA 1984) major purpose is to produce and preserve a strong and healthy forest. It provides a long-term plan for managing the Pike and San Isabel National Forest and the Comanche and Cimarron National Grasslands.

U.S. Army Fort Carson Military Reservation

The U.S. Army Fort Carson Military Reservation is about 8 miles south of Colorado Springs in El Paso and Pueblo counties. Land use planning at Fort Carson is the responsibility of the Directorate of Public Work's Master Planning Division. Although a formal land use plan guiding future land management does not exist for Fort Carson, the Master Planning Division continuously assesses new facilities needs and how these facilities can be sited to complement existing land uses at Fort Carson (Corps 2007).

3.15.5 Environmental Consequences

Socioeconomic effects were evaluated separately for each portion of the overall study area: El Paso County, the upper Arkansas Valley, Pueblo County, and the lower Arkansas Valley. The evaluation of effects was organized based on the primary socioeconomic concerns related to proposed alternatives: the recreation-related economy, the agricultural economy, property values, the cost of water and wastewater services, construction-related economic activity and overall regional population and economic growth. Quality of life cannot be directly quantified, but this scoping concern is likely closely associated with regional population and economic growth. Supporting analyses and information sources, along with more detailed information about socioeconomic effects, are provided in the Socioeconomic Effects Analysis (BBC 2008a) and Socioeconomic Resources Administrative Record Documentation (BBC 2008b).

Direct and indirect effects on land use across all potentially affected portions of the study area are described at the end of this section.

3.15.5.1 Direct and Indirect Socioeconomic Effects

El Paso County

Relative to Existing Conditions, the No Action Alternative would lead to minor beneficial effects to the recreation-related economy and construction-related economy in El Paso County, major adverse effects on the cost of water service for customers of Colorado Springs Utilities and Security Water District. There would be a minor short-term benefit to the construction industry in El Paso County.

Compared to the No Action Alternative, there are negligible differences in most of the socioeconomic effects of the Action

Alternatives; however, a major adverse effect on the cost of water service for Security Water District customers would be expected under all Action Alternatives relative to the No Action Alternative. Relative effects on salinity levels in Fountain Creek would provide a minor benefit under the Downstream Intake Alternative and a minor adverse effect under the Wetland, Arkansas River, and Fountain Creek alternatives (Section 3.7.5.1). Table 126 summarizes anticipated socioeconomic effects in El Paso County.

Where the effects of the Action Alternatives would be none or negligible, the effects are relative to, and would be the same or similar to, the No Action Alternative. It does not necessarily mean that there would no effect relative to Existing Conditions.

There would be no major adverse effects to the quality or availability of outdoor recreation in El Paso County under any of the alternatives (Section 3.14). Accordingly, there would be no adverse effects to the local recreation-related economy.

Under the No Action Alternative, construction of a new Jimmy Camp Reservoir and related facilities would produce additional recreation benefits for residents of El Paso County and other users of the proposed Jimmy Camp Creek Park. Similar facilities also would be constructed under each of the Action Alternatives, although the reservoir would be located on Upper Williams Creek under the Participants' Proposed Action and the Wetland alternatives. Therefore, there would be no differences in the recreation-related economic

Table 126. Summary of Socioeconomic Effects in El Paso County.

Indicator	Alt 1†	Alt 2	Alt 3	Alt 4	Alt 5	Alt 6	Alt 7
Recreation-related Economy	⊕	—	—	—	—	—	—
Agricultural Economy	—	—	⊙	⊙	⊙	⊕	—
Property Owners	—	—	—	—	—	—	—
Cost of Water/Wastewater Services‡:							
Colorado Springs	●	—	—	—	—	—	—
Fountain	—	—	—	—	—	—	—
Security	●	●	●	●	●	●	●
Construction-related Economy	—	—	—	—	—	—	—
Population/Economic Growth	—	—	—	—	—	—	—

Legend:

- ○ Major beneficial
- ⦶ Moderate beneficial
- ⊕ Minor beneficial
- — None/negligible
- ⊙ Minor adverse
- ◑ Moderate adverse
- ● Major adverse

Notes:

† Alternative 1 (No Action) is compared to Existing Conditions and Alternatives 2 through 7 (Action Alternatives) are compared to Alternative 1.

‡ Effects on cost of water/wastewater services based on averages of rate effects in 2015 and 2025.

benefits between the Action Alternatives and the No Action Alternative (Section 3.14). The proposed park and reservoir could be an important recreational amenity for local residents, especially boaters and anglers—with benefits to recreation users estimated at $2.2 million to $3.5 million per year. The annual recreation benefit from the proposed reservoir would be a minor benefit, relative to the total annual economic benefits El Paso County residents currently receive from participating in similar types of recreation activities (wherever they may participate). However, the proposed reservoir would be an important local recreational resource because it would provide these activities within a relatively short drive from the homes of many county residents.

Proposed SDS dams on Jimmy Camp Creek or Williams Creek would provide incidental flood control benefits for properties downstream. The proposed facilities would be considered high hazard dams. Catastrophic dam failure is a low probability event, but could lead to substantial property damage and loss of life downstream.

High hazard dams above developed areas are common along Colorado's Front Range. A substantial portion of the population in Colorado's major cities (e.g., Fort Collins, Denver, Colorado Springs, and Pueblo) resides downstream of such facilities. There is no evidence that the presence of these dams and reservoirs has reduced downstream property values. Development of the proposed SDS Project dams and reservoirs would not increase the 100-year floodplain downstream or require downstream homeowners that are not already residing within Special Flood Hazard Areas to purchase flood insurance.

Compared to Existing Conditions, the No Action Alternative and the Action Alternatives would likely have offsetting effects on property values in El Paso County. Minor, short-term adverse effects on properties immediately adjacent to facilities during construction would be offset by major beneficial effects on property values in close proximity to recreation at the proposed Jimmy Camp Creek Reservoir or Upper Williams Creek Reservoir. The net effect on property values in El Paso County would be negligible.

The cost of water service for customers of Colorado Springs Utilities and Security Water District would increase substantially under the No Action Alternative and all Action Alternatives. Water rates (CH2M HILL 2008d) are projected to remain affordable (well below 2 percent of median household income levels) for customers of both of these Participants. For Colorado Springs customers, the Participants' Proposed Action would require the smallest increases in rates and connection charges. The Highway 115 Alternative would also result in smaller increases in rates and connection charges than the No Action Alternative for Colorado Springs customers. All of the other Action Alternatives would result in larger increases in rates and charges than the No Action Alternative for Colorado Springs customers, although the differences are small (generally less than 10 percent).

For Fountain and Security, the No Action Alternative would have the lowest total capital and cumulative operating costs and the Downstream Intake Alternative would have the highest costs. Water rates in Security would be substantially higher in all Action Alternatives compared to the No Action Alternative.

Construction of the No Action Alternative would support additional employment in the local construction industry relative to Existing Conditions. Construction of the Action Alternatives would provide a similar benefit. Projected annual construction employment ranges from about 770 to 1,100 jobs during the first 4 years, depending on the alternative. About 25 percent of these jobs are expected to be based in El Paso County (CSU 2004). During the first 4 years of construction, construction is expected to support between 671 and 956 total jobs in El Paso County, including employment resulting from purchases of supplies, materials, and services and purchases by construction worker households. Much smaller construction employment is anticipated during subsequent years of construction, for example of the Williams Creek Reservoir. Overall, this benefit would be negligible relative to the overall size of the economy and the construction sector.

All alternatives, including the No Action Alternative, are designed to meet the anticipated water needs of the Participants in El Paso County. Implementation of any of the alternatives would not increase long-term employment opportunities, or increase other long-term regional growth pressures in El Paso County. Population growth and development in El Paso County are likely to continue regardless of whether any of the alternatives are constructed.

Upper Arkansas Valley

The No Action Alternative would have a short-term minor adverse effect on some property values in the upper Arkansas Valley due to the construction of facilities in Fremont County. Compared to the No Action Alternative, the Participants' Proposed Action, the Fountain Creek Alternative, and the Downstream Intake Alternative would provide a minor benefit for these same properties because these alternatives do not require construction in Fremont County. Other socioeconomic effects of all alternatives in the upper Arkansas Valley are expected to be negligible. Table 127 summarizes anticipated socioeconomic effects in the upper Arkansas Valley.

Rafting and kayaking trips on the Arkansas River make up the largest component of recreation and tourism in the upper Arkansas Valley, directly and indirectly accounting for about $53 million in local economic activity in 2004 (CROA 2005).

In general, all alternatives would result in modest changes in flows in the upper Arkansas River during the summer recreational boating season. The Upper Arkansas Valley Flow Management Program recreation flow minimum target of 700 cfs would be met 91 percent of the time under Existing Conditions and under the No Action Alternative. Under the Action Alternatives, the minimum target would be met between 88 percent of the time (under the Participants' Proposed Action) and 92 percent of the time (under the Highway 115 Alternative) (Section 3.5). There would be no substantial changes in the quality or availability of recreational experiences in the upper Arkansas Valley under any of the alternatives (Section 3.14). Effects on the recreation-related economy in the upper Arkansas Valley are expected to be none or negligible.

Existing agricultural water rights for irrigation and stock watering are all senior to the proposed exchanges. Consequently, none of the alternatives would affect the quantity of water available to upper Arkansas Valley irrigators through their existing water rights. Salinity levels in the Arkansas River at Portland are below the High Salinity Hazard level under Existing Conditions and are projected to remain below that level under the No Action Alternative and all Action Alternatives (Section 3.7). Based on these analyses, there would be no effect from the alternatives on the upper Arkansas Valley agricultural economy.

Table 127. Summary of Socioeconomic Effects in the Upper Arkansas Valley.

Indicator	Alt 1†	Alt 2	Alt 3	Alt 4	Alt 5	Alt 6	Alt 7
Recreation-related Economy	—	—	—	—	—	—	—
Agricultural Economy	—	—	—	—	—	—	—
Property Owners	⊙	⊕	—	—	⊕	⊕	—
Cost of Water/Wastewater Services‡	—	—	—	—	—	—	—
Construction-related Economy	—	—	—	—	—	—	—
Population/Economic Growth	—	—	—	—	—	—	—

Legend:

- ○ Major beneficial
- ⦶ Moderate
- ⊕ Minor beneficial
- — None/negligible
- ⊙ Minor adverse
- ◑ Moderate adverse
- ● Major adverse

Notes:

† Alternative 1 (No Action) is compared to Existing Conditions and Alternatives 2 through 7 (Action Alternatives) are compared to Alternative 1.

‡ Effects on cost of water/wastewater services based on averages of rate effects in 2015 and 2025.

None of the alternatives would affect overall property values throughout the upper Arkansas Valley. The No Action Alternative and three Action Alternatives (the Wetland Alternative, the Arkansas River Alternative, and the Highway 115 Alternative) would involve the construction of water transmission facilities (untreated water or return flow pipelines) on lands near Colorado 115 in Fremont County. Consequently, the No Action Alternative would have a minor adverse effect on property value in the short term relative to Existing Conditions and the Wetland Alternative, the Arkansas River Alternative, and the Highway 115 Alternative would have negligible effects relative to the No Action Alternative. Compared to the No Action Alternative, the Participants' Proposed Action, the Fountain Creek Alternative, and the Downstream Intake Alternative represent a minor benefit to upper Arkansas Valley property owners because they do not require construction of any facilities in the region. The base flow along Lake Creek would increase under the No Action Alternative and the Highway 115 Alternative, but flow-related effects on property values would likely be negligible.

There would be no direct or indirect effects from the alternatives on the cost of water and wastewater service or the overall population and economic growth of the upper Arkansas Valley.

Pueblo County

The No Action Alternative would have no discernable socioeconomic effects in Pueblo County compared to Existing Conditions. Relative to the No Action Alternative, the Participants' Proposed Action, the Wetland Alternative, and the Fountain Creek Alternative would have minor adverse effects on the Pueblo County recreation-related economy. The Wetland Alternative, the Arkansas River Alternative, and the Fountain Creek Alternative could have minor adverse effects on Pueblo County agriculture due to higher salinity levels in lower Fountain Creek, while the Downstream Intake Alternative could offer a minor benefit due to lower salinity levels (Section 3.7.5.1). All Action Alternatives, except the Arkansas River Alternative, would have minor adverse effects on some property values in Pueblo County. Table 128 summarizes projected socioeconomic effects in Pueblo County.

The No Action Alternative would have a negligible effect on the Pueblo County recreational economy. Compared to the No Action Alternative, the Action Alternatives would have varied effects on the surface water elevation at Pueblo Reservoir, but the projected differences in surface water elevation and surface water area would be too small to affect visitation levels or the quality of the recreation experience at Pueblo Reservoir (Section 3.14). None of the alternatives would affect the long-term quality and availability of land-based recreation at Lake Pueblo State Park, including camping, picnicking, walking, cycling, hunting, and wildlife observation. However, under the Participants' Proposed Action, the Wetland Alternative, and the Fountain Creek Alternative, construction may create a minor short-term effect on visitation levels at Pueblo Reservoir and a minor short-term adverse effect to the recreation-related economy. All Action Alternatives, except the Highway 115 Alternative, would meet the summer flow targets of the PFMP more frequently than the No Action Alternative, but the differences would generally be small. The Arkansas River Alternative would meet PFMP targets most often—96 percent of the time, compared to 90 percent of the time under the No Action Alternative (Section 3.5). Overall, long-term effects on the recreation-related economy in Pueblo County, including Pueblo Reservoir-related activity and downtown Pueblo whitewater rafting, would be negligible under all alternatives. Minor adverse effects to the recreational economy under the

Table 128. Summary of Socioeconomic Effects in Pueblo County.

Indicator	Alt 1†	Alt 2	Alt 3	Alt 4	Alt 5	Alt 6	Alt 7
Recreation-related Economy	—	⊙	⊙	—	⊙	—	—
Agricultural Economy	—	—	⊙	⊙	⊙	—	—
Property Owners	—	⊙	⊙	—	⊙	⊙	⊙
Cost of Water/Wastewater Services‡	—	—	—	—	—	—	—
Construction-related Economy	—	—	—	—	—	—	—
Population/Economic Growth	—	—	—	—	—	—	—

Legend:

- ○ Major beneficial
- ⦶ Moderate beneficial
- ⊕ Minor beneficial
- — None/negligible
- ⊙ Minor adverse
- ◑ Moderate adverse
- ● Major adverse

Notes:

† Alternative 1 (No Action) is compared to Existing Conditions and Alternatives 2 through 7 (Action Alternatives) are compared to Alternative 1.

‡ Effects on cost of water/wastewater services based on averages of rate effects in 2015 and 2025.

Participants' Proposed Action, the Wetland Alternative, and the Fountain Creek Alternative would reflect anticipated short-term effects on Pueblo Reservoir trail access during construction.

SDS construction could provide some economic opportunities for Pueblo County construction workers and construction firms. The impacts of increased employment and economic activity generated by construction of SDS facilities would be negligible under all alternatives relative to the size of the local construction industry and the Pueblo County economy.

Existing agricultural water rights for irrigation and stock watering in Pueblo County are all senior to the proposed exchanges. Consequently, none of the alternatives would affect the quantity of water available to Pueblo County irrigators through their existing water rights. The Wetland Alternative, the Arkansas River Alternative, and the Fountain Creek Alternative would result in 24 percent increases in salinity in lower Fountain Creek, relative to No Action (Section 3.7). These increases could affect crop yields in this area under these alternatives. Relative to overall agricultural production across Pueblo County, this would result in a minor adverse effect under the Wetland Alternative, the Arkansas River Alternative, and the Fountain Creek Alternative. The Downstream Intake Alternative would reduce salinity levels by 12 percent relative to the No Action Alternative (Section 3.7.5.1).

Three potential concerns related to Pueblo County property values were evaluated: the potential for diminished flows in the Arkansas River through the City of Pueblo; the possibility of increased flood risk and flood damage for Pueblo County properties near Fountain Creek; and the effects on Pueblo County properties along possible pipeline alignments.

Based on these evaluations, the No Action Alternative would have negligible effects on Pueblo County property values relative to Existing Conditions. All Action Alternatives except the Highway 115 Alternative would have a minor adverse effect on property values along proposed pipeline alignments, but this would be mostly a short-term effect during construction. The Arkansas River Alternative, however, would provide an offsetting benefit to some properties in the county because it would meet Arkansas River target flows under the PFMP more often than the No Action Alternative or the other Action Alternatives. The Highway 115 Alternative would not require construction of facilities in Pueblo County, but would create minor adverse effects on property values due to meeting target flows on the Arkansas River less frequently than other alternatives.

Under any alternative, effects on water services costs for Pueblo West (and residents of that community) would be low in comparison with the other Participants. Under the No Action Alternative, changes in the cost of water service from Existing Conditions would be negligible The costs of all Action Alternatives that Pueblo West would participate in (the Participants' Proposed Action, Wetland, and Fountain Creek alternatives) would be less than the cost of the No Action Alternative for that utility. Salinity levels at the Above Pueblo Gage on the Arkansas River would be similar to Existing Conditions under the No Action Alternative; 10 percent increases in salinity under the Wetland and Arkansas River alternatives could lead to increases in the cost of municipal water treatment (Section 3.7.5.1). These cost increases, however, should have a negligible effect on the overall cost of drinking water.

Reductions in streamflow are not expected to affect the Pueblo wastewater treatment facility's treatment requirements or the cost of wastewater service for Pueblo residents because the City of Pueblo has determined that substantial improvements to this facility are required to meet new water quality standards for ammonia (Section 3.7).

Construction of the alternatives would provide some economic opportunities for Pueblo County construction workers and construction firms. Phase 1 construction employment and non-labor construction expenditures could generate between 123 total jobs under the Participants' Proposed Action and 205 total jobs under the Arkansas River Alternative in Pueblo County. Overall, this benefit would be negligible relative to the overall size of the economy and the construction sector.

There would be no direct or indirect effects to overall Pueblo County population and economic growth from the No Action Alternative or any of the Action Alternatives.

Lower Arkansas Valley

No discernable socioeconomic effects would occur in the lower Arkansas Valley under the No Action Alternative. There would be minor adverse effects on the recreation economy under the Fountain Creek Alternative and the Highway 115 Alternative due to anticipated cumulative effects to lake levels and recreation opportunities at Lake Henry and Lake Meredith. Projected adverse effects from the alternatives on the agricultural economy and the costs of municipal water service are expected to be too small to be discernable. Table 129 summarizes projected socioeconomic effects in the lower Arkansas Valley from the No Action Alternative (relative to Existing Conditions) and each of the potential Action Alternatives (relative to the No Action Alternative).

Developed recreational opportunities in the lower Arkansas Valley are relatively limited and consist primarily of water-based activities at Lake Meredith and Lake Henry. The No Action Alternative would result in small

Table 129. Summary of Socioeconomic Effects in the Lower Arkansas Valley.

Indicator	Alt 1†	Alt 2	Alt 3	Alt 4	Alt 5	Alt 6	Alt 7
Recreation-related Economy	—	—	—	—	—	—	—
Agricultural Economy	—	—	—	—	—	—	—
Property Owners	—	—	—	—	—	—	—
Cost of Water/Wastewater Services‡	—	—	—	—	—	—	—
Construction-related Economy	—	—	—	—	—	—	—
Population/Economic Growth	—	—	—	—	—	—	—

Legend:

- ○ Major
- ⦶ Moderate
- ⊕ Minor
- — None/negligible
- ⊙ Minor adverse
- ◑ Moderate
- ● Major adverse

Notes:

† Alternative 1 (No Action) is compared to Existing Conditions and Alternatives 2 through 7 (Action Alternatives) are compared to Alternative 1.

‡ Effects on cost of water/wastewater services based on averages of rate effects in 2015 and 2025.

decreases in summer lake levels at Lake Henry under average, wet, and dry years relative to Existing Conditions. At Lake Meredith, the No Action Alternative would lead to an increase in summer lake levels in dry years. The Participants' Proposed Action and Fountain Creek alternatives also would lead to higher summer lake levels in dry years than under Existing Conditions. Summer lake levels under other alternatives, and other hydrologic conditions, would be similar to Existing Conditions (Section 3.5). Given the historical variability in lake levels at Lake Meredith and Lake Henry, the relatively small differences in summer lake levels direct and indirect effects on the local recreational economy likely would be negligible.

Under the No Action Alternative, irrigation season salinity levels would increase by 6 to 10 percent (Section 3.6). Salinity levels under the Participants' Proposed Action would range from the same as the No Action Alternative to a 1 percent increase. The other Action Alternatives would also have irrigation season salinity levels comparable to the No Action Alternative, with differences ranging from 1 percent higher to 3 percent lower total dissolved solids (TDS) (Section 3.7.5.1). Crop production in the lower Arkansas Valley would be adversely affected by increases in salinity under the No Action Alternative, but these effects are projected to be negligible relative to the overall agricultural economy in the region. Estimated effects of the Action Alternatives on crop yield compared to No Action are negligible, ranging from a 0.1 percent decrease to a 0.4 percent increase depending on the alternative and the hydrologic condition (Section 3.7.5.1). Projected effects on agricultural income and input purchases would be $500,000 per year or less, relative to an overall agricultural economy of over $200 million per year. No physical features would be located in the lower Arkansas Valley under any of the alternatives. Hydrologic effects of the alternatives are not anticipated to affect property values in the region.

Increases in salinity under the No Action Alternative may affect the costs of water treatment in the lower Arkansas Valley. However, these changes in treatment costs would have a negligible effect on overall water bills. The Water Quality Effects Analysis concluded that neither the Rocky Ford wastewater treatment facility nor the facility for La Junta would be required to change their treatment systems as a result of the No Action Alternative or any of the Action Alternatives (Section 3.7). Overall, effects on water and wastewater costs in the lower Arkansas Valley would be negligible.

Over the past few years, several major employers have left the lower Arkansas Valley. The negligible direct and indirect effects of the alternatives, however, are not expected to have a discernable direct, indirect, or cumulative effect on overall regional population or economic conditions.

Western Slope

The analyses of aquatic effects and recreation effects on the Western Slope do not indicate any major adverse effects to angling opportunities or other recreational resources. Socioeconomic effects would be negligible.

3.15.5.2 Direct and Indirect Land Use Effects

Direct effects for land use due to the SDS Project are areas where land use would need to be changed to enable construction of the SDS Project infrastructure. Changes in land use would be due primarily to construction of SDS Project infrastructure and not by operation of the SDS Project.

Effects from No Action Alternative

Construction of the No Action Alternative would include well systems for Colorado Springs, Fountain, and Security, two reservoirs, five pump stations, one booster pump station, a treatment plant, and three intakes (Table 130). These facilities would be new, permanent, aboveground structures, which would disturb about 2,400 acres of land (Table 130). The No Action Alternative would have land use effects similar to the Participants' Proposed Action, Fountain Creek, Downstream Intake, and Highway 115 alternatives. However, the No Action Alternative would have the greatest temporary land use effect due to the well systems, which require additional pipeline.

Except for federally owned land, land on which permanent, aboveground structures would be situated would be acquired by the Participants through a fee title purchase. To

Table 130. Aboveground Disturbances by Alternative.

Facility	No Action Alternative	Participants' Proposed Action	Wetland Alternative	Arkansas River Alternative	Fountain Creek Alternative	Downstream Intake Alternative	Highway 115 Alternative
Untreated Water Intakes	3	1	1	1	1	1	2
Pump Stations	5	3	5	6	3	4	6
Booster Pump Stations	1	0	0	1	1	1	1
Reservoirs	2	2	1	1	2	2	2
Water Treatment Plants	1	1	1	1	1	1	1
Total Permanent Above-ground Disturban-ces (acres)†	2,398	2,684	1,581	1,309	2,459	2,343	2,397
Temporary Above-ground Disturban-ces (acres)‡	1,774	965	1,433	1,637	1,490	1,192	1,330

† The permanent impacts encompass the pipeline, pump stations, water treatment plant, and reservoirs. Permanent impacts will occur along the whole alignment and represent areas where nothing can be built because the pipeline is underneath or facilities are already there (pump stations, water treatment plant, or reservoirs).

‡ Temporary impacts will occur during construction and include areas for storage/laydown, equipment movement, construction trailers, etc. Once construction is complete, the temporary impact areas will be restored to as-previous conditions and uses.

accommodate untreated water intakes, pump stations, the treatment plant and well systems on non-federal land, the land use would need to be changed from its current land uses to industrial land use.

A list of properties affected by each alternative is presented in Appendix H. Any land used for the new reservoirs that is not already owned by Colorado Springs would be purchased. Land used for the two new reservoirs would be changed to open space. Land use changes would be required in Chaffee, Fremont, and El Paso counties.

A right-of-way would be secured for construction of any structure on federal land, and would be in accordance with the managing agency's land management plan. The Participants have not yet applied for any special use permits or rights-of-way grants for any alternative. Short term effects on training could occur at Fort Carson Military Reservation. These effects would be minimized through construction coordination between the Participants and Fort Carson.

The Participants would obtain easements from public and private entities to construct new pipelines, open channel conveyances, powerlines, and access roads. Construction of these facilities would result in temporary land disturbances, and therefore would not result in any land use changes. See Section 2.4.3 for more information on easements and fee title purchases. All alternatives may result in the conversion of prime farmland and other agricultural land uses to non-agricultural uses.

Effects from Action Alternatives

Land use effects would be limited to El Paso and Pueblo counties under the Participants' Proposed Action, Fountain Creek, and Downstream Intake alternatives. The Wetland and Arkansas River alternatives also would result in land use effects in Fremont County. In addition to affecting El Paso and Fremont counties, the Highway 115 Alternative also would result in land use effects in Chaffee County.

The Wetland and Arkansas River alternatives would result in fewer land use effects than the No Action Alternative because those alternatives each have only one reservoir, which accounts for a large portion of land use effects, while the No Action Alternative and other Action Alternatives have two reservoirs each (Table 130). Because the reservoirs would permanently change the land use for the area that they inundate, they would have greater effects on land use than pipelines, for which future land use can normally remain the same as current land use (with some restrictions, such as prohibition of permanent structures). The Wetland and Arkansas River alternatives would have the least effect on land use, resulting in about 1,580 and 1,310 acres of aboveground disturbances, respectively. The Participants' Proposed Action, Fountain Creek, Downstream Intake, and Highway 115 alternatives would have similar land use effects that would be greater than the Wetland and Arkansas River alternatives, but similar to the No Action Alternative. These alternatives would have between 2,340 and 2,680 acres of aboveground disturbances (Table 130). With the exception of the Highway 115 Alternative, activities associated with the Action Alternatives would require the project proponent to secure a 1041 land use permit from Pueblo County if necessary.

A small portion of the Western Untreated Water Pipeline (Participants' Proposed Action, Wetland, and Arkansas River alternatives), would be within the Frost Ranch conservation easement. The Project Participants would work with the Frost Ranch to modify a portion of the easement to accommodate the pipeline.

Like the No Action Alternative, use of federal lands for the Action Alternatives would require rights-of-way in accordance with each managing agency's land management plan. Construction of new pipelines, open channel conveyances, powerlines, and access roads would not result in any land use changes. All alternatives may result in the conversion of prime farmland and other agricultural land uses to non-agricultural uses.

There would be no changes in land use on the Western Slope associated with SDS alternatives.

3.15.5.3 Cumulative Effects

Other reasonably foreseeable activities that are important from the standpoint of potential socioeconomic effects and land use include ongoing urbanization and development throughout the study area and associated increases in water use and return flows. Cumulative socioeconomic effects, in light of other reasonably foreseeable developments, are generally similar to the direct and indirect effects. The following are exceptions, where cumulative effects are expected to differ appreciably from direct and indirect effects.

From a cumulative effects standpoint, higher flood flows in Fountain Creek under the Wetland and Arkansas River alternatives than the other alternatives would likely correspond to minor increases in flood risk and damage in southern El Paso County and Pueblo County compared with the other alternatives (Section 3.8).

Cumulative effects hydrologic modeling indicates that Pueblo Reservoir storage will decrease by about 18 percent under the No Action Alternative compared to Existing Conditions. This reduction in storage and lake levels would likely cause a minor adverse effect on the local recreational economy. Storage and lake levels under the Action Alternatives are generally slightly lower than under No Action (Section 3.5.5), but the differences are likely to be negligible from the standpoint of the recreation economy.

Cumulative effects hydrologic modeling indicates reductions in Lake Meredith and Lake Henry lake levels under No Action and the Action Alternatives would be more severe when future increases in other upstream water uses are considered. There would be minor to moderate adverse effects during the summer recreation season for boating and angling under most of the Action Alternatives, though the Highway 115 Alternative would lead to the smallest reductions in storage at Lake Henry and a slight increase in storage at Lake Meredith compared to No Action (Section 3.5.5). A minor to moderate cumulative negative effect on the local recreation economy would likely result under all Action Alternatives except the Highway 115 Alternative.

Based on findings from the Water Quality effects analysis, the cumulative effects of most of the Action Alternatives on salinity in the lower Arkansas Valley, relative to No Action, would be very small reductions in salinity and negligible increases in crop yield. The exception would be the Fountain Creek Alternative which is projected to lead to at least a 20 percent increase in irrigation season salinity in the cumulative effects modeling (Section 3.7.5.2), which would cause a minor adverse effect on the agricultural economy.

Reasonably foreseeable future actions that would result in cumulative effects on land use, when combined with the effects of the proposed project, include urban development and land use. Urban development and land use activities are expected throughout the study area in the future. This will result in more residential, commercial, and industrial land uses, while agricultural and vacant land uses will decrease. Changes to land use as a result of urban and suburban development would be much greater than changes to land use as a result of the SDS Project. Therefore, cumulative effects on land use would be very similar for all alternatives because urban development would be on a much larger scale than any of the alternatives.

3.15.5.4 Resource Commitments

There would be no irreversible commitments of socioeconomic resources under the alternatives. Under each of the alternatives, the Participants would irretrievably commit the financial resources of their utilities and their current and future customers to the development of the alternative.

There would be no irreversible commitment of land use from the alternatives. Irretrievable commitment of resources would include changes to land use as a result of construction of aboveground facilities such as reservoirs, pump stations, or water treatment plants. Property acquisition by the Participants to build SDS Project infrastructure and temporary limitations on land use during construction of buried pipelines would also be an irretrievable commitment of resources. These commitments would be irretrievable rather than irreversible because they are only necessary during the life of the project.

3.15.5.5 Mitigation

Proposed Measures

Very few major adverse socioeconomic effects are associated with the alternatives. The most noticeable socioeconomic effects, especially over the longer term, are likely to be the anticipated water rate and connection charge increases for customers of some of the Participants—particularly Colorado Springs and Security (though water rates are projected to remain affordable based on the 2 percent of median household income threshold used for this evaluation). Potential mitigation related to financial impacts on water customers is primarily concerned with the distribution of the burden of repaying the costs of the alternatives and is discussed in the following section on Environmental Justice (Section 3.16).

Construction of any of the alternatives would also have localized socioeconomic effects on property values and quiet enjoyment of properties where pipelines and other facilities would be located. Most of these effects will be of short-term duration during actual construction.

Land use effects would be avoided or minimized by the following mitigation measures:

- Acquire properties and easements through voluntary, willing Participant agreements to the maximum extent practicable
- Develop a construction management plan to outline best management practices to minimize impacts to surrounding properties

Mitigated Effects

Adverse short-term effects on landowners with parcels that will contain SDS features will be offset through mutually agreed upon compensation.

The land use mitigation measures would minimize disturbances to properties near the project during construction or minimize land use changes and conflicts.

3.16 Environmental Justice

Fundamental principles (FHWA 2000) of environmental justice require that federal agencies:

- Avoid, minimize, or mitigate disproportionately high and adverse human health and environmental effects, including social and economic effects, on minority populations and low-income populations
- Ensure the full and fair participation by all potentially affected communities in the decision-making process
- Prevent the denial of, reduction in or significant delay in the receipt of benefits of the project by minority and low-income populations

Pursuant to Executive Order 12898, evaluation of environmental justice effects requires identification of minority and low-income populations (including Native American tribes) within the area affected by the proposed project and evaluation of the potential for the project alternatives to have disproportionate adverse effects on such populations. This includes evaluation of whether the significant adverse effects would occur in a disadvantaged community affected by cumulative or multiple adverse exposures from environmental hazards. Indicators for this analysis include proportions of low-income and minority residents among the overall population by Census block group and by county (to identify low-income and minority communities) and the evaluations of environmental consequences of the alternatives discussed elsewhere in this chapter.

Chapter 4 describes the public participation process for this FEIS and opportunities for potentially affected communities to be involved in the decision-making process. Scoping meetings were advertised and conducted throughout the study area, including meetings in the upper Arkansas Valley (Buena Vista), Pueblo and the lower Arkansas Valley (La Junta). Public meetings on the alternatives also were held throughout the study area. Newsletters and a public web-site were provided to help the interested public remain informed throughout the process. In compliance with Reclamation's Protocol Guidelines: Consulting with Indian Tribal Governments, a general consultation process for the SDS Project has been initiated (Section 3.17).

The primary benefits of the project are described in Chapter 1, Purpose and Need. These benefits would be shared by all existing and new residents served by the Project Participants, including minority and low-income residents. Additional project benefits are described in other sections of Chapter 3 of this FEIS. There is no anticipated denial, reduction, or significant delay in the receipt of these benefits by disadvantaged groups.

3.16.1 Summary of Effects

Identified populations of potential concern for Environmental Justice included low-income or minority groups employed in agriculture within portions of the analysis area, Native American tribes, low-income or minority communities proximate to potential SDS Project facilities or to streams that may be affected and low-income water rate payers receiving their water supplies from Project Participants.

Effects on agriculture in the lower Arkansas Valley or properties proximate to the Arkansas

River and Fountain Creek would be negligible or minor under all alternatives.

During construction, properties along pipeline routes are expected to experience other short-term, minor adverse effects. However, facilities for the No Action Alternative and all Action Alternatives would not be proximate to a greater proportion of low-income or minority populations than found across the analysis area as a whole.

These evaluations indicate that there would not be disproportionately high and adverse effects to minority and low income populations.

3.16.2 Regulatory Framework

Executive Order 12898 established the requirement to address Environmental Justice concerns within the context of federal agency operations. This analysis follows the guidance established by the Council on Environmental Quality and EPA (CEQ 1997; EPA 1998, 1999).

3.16.3 Analysis Area and Methods

3.16.3.1 Analysis Area

Potential Environmental Justice effects were evaluated throughout the study area identified for socioeconomic effects analysis (Section 3.15). The area includes eight Colorado counties, grouped into the following sub-areas: El Paso County, upper Arkansas Valley, Pueblo County, and lower Arkansas Valley. The primary focus for the Environmental Justice analysis was on communities in proximity to the proposed locations of SDS Project facilities or in proximity to stream segments that might be affected by the alternatives. For this analysis, communities were considered proximate to SDS Project facilities or potentially affected streams if the facility or stream abutted or crossed the Census block group containing the community. Additional information about this approach is provided in the Socioeconomic Resources Technical Report (BBC 2007).

3.16.3.2 Analysis Methods

In accordance with CEQ guidance (1997), the evaluation consisted of three steps: identification of populations of concern; consideration of effects to those populations based on identified effects; and determination of whether those effects would be disproportionately high and adverse.

As described in the Socioeconomic Resources Technical Report (BBC 2007), populations of concern were primarily identified based on 2000 Census data and Census Public Use Microdata (PUMS) for 2000. Data from the National Agricultural Statistics Service 2002 Agricultural Census were used to further evaluate the socioeconomic characteristics of farm owner/operators in the lower Arkansas Valley (Census 2000a; NASS 2002).

Census block group data were used to identify areas with large proportions of minority and low-income residents in proximity to pipeline routes and other facilities of the alternatives. The Census Bureau strives to define block groups so that they will include about 1,500 people, although block group population sizes vary (Census 2000b).

The proportions of low-income and minority residents were examined for 508 Census block groups within the study area containing the physical features of the alternatives (El Paso County, Fremont County, Pueblo County, and a small portion of Chaffee County).

Based on the relative proportions of low-income and minority residents across the 508 block groups, categories (high, above average, average, and below average) were defined for each key characteristic. For example, block groups with more than 25 percent of their households living below the poverty line were categorized as having a high incidence of poverty, while block groups in which over 50 percent of the population were members of minority groups were defined as having a high minority population concentration.

For the environmental justice analysis, block groups with high proportions of households below the poverty line, low median household income or high proportions of minority residents were defined as high risk. Block groups with above average concentrations of poverty or minority residents or below average median income were defined as potential concern block groups. All other block groups have average or low proportions of both low-income and minority residents and were categorized as low risk from an environmental justice standpoint. The Fort Carson military base, which includes one block group in El Paso County and one block group in Pueblo County, was not included in the block group analysis. However, the June 2007 environmental impact statement concerning the army's transformation programs at Fort Carson concluded that the proportion of the minority population and the poverty rate were not significantly greater than in El Paso County or the State of Colorado (CH2M HILL 2007h). Additional information on the identification of low-income and minority populations can be found in the Socioeconomic Resources Technical Report (BBC 2007). Whether any high and adverse effects are disproportionate was determined by comparing effects on populations of concern to effects on the broader population in the region (e.g., comparing effects on low-income ratepayers to effects on ratepayers as a whole).

3.16.3.3 Limitations

The most recent, detailed population data were used for the Environmental Justice evaluation. These data were from the 2000 Census.

Census block group data must be interpreted with some caution. Particularly in more sparsely populated areas, the block groups can be relatively large. It is not possible to determine if the average characteristics of the block group as a whole are representative of the characteristics of the individual households living in closest proximity to the potential SDS Project features, Fountain Creek, Lake Creek, or the Arkansas River.

Other limitations identified for environmental effects analyses discussed throughout this chapter also apply to the Environmental Justice analysis, which relies on the results of the those analyses.

3.16.4 Affected Environment

Populations of potential concern for this FEIS include migrant, low-income, or minority groups employed in agriculture within portions of the analysis area, Native American tribes, low-income or minority communities proximate to potential SDS Project facilities or to streams that may be affected and low-income water rate payers receiving their water supplies from Project Participants.

For purposes of examining the socioeconomic characteristics of the farm community, the farming population was divided into three groups: farm operators/owners, resident farm workers, and migrant farm workers. Based on both their income levels and relatively low proportion of minority members, farm operators/owners in the lower Arkansas Valley are unlikely to be low-income or minority as a group. However, it is likely that the resident farm worker population of the valley could be considered a low-income or minority group and almost certain that the migrant farm worker population constitutes such a group. The mobility of the latter group, however, may limit their susceptibility to disproportionate effects from geographically isolated agricultural effects.

In terms of low-income ratepayers within the Participants' service areas, about 9 percent of Colorado Springs households in 2000 (or about 12,000 households in total) lived below the poverty level. In Fountain, about 8 percent of all households in 2000 (or about 440 households) lived below the poverty level. In the Security-Widefield census designated place, about 6 percent of households (or about 580 households in total) lived below the poverty level. About 5 percent of households (or 240 households in total) lived below the poverty level in Pueblo West.

Some potential socioeconomic effects related to the alternatives, such as short-term construction disruption or possible changes in flood risk or erosion along Fountain Creek, may be highly localized. Figure 93 shows the block groups within the analysis area defined as "at risk" or "potential concern" based on their minority and low-income populations.

A relatively high proportion of the area along the Arkansas River between Florence and the Fountain Creek confluence is composed of high-risk block groups (30 percent, versus 19 percent for the overall three county potential project area). A relatively high proportion of the block groups along Fountain Creek is categorized as potential concern block groups (36 percent versus 22 percent for the overall potential project area). The analysis also includes a small area surrounding Lake Creek in Lake County. Both block groups along Lake Creek are classified as high risk.

Table 131 compares the socioeconomic characteristics of block groups along key segments of the Arkansas River and Fountain Creek to the overall study area.

Table 132 summarizes the socioeconomic characteristics of areas in proximity to alternative features. Relatively few high risk or potential concern block groups are in proximity to the pipelines, reservoirs and other physical features of the No Action Alternative or the Participants' Proposed Action. The features of the Wetland and Arkansas River alternatives are proximate to a larger number of block groups of potential concern from an environmental justice standpoint than the other alternatives. However, none of the alternatives is proximate to a greater proportion of high-risk block groups than found across the study area as a whole.

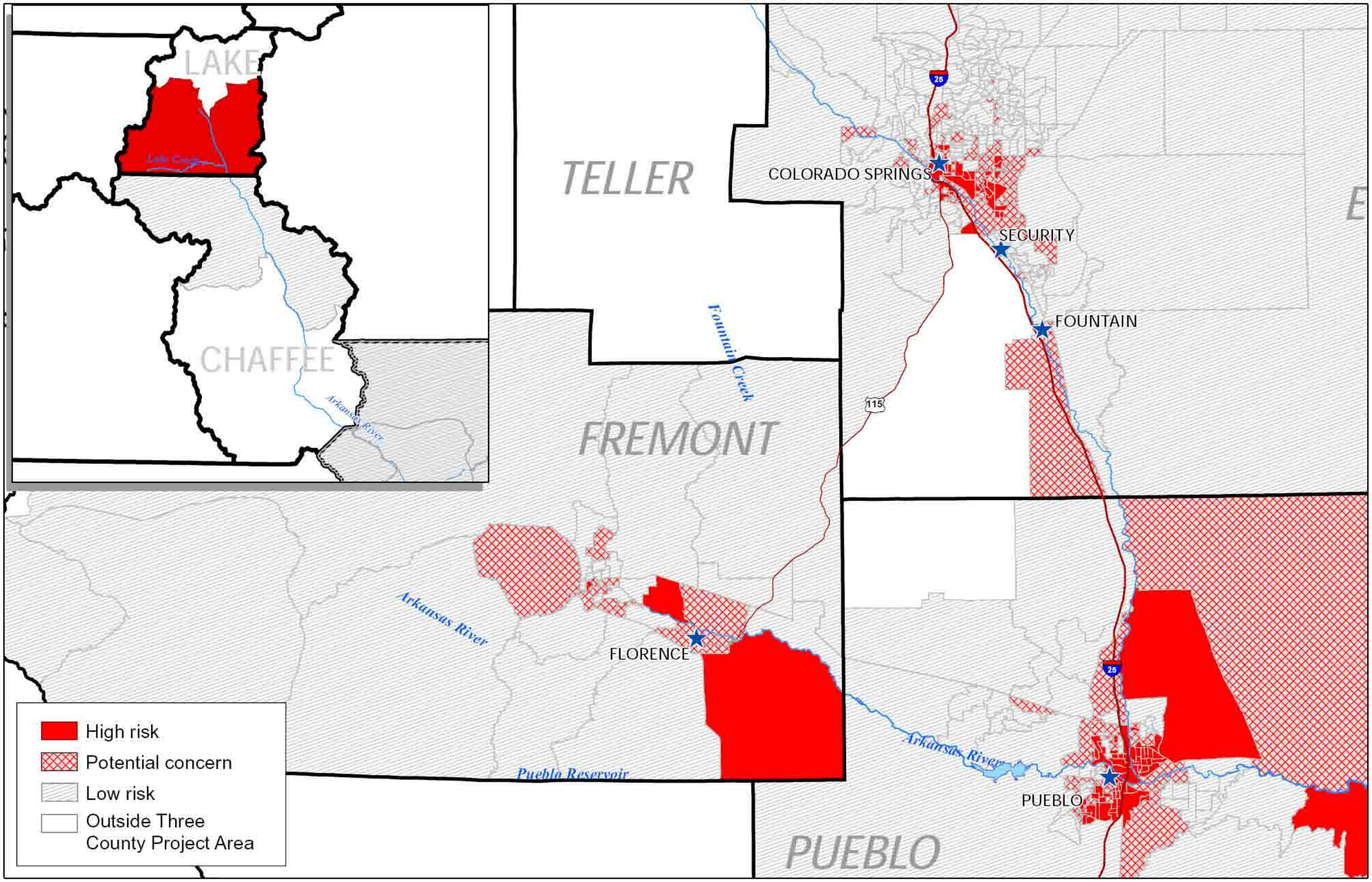


Figure 93. Study Area Block Group Analysis.

Table 131. Baseline Socioeconomic Characteristics of Key Arkansas River and Fountain Creek Segments Census Block Groups, 2000.

Block Group Characteristics		Number of Block Groups		Percent of Total		Overall Project Area	
		Arkansas River	Fountain Creek	Arkansas River	Fountain Creek	Number of Block Groups	Percent of Total
Households Below Poverty Line†							
High	>25%	2	8	8%	21%	41	8%
Above Avg.	15-25%	5	7	19%	18%	78	16%
Average	5%-15%	12	19	46%	49%	218	43%
Below Avg.	<5%	7	5	27%	13%	166	33%
Median HH Income†							
Low	<$20k	2	5	8%	13%	22	4%
Below Avg.	$20k-$30k	5	10	19%	26%	104	21%
Average	$30k-$50k	15	19	58%	49%	221	44%
Above Avg.	>$50k	4	5	15%	13%	156	31%
Percent Minority‡							
High	>50%	7	5	27%	13%	80	16%
Above Avg.	35-50%	4	9	15%	23%	78	15%
Average	15%-35%	12	15	46%	38%	192	38%
Below Avg.	<15%	4	10	15%	26%	158	31%
Summary$^{\Phi}$							
High Risk BGs		8	9	30%	23%	96	19%
Potential Concern BGs		6	14	22%	36%	110	22%
Low Risk BGs		13	16	48%	41%	302	59%
Total Block Groups		**27**	**39**	**100%**	**100%**	**508**	**100%**

† A few block groups (BGs) had no income statistics.

‡ Non-white or Hispanic.

Φ High Risk Block Groups have either a “high” percentage of minority residents, a “high” percentage of households below the poverty threshold or a “low” median household income level. Potential Concern Block Groups have either an “above average” proportion of minority residents, an “above average” incidence of poverty, or a “below average” median household income. In either category, these characteristics frequently occur together.

Source: Estimated by BBC based on Census 2000c.

Table 132. Baseline Socioeconomic Characteristics of Areas in Proximity to SDS Project Features Census Block Groups, 2000.

Alternative	Number of Block Groups†			Percent of Block Groups		
	High Risk Block Groups	Potential Concern Block Groups	Low Risk Block Groups	High Risk Block Groups	Potential Concern Block Groups	Low Risk Block Groups
No Action Alternative	1	3	42	2%	7%	91%
Participants' Proposed Action	0	5	25	0%	17%	83%
Wetland Alternative	1	13	34	2%	27%	71%
Arkansas River Alternative	7	15	29	14%	29%	57%
Fountain Creek Alternative	4	8	26	11%	21%	68%
Downstream Intake Alternative	8	7	29	18%	16%	66%
Highway 115 Alternative	1	6	23	3%	20%	77%
Overall Study Area	96	110	302	19%	22%	59%

† High Risk Block Groups have either a "high" percentage of minority residents, a "high" percentage of households below the poverty threshold or a "low" median household income level. Potential Concern Block Groups have either an "above average" proportion of minority residents, an "above average" incidence of poverty, or a "below average" median household income. In either category, these characteristics frequently occur together.

Source: Estimated by BBC based on Census 2000c.

3.16.5 Environmental Consequences

The potential for disproportionate high and adverse effects on low-income and minority populations was evaluated. Disproportionate high and adverse effects would include any major adverse effect that is borne to a greater extent by a minority or low-income population than by the general population as a whole. Potential environmental justice concerns raised during public and agency scoping included: Table 132 summarizes the socioeconomic characteristics of areas in proximity to alternative features. Relatively few high risk or potential concern block groups are in proximity to the pipelines, reservoirs and other physical features of the No Action Alternative or the Participants' Proposed Action. The features of the Wetland and Arkansas River alternatives are proximate to a larger number of block groups of potential concern from an environmental justice standpoint than the other alternatives. However, none of the alternatives is proximate to a greater proportion of high-risk block groups than found across the study area as a whole.

- Income and employment effects in the lower Arkansas Valley from changes in crop productivity resulting from changes in water quality
- Effects on household water bills in Participant communities
- Effects on properties and property values proximate to the Arkansas River, Fountain Creek or Lake Creek
- General environmental and human health effects on residents and

properties in proximity to SDS Project features

Based on the socioeconomic effects analysis, effects on agriculture in the lower Arkansas Valley and effects on the values of properties proximate to the Arkansas River would be negligible or minor under all alternatives (BBC 2008a, 2008b).

Effects on low-income ratepayers in Participant communities would not be disproportionate, given proper rate design (discussed in Section 3.17.5.3). Increases in water bills are expected to be proportionate to water use, which is typically correlated with household wealth and income.

Effects on properties and property values near the Arkansas River, Fountain Creek, and Lake Creek would be negligible or minor under all alternatives.

Noise, disruption, traffic, and other adverse effects due to the construction and maintenance of pipelines and other facilities are expected to be primarily short-term in nature and minor overall. The proportions of low-income and minority residents along the facility routes under all alternatives are comparable to or lower than the proportions of low-income and minority residents in the study area as a whole.

Based on these evaluations, no direct or indirect Environmental Justice effects are anticipated under any of the alternatives.

3.16.5.1 Cumulative Effects

Other reasonably foreseeable actions considered in this FEIS include ongoing urban development and land use changes, five major transportation projects in El Paso County and Pueblo County and global climate change. Each of these actions may or may not have disproportionate adverse effects on low-income and minority populations in the study area. It is not anticipated, however, that the alternatives would further contribute to disproportionate adverse effects on such populations with the exception of possible effects on cultural resources. Cumulative effects would be similar for all alternatives.

3.16.5.2 Resource Commitments

There are no irreversible or irretrievable commitments of resources from the standpoint of Environmental Justice.

3.16.5.3 Mitigation

Proper water rate design in recovering the costs associated with any of the SDS alternatives will minimize the potential for disproportionate effects on low-income water users.

Proposed Measures

No mitigation is recommended.

Mitigated Effects

None of the mitigation measures proposed for other resources would affect the environmental justice effects analysis discussed in this section.

3.17 Cultural Resources

The SDS Project study area and vicinity contain the remains of many significant historic and prehistoric sites (cultural resources) that constitute an important part of the legacy of human presence on the land. The alternatives may affect such resources either directly or indirectly.

The indicators for effects on cultural resources are the number of historic properties that may be disturbed by construction and operation of SDS Project components. Such effects may be caused by inundation, surface elevation fluctuations of reservoirs, surface disturbance during construction, or surface disturbance related to increased public access to site locations.

3.17.1 Summary of Effects

All alternatives would affect cultural resource sites that are officially eligible for inclusion in the NRHP or sites that are currently unevaluated but could potentially be eligible. Direct effects would result from construction of project facilities and inundation and shoreline wave action by new reservoirs. Indirect effects may be caused by public uses in the buffer areas around the project facilities resulting in trampling, erosion, and illicit collecting. All effects on cultural resources, whether direct or indirect, are considered to be permanent. The minimum number of significant cultural resource sites potentially affected by each alternative is shown in Table 133.

Table 133. Number of Known Significant Cultural Resource Sites Directly and Indirectly Affected by Alternative.

Alternative	Direct Effects*	Indirect Effects*
No Action	105	163
Participants' Proposed Action	43	64
Wetland	34	79
Arkansas River	88	130
Fountain Creek	103	156
Downstream Intake	99	151
Highway 115	97	154

*Some sites overlapped into both the Analysis Area and APE outside the Analysis Area, so they were considered in both counts and averaged about 30 to 40 sites per alternative.

3.17.2 Regulatory Framework

Section 106 of the National Historic Preservation Act (NHPA) of 1966 as amended (16 U.S.C. §§470, et seq.) and its implementing regulations under 36 CFR 800 require federal agencies to consider the effects of their undertakings on cultural resources and to coordinate the undertaking with regard to other cultural resource laws and consulting parties. Cultural resources are the physical remains of a site, building, structure, object, district, or property of traditional and cultural importance to Native Americans. Historic properties are significant cultural resources that are either included in or that may be eligible for listing in the NRHP and as such are considered to have local, state, regional, or national historic or prehistoric significance. For this study, direct or indirect effects on all known cultural resources listed or determined eligible for listing in the NRHP as well as all cultural resource sites that have not yet received a final NRHP determination are considered.

A general consultation process for the SDS Project was initiated in compliance with the following:

- Section 106 of the NHPA

- Archaeological Resources Protection Act (ARPA) (as amended)
- Executive Order 13007 – Indian Sacred Sites
- Reclamation's Protocol Guidelines: Consulting with Indian Tribal Governments (Reclamation 2001)

Federal agencies are prohibited from disclosing cultural resource site information to the public, in accordance with the NHPA and the ARPA. In addition, Colorado State Law 24-80-405 also provides for the denial of public viewing of archaeological records including site location information. As a result, location information regarding sites within the APE and analysis areas has not been provided.

Traditional Cultural Properties (TCPs) are protected under Section 106 of the NHPA with further coordination under NEPA and the American Indian Religious Freedom Act of 1978. A TCP may be eligible for listing in the NRHP because of its association with cultural practices or beliefs of a living community that (a) are rooted in the history of the community or tribe, and (b) are important in maintaining the continuing cultural identity of the community or tribe.

Several state statutes and regulations address cultural resource issues. In addition, Colorado Springs and Pueblo are Certified Local Governments (CLG). CLGs are local governments that have established partnerships with the SHPO (State Historic Preservation Officer) and National Parks Service to create local historic preservation ordinances and commissions.

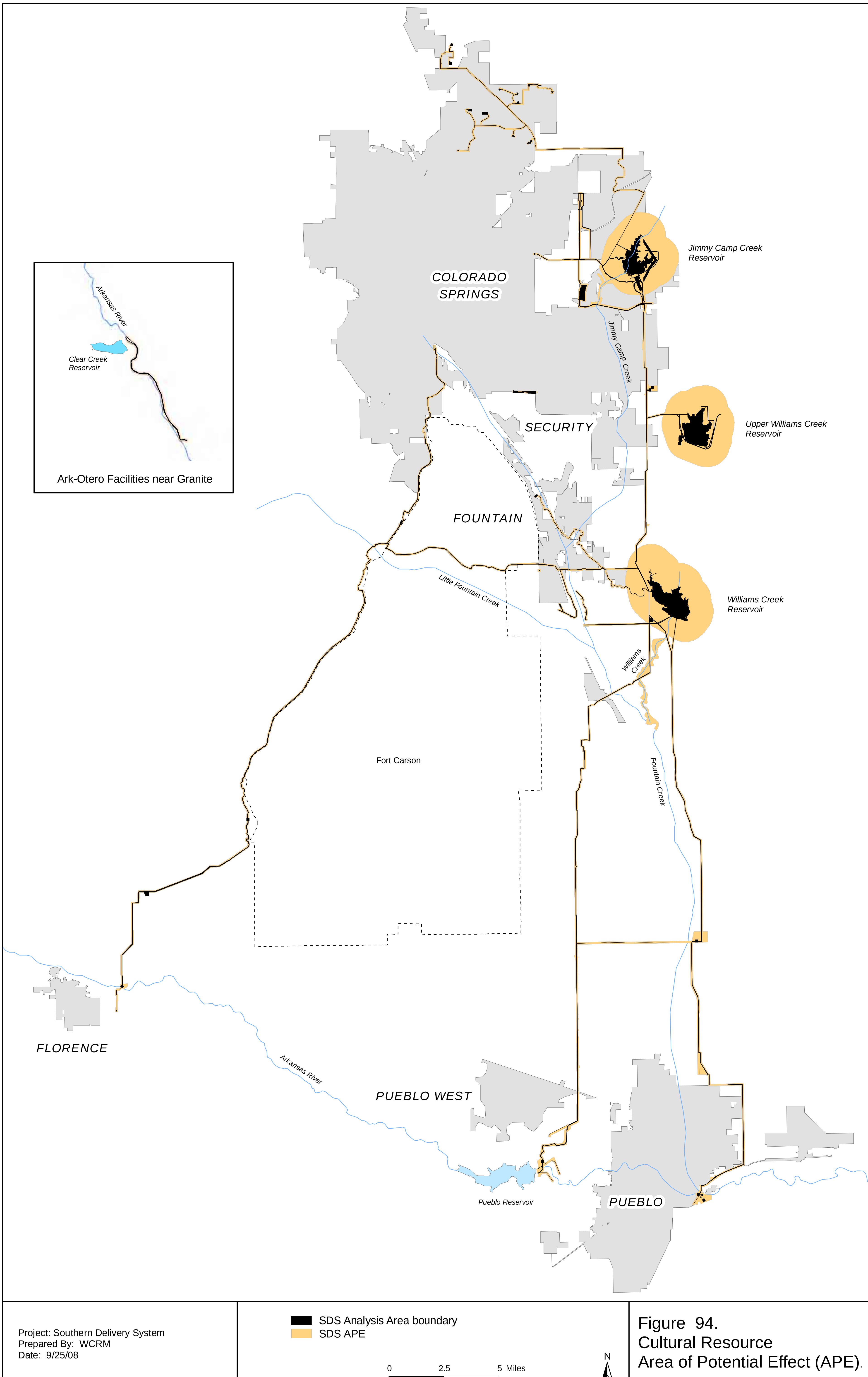
3.17.3 Analysis Area and Methods

3.17.3.1 Analysis Area

In 2004, the Colorado SHPO, the Advisory Council on Historic Preservation (ACHP), and Reclamation met to discuss the project. Members of the SHPO also attended a subsequent in-field project review. A continuing consultation process between Reclamation and the SHPO led to the definition of the geographical boundary for the Area of Potential Effect (APE) for cultural resources as required under NHPA and development of a Programmatic Agreement (Appendix I). Figure 94 defines the cultural resources APE as all project components inclusive of a 1-mile buffer around each proposed reservoir site; 500-foot wide corridors for pipelines, power lines, and telecommunications lines; and a 250-foot buffer around other facilities (e.g., water treatment plants and pump stations). For purposes of this discussion, the cultural resources study area and the cultural APE are synonymous.

The SDS Project analysis area lies within the APE and is defined as the area that will be used for characterizing potential direct effects within the footprint of each alternative. In addition, those areas outside of the analysis area but still within the APE are evaluated for potential indirect effects. For the purposes of this analysis, unevaluated sites were assumed to be eligible for listing in the NRHP. Unevaluated sites are those that have not been officially reviewed for NRHP eligibility by the SHPO.Methods

The intensity of data collection varied within the analysis area. Survey levels included Class I file search, Class I field-check, and Class III; Class II survey methods were not used for the SDS Project. It was decided in meetings between the SHPO, ACHP, and Reclamation



Project: Southern Delivery System
Prepared By: WCRM
Date: 9/25/08

Figure 94.
Cultural Resource
Area of Potential Effect (APE).

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Area of Potential Effect is the geographic area or areas within which an undertaking may directly or indirectly cause changes in the character or use of historic properties, if such properties exist. The APE is influenced by the scale and nature of the undertaking and may be different for different kinds of effects caused by the undertaking.

Class I survey involves the thorough review and synthesis of the existing literature concerning a survey area.

Class I field-check survey consists of walking two parallel transects 100 feet to either side of the analysis area boundary centerline of the 500 feet (typical width) pipeline corridor. Within the Upper Williams Creek Reservoir, site parcels were surveyed where permission to access had been obtained. The parcels were surveyed using alternating 100 foot corridors.

Class II survey is a sample intensive pedestrian survey involving less than a 100% of the project area.

Class III survey is a 100% pedestrian coverage of the project area.

in 2004 that Class III level survey of all project alternatives was not cost efficient or feasible. As a result, it was agreed that a Class I field-check level of survey could be conducted within the pipeline alternatives and Upper Williams Creek Reservoir; these facilities were not components of the majority of the alternatives. Components involved in most of the proposed alternatives (i.e., Jimmy Camp Creek and Williams Creek Reservoir sites, Central Untreated Water Pipeline alignment, portions of the Western Untreated Water Pipeline alignment, some areas near Pueblo Dam, and the Reduced Northfield Booster Pump Station site) were the focus of Class III survey because the likelihood that these facilities might be part of a Preferred Alternative was considered to be greater.

Class I level survey consists of a field-check of all areas within the alternatives not surveyed to a Class III level; this level of survey was conducted to ascertain the potential for the presence of cultural resources. This method of investigation did not involve cultural resource recordation; resources were noted (i.e., identified by site or isolate type) and a GPS reading was taken. Field-checks were conducted in all areas not subject to a Class III level survey.

The entire APE, including the analysis area, was subjected to a Class I file search. The percentage of analysis area by alternative that was subjected to Class I field-check and Class III level investigations is provided in Table 134. In the case of the Participants' Proposed Action and the Wetland alternatives, a percentage of the analysis area could not be surveyed either to Class I field-check or Class III levels due to site access constraints. Consequently, a percentage of these alternatives was only studied by means of Class I file search analysis.

3.17.3.2 Limitations

The intensity of data collection varied within the APE. This method of data collection undoubtedly influenced the quantity of cultural sites identified within each alternative. As a result, the likelihood of identifying cultural sites on the surface would be highest in areas that were surveyed to a Class III level; subsurface evidence of cultural resources may or may not be evident from surface expressions. In contrast, fewer numbers of cultural resources would have been noted in areas evaluated solely using Class I file search information (i.e., areas within the APE but outside the NEPA study area boundary). The likelihood of identifying cultural sites on the surface would be intermediate for all other areas evaluated by means of a Class I field-check. Additionally, some properties within the Class I field-check area were inaccessible (e.g., portions of the Participants' Proposed Action and portions of the Upper Williams Creek Reservoir site) and were evaluated using the Class I file search information only (Table 134).

Federal regulations preclude giving precise locations of inventoried resources. The results of cultural resource investigations are not available to the public (they are, however, on file with the Colorado Office of Archaeology and Historic Preservation (OAHP)) and can be disclosed only in statistical or aggregate formats.

3.17.4 Affected Environment

3.17.4.1 Cultural History Overview

Summarizing the cultural history within the APE requires consideration of human history over the last 12,000 years. A succinct summary of this history is provided below, subdivided into chronologically sequential stages defined primarily by changes in subsistence strategies (i.e., ways in which societies transform the material resources of the environment into food, clothing, and shelter) and material culture (i.e., objects manufactured by people and the meaning of those objects). These stages are Pre-projectile Point, Paleoindian, Archaic, Late Prehistoric, and Historic. The cultural overview provided below is taken entirely from regional overviews published by the Colorado Council of Professional Archaeologists (Zier and Kalasz 1999).

Krieger (1964) hypothesized the existence of a Pre-Projectile Point Stage. This stage is characterized by the presence of stone core and flake tools made by percussion, pebble tools and bone tools all pre-dating the Paleoindian stage (described below). Three northeastern Colorado sites contain evidence supporting this hypothesized stage. Dates from these sites range from 11,190 B.C. to 9,760 B.C. (Agenbroad 1984). Pre-Projectile Point stage sites are presently unknown in east-central Colorado. A paleosol (i.e., a soil horizon from the geologic past) investigation of the Jimmy Camp Creek and Williams Creek areas (LaRamie Soils Service 2004) suggested that third terrace (T3) sediments "have the potential to yield Paleoindian age components."

The Paleoindian stage (10,500 B.C. to 5,000 B.C.) is subdivided into three periods: Clovis,

Table 134. Percentage of SDS Alternative Analysis Area Subjected to Class I Field-Check and Class III Level of Investigations.

Minimum Level of Investigation	No Action Alternative	Participants' Proposed Action	Wetland Alternative	Arkansas River Alternative	Fountain Creek Alternative	Down-stream Intake Alternative	Highway 115 Alternative
No Access	0%	19%	27%	0%	0%	0%	0%
Class I Field-Check	37%	28%	42%	53%	25%	31%	26%
Class III	63%	53%	31%	47%	75%	69%	74%

Folsom, and Plano. Each of these periods is characterized by highly stylized projectile points – a reflection of the emphasis these people placed on hunting now-extinct mammoth and bison and later modern but smaller species of bison. Sites common to the periods include camps and kill sites. Archaeological sites of this general period are relatively rare, but some of the better-known sites are found in the Denver Basin along the Front Range and include the Dent site (Figgins 1933), the Dutton site (Stanford 1979), the Jurgens site (Wheat 1974, 1975) and the Lamb Springs site (Wedel 1963). Paleoindian projectile points have been reported from many areas in eastern Colorado; some Paleoindian materials have been found on the Fort Carson Military Reservation (Zier and Kalasz 1999).

The Archaic stage (5,000 B.C. to A.D. 200) is subdivided into Early, Middle, and Late period designations, based partially on changes in projectile point form and changes in settlement and subsistence strategies. Changes in climate led to adaptive human subsistence strategies geared more toward generalized hunting and gathering where each was an equally important food. The appearance of a more diverse tool kit, the development of an expanded ground stone technology, and a general decrease in size of projectile points are seen in the archaeological record. It is during this stage that hunter-gatherers likely began to form into bands reminiscent of those tribes encountered during the 19th century. Common sites include camps, hunting sites, and limited-activity lithic (i.e., worked stone or rock) scatters.

The Late Prehistoric stage (A.D. 200 to A.D. 1750) again comprises three periods: Early Ceramic, Middle Ceramic, and Protohistoric. The Early Ceramic period witnessed the adoption of ceramic technology, the bow and arrow, and horticulture. Ceramics and horticulture were never dominant traits in southeastern Colorado cultures, but their presence is a distinct marker of this stage. In southeastern Colorado, small masonry structures also seem to have appeared during the Late Prehistoric stage/Ceramic period. A marked increase in the number of sites dating to this time period suggests a significant population increase or greater site visibility due to the presence of architectural remains. Early Ceramic sites are reported within close proximity to the SDS Project APE on the Fort Carson Military Reservation (Alexander et al. 1982; Zier 1989, Zier and Kalasz 1985), along the Powers Boulevard Corridor (Gooding 1977), and on the Banning-Lewis Ranch (Anderson 1989; Anderson et al. 1986). A change in climate initiated the transition to the Middle Ceramic period, when much of the Front Range may have been abandoned due to drought that forced an emigration into the mountains. The Protohistoric period begins in A.D. 1540 with the arrival of the Spanish in the Southwest; however, it took nearly 200 years for Euro American goods, including horses, to effect a change in Native American culture.

The advent of the horse radically changed the disposition of Native American tribes, turning semi-nomadic hunter-gatherers into highly nomadic, horse-mounted cultures. New groups of people, the Apache, the Comanche, the Kiowa and Kiowa Apache, the Cheyenne and Arapaho, successively arrived from the north, sometimes driving one another from the area or forming alliances. From the west, the Ute continued to exploit the resources of the Arkansas Valley. Increasingly, these aboriginal groups were caught in the fight for the possession of the territory first between the Spanish and the French, the Spanish and the Americans, and, finally, the Mexicans and the Americans. By the 1880s, Native Americans had been forcibly removed to reservations in

Colorado, Oklahoma, Utah, and Wyoming (Hughes 1977).

The discovery of gold near modern Denver in 1859 began the Historic period in earnest. Thousands of prospectors and commercial opportunists swarmed across Colorado lured by the incentive of easy wealth. Routes to get to the gold fields were well known because of the earlier waves of gold miners and settlers who had moved across the country on the Oregon and Santa Fe Trails to California in 1849 and 1850. Once the furor of gold abated, many who failed at prospecting tried ranching and farming. Inexpensive land and ranching opportunities were incentives for Euro Americans to settle in eastern Colorado and the Arkansas Valley. Ranching and farming were and continue to be the primary commercial enterprises within the APE. Common historic archaeological sites include: active and/or abandoned farms and ranches and associated facilities; early commercial endeavors such as water reclamation projects; historic campsite remnants; and, early transportation features such as the railroad and roads.

3.17.4.2 Existing Conditions

File searches at the OAHP indicated that numerous studies have been previously conducted within the APE for cultural resources. In addition, Class III field work was conducted at several locations (Section 3.17.3).

Table 135 provides by alternative the total number of known sites eligible or potentially eligible for inclusion in the NRHP. At this juncture, there are no known Paleoindian, large prehistoric habitation villages, or deeply buried trader sites within the project area.

The number of sites located within the APE of each alternative varies due to the project components within each. The No Action, Fountain Creek, Downstream Intake, and Highway 115 alternatives include the Jimmy Camp Creek and Williams Creek reservoirs. Field work conducted at these reservoir sites yielded 121 cultural resource sites; thus, these alternatives contain a greater number of resources than the other alternatives. The APE of the Participants' Proposed Action has 100, the lowest number of known sites eligible for inclusion in the NRHP or unevaluated but potentially eligible sites. The APE of the Wetland Alternative has 106 known sites. Both the Participants' Proposed Action and the Wetland alternatives do not include the Jimmy Camp Creek Reservoir site. The Arkansas River Alternative excludes the Williams Creek Reservoir site and thus has a smaller number of resources than No Action, Fountain Creek, Downstream Intake, and Highway 115 alternatives but a greater number than the Wetland Alternative.

3.17.5 Environmental Consequences

Table 135. Known NRHP Eligible or Unevaluated Sites within the APE by Alternative.

Alternative	Total Prehistoric Sites	Total Historic Sites	Total Multi-component Sites	Total Sites
No Action Alternative	128	103	22	253
Participants' Proposed Action†	45	55	0	100
Wetland Alternative†	47	58	1	106
Arkansas River Alternative	102	72	19	193
Fountain Creek Alternative	134	91	19	244
Downstream Intake Alternative	122	88	19	229
Highway 115 Alternative	126	90	20	236

†Most of the Upper Williams Creek Reservoir site was inaccessible in these alternatives.

This section describes the number of known cultural resource sites contained in the APE of each alternative by NRHP status (i.e., eligible or unevaluated) and effect (direct or indirect). The number of sites presented reflects the sites recorded to date. More sites will likely be encountered when a Class III inventory is completed for the Preferred Alternative. The analysis focuses on two areas: 1) potential construction-related areas; and 2) buffer zone areas. Sites located within construction-related areas are considered to be potentially subject to direct effects. Sites located within the buffer zones are considered to be subject to potential indirect effects. Sites throughout the APE are subject to potential cumulative effects.

Table 136 provides the totals of known eligible or potentially eligible sites within the alternatives by direct and indirect effects. Eligible and unevaluated sites are considered to have the potential to address important research themes as discussed in the SDS Project cultural resources technical reports (Chambellan 2005a through 2005n, 2008a, 2008b; Chambellan et al. 2005, 2008; Fiske 2005, 2006; Fiske and Chambellan 2006).

3.17.5.1 Direct and Indirect Effects

Construction of all SDS Project components has the potential to affect cultural resources adversely. Direct adverse effects may occur from construction of access roads, borrow pits, power lines, pipelines, dams, and related facilities. Inundation and shoreline wave action also can be considered potential direct effects. Indirect adverse effects may occur from increased traffic by the public resulting in site trampling and possible subsequent erosion, illicit collection of artifacts, and unauthorized excavation of archaeological materials.

The location of prehistoric sites is generally governed by the location of natural resources at the time of occupation. Preferred locations

Table 136. Number of Known Eligible and Unevaluated Sites by Effect Type and Alternative.

Alternative	Sites Recorded in Direct Effects Area (Analysis Area)†	Sites Recorded in Indirect Effects Area (APE Outside of Analysis Area)‡
No Action Alternative	105 (Jimmy Camp Creek 52; Williams Creek 13)	163
Participants' Proposed Action†	43 (Williams Creek 13)	64
Wetland Alternative†	34	79
Arkansas River Alternative	88 (Jimmy Camp Creek 52)	130
Fountain Creek Alternative	103 (Jimmy Camp Creek 52; Williams Creek 13)	156
Downstream Intake Alternative	99 (Jimmy Camp Creek 52; Williams Creek 13)	151
Highway 115 Alternative	97 (Jimmy Camp Creek 52; Williams Creek 13)	154

†Most of the Upper Williams Creek Reservoir site was inaccessible in these alternatives.

‡Some sites overlapped into both the Analysis Area and APE outside the Analysis Area, so they were considered in both counts and averaged about 30 to 40 sites per alternative.

Cultural Resources Terms

Core drilling is a mineral exploration technique using portable drilling equipment; it is a temporary land use.

Habitation is a historic dwelling place.

Isolate or **isolated find** is the occurrence, usually on the surface, of less than three artifacts.

Multi-component is a site containing cultural material from both prehistoric and historic time periods.

Rock alignment is a grouping of rocks in a linear configuration.

Scatter is an arbitrary grouping of artifacts on a site surface.

Structure is a functional resource constructed for purposes other than to provide shelter.

Prospect pit is a small, hand dug excavation for the purpose of searching for minerals.

Rock concentration is a grouping of rocks either above or below the ground surface.

Stone monument is a type of marker, such as a boundary marker for a land claim, or a grave marker. Monuments differ from cairns in that they usually made of one or only a few stones, whereas cairns generally consist of numerous, random stones. Monuments often exhibit stone masonry techniques.

favor proximity to vegetal, animal, and water resources. Camp sites in particular favor these locations (i.e., gentle slopes, saddles, permanent water sources). In addition, task-specific sites can be found in locations affording a good view for hunting and procurement of resources (e.g., lithic resources). Access to water, proximity to transportation routes, and availability of land appear to have been the determining factors for the location of historic resources in the SDS Project area.

No Action Alternative

Direct Effects

A total of 122 sites were identified within the analysis area for the No Action Alternative. Of these, 105 sites are eligible or unevaluated for listing in the NRHP. Identified site types include 49 prehistoric, 45 historic, and 11 multi-component.

The prehistoric sites include 13 lithic scatters, 6 campsites, one lithic and ceramic scatter, four lithic and ground stone scatters, and 25 unspecified. The historic sites include 15 railroad segments, seven ditch segments, 10 road segments, three trash scatters, three foundations, three structures, one fence, one ranch, one water pipe, one possible mine, and one root cellar. The multi-component sites include one prehistoric lithic and historic trash scatter, one prehistoric camp associated with historic trash, one prehistoric camp associated with a historic homestead, one lithic scatter associated with a historic camp, one prehistoric camp associated with a historic isolate, and six unspecified.

Indirect Effects

A total of 191 sites were identified within the No Action Alternative APE buffer area. Of these, 165 sites are eligible or unevaluated for inclusion in the NRHP. Identified site types include 81 prehistoric, 69 historic, 13 are multi-component, and two have not been specified.

The prehistoric sites include 45 lithic scatters, 24 campsites, and 10 lithic and ground stone scatters. The historic sites include 12 railroad segments, 10 trash scatters, five foundations, nine structures, 13 road segments, four ranches, five ditch segments, four bridge remnants, one check dam, one water pipe, one homestead, one wall, one windbreak, one artesian well, and one mine. The multi-component sites include one prehistoric lithic scatter associated with a historic trash scatter, two prehistoric camps associated with a historic trash scatter, two prehistoric camps associated with a historic foundation, and seven unspecified.

Participants' Proposed Action

Direct Effects

Within the Participants' Proposed Action analysis area, a total of 55 sites were identified. Of these, 43 sites are eligible or unevaluated for inclusion in the NRHP. Identified site types include 18 prehistoric and 25 historic.

The prehistoric sites include 30 lithic scatters, 14 campsites, one campsite and burial, one bone bead site, one ceramic scatter, one lithic and ceramic scatter, one lithic and bone scatter. The historic sites include 13 railroad segments, six trash scatters, 10 ditch segments, two road segments, one structure, two foundations, and one mine.

Indirect Effects

A total of 84 sites were identified within the Participants' Proposed Action APE buffer. Of these, 64 sites are eligible or unevaluated for inclusion in the NRHP. Identified site types include 31 prehistoric and 33 historic.

The prehistoric sites include 21 lithic scatters, four campsites, seven lithic and ground stone scatters, two lithic scatters associated with a rock concentration, and one stone wall. The historic sites include 14 railroad segments, seven trash scatters, nine ditch segments, six structures, three foundations, two road segments, one ranch, one stone wall, one mine, two corrals, and one pump associated with a foundation.

Wetland Alternative

Direct Effects

A total of 45 sites were identified within the Wetland Alternative analysis area. Of these, 34 sites are eligible or potentially eligible for inclusion in the NRHP. Identified site types include 10 prehistoric and 24 historic.

The prehistoric sites include seven lithic scatters and four campsites. The historic sites include 11 railroad segments, five trash scatters, eight ditch segments, one structure, two foundations, one fence, one possible mine, two road segments, one prisoner of war camp, and one rock concentration with associated trash.

Indirect Effects

A total of 99 sites were identified within the Wetland Alternative APE buffer. Of these, 79 sites are eligible or unevaluated for inclusion in the NRHP. Site types identified include 41 prehistoric, 37 historic, and one multi-component.

The prehistoric sites include 27 lithic scatters, ten lithic and ground stone scatters, six camps, two lithic scatters associated with a rock concentration, and one stone wall. The historic sites include 11 railroad segments, 10 ditch segments, nine trash scatters, three foundations, one rock concentration with an associated trash scatter, five structures, one bridge, one ranch, two road segments, one prisoner of war camp, one foundation with associated artesian well, one foundation associated with a pump, two corrals, one mine, and one stone monument. The multi-component site consisted of a prehistoric camp with and associated historic quarry.

Arkansas River Alternative

Direct Effects
Within the Arkansas River Alternative analysis area, a total of 96 sites were identified. Of these, 88 sites are eligible or potentially eligible for inclusion in the NRHP. Identified site types include 38 prehistoric, 37 historic, and 11 multi-component sites.

The prehistoric sites include nine lithic scatters, six campsites, and 25 unspecified. The historic sites include 12 railroad segments, seven structures, seven ditch segments, five road segments, one trash scatter, one fence, one set of footings, one root cellar, one prisoner of war camp, and one possible mine. The multi-component sites include one prehistoric lithic and historic trash scatter, one prehistoric camp with associated historic trash scatters, and one prehistoric lithic scatter associated with a homestead, one prehistoric camp, and historic isolate.

Indirect Effects
A total of 143 sites were identified within the Arkansas River Alternative APE buffer. Of these, 130 sites are eligible or potentially eligible for inclusion in the NRHP. Identified site types include 69 prehistoric, 44 historic, and 11 multi-component sites.

The prehistoric sites include 25 lithic scatters, 20 camps, five lithic and ground stone scatters, and 20 unspecified. The historic sites include 10 railroad segments, five ditch segments, four trash scatters, six structures, four foundations, 10 road segments, two ranches, one bridge abutment, one corral, one homestead, one check dam, one wall, one windbreak, one mine, and one depression associated with trash. The multi-component sites include one prehistoric lithic scatter with associated historic trash scatter, one prehistoric camp associated with a historic trash scatter, one prehistoric camp associated with a historic foundation, one prehistoric camp associated with a historic homestead, and seven unspecified.

Fountain Creek Alternative

Direct Effects
Within the Fountain Creek Alternative analysis area, a total of 117 sites were identified. Of these, 103 sites are eligible or unevaluated for inclusion in the NRHP. Identified site types include 51 prehistoric, 41 historic, and 11 multi-component sites.

The prehistoric sites include 13 lithic scatters, seven campsites, five lithic and ground stone scatters, and 26 unspecified. The historic sites include 11 railroad segments, seven structures, eight ditch segments, five trash scatters, five road segments, one mine, one root cellar, one rock concentration associated with historic trash, and three unspecified. The multi-component sites include one prehistoric lithic and historic trash scatter, one prehistoric camp associated with historic trash, one prehistoric camp associated with a homestead, one prehistoric camp and historic isolate, and seven unspecified.

Indirect Effects
A total of 183 sites were identified within the Fountain Creek Alternative APE buffer. Of these, 156 sites are eligible or unevaluated for inclusion in the NRHP. Identified site types include 90 prehistoric, 55 historic, and 11 multi-component sites.

The prehistoric sites include 33 lithic scatters, 23 campsites, 12 lithic and ground stone scatters, two lithic scatters associated with rock concentrations, and one stone wall. The historic sites include 16 railroad segments, 15 ditch segments, six trash scatters, nine structures, four foundations, ten road segments, one trash scatter associated with a rock concentration, two bridge remnants, one homestead, one check dam, two corrals, one mine, one windbreak, one ranch, one depression associated with associated trash, and three unspecified. The multi-component sites include one prehistoric lithic scatter associated with a historic trash scatter, one prehistoric camp associated with historic trash, one prehistoric camp associated with a historic foundation, one prehistoric camp associated with a historic homestead, and seven unspecified.

Downstream Intake Alternative

Direct Effects
A total of 107 sites were identified within the Downstream Intake Alternative analysis area. Of these, 99 sites are eligible or potentially eligible for inclusion in the NRHP. Identified site types include 48 prehistoric, 40 historic, and 11 multi-component sites.

The prehistoric sites include 12 lithic scatters, five campsites, five lithic and ground stone scatters, and 26 unspecified. The historic sites include 15 railroad segments, seven structures, seven ditch segments, three trash scatters, five road segments, a portion of the Colorado Fuel and Iron (CF&I) plant, one root cellar, and one mine. The multi-component sites include one prehistoric lithic and historic trash scatter, one prehistoric camp associated with historic trash, one lithic scatter associated with a homestead, one prehistoric camp and an historic isolate, and seven unspecified.

Indirect Effects
A total of 167 sites were identified within the Downstream Intake Alternative APE buffer. Of these, 151 sites are eligible or potentially eligible for inclusion in the NRHP. Identified site types include 80 prehistoric, 60 historic, and 11 multi-component.

The prehistoric sites include 32 lithic scatters, 21 campsites, 10 lithic and ground stone scatters, and 17 unspecified. The historic sites include 17 railroad segments, nine structures, six trash scatters, nine ditch segments, four foundations, 11 road segments, one corral, two bridge remnants, one homestead, one check dam, one windbreak, two ranches, one depression with associated trash, one mine, and three unspecified. The multi-component sites include one prehistoric lithic and historic trash scatter, one prehistoric camp with historic trash scatter, one prehistoric camp associated with a historic homestead, one prehistoric camp associated with a historic foundation, and seven unspecified.

Highway 115 Alternative

Direct Effects
Within the Highway 115 Alternative analysis area, a total of 107 sites were identified. Of these, 97 sites are eligible or potentially eligible for inclusion in the NRHP. Identified site types include 49 prehistoric, 37 historic and 11 multi-component.

The prehistoric sites include 14 lithic scatters, six campsites, four lithic and ground stone scatters, and 25 unspecified. The historic sites include 14 railroad segments, seven ditch segments, three trash scatters, five road segments, one fence, one foundation, two structures, one water pipe locale, one possible mine, one root cellar, and one set of concrete footings. The multi-component sites include one prehistoric lithic and historic trash scatter, one prehistoric camp associated with a historic trash scatter, one lithic scatter associated with a homestead, one prehistoric camp and historic isolate and seven unspecified.

Indirect Effects

A total of 177 sites were identified within the Highway 115 Alternative APE buffer. Of these, 154 sites are eligible or potentially eligible for inclusion in the NRHP. Identified site types include 81 prehistoric, 61 historic, 12 multi-component, and one unspecified.

The prehistoric sites include 35 lithic scatters, 22 campsites, nine lithic and ground stone scatters, and 15 unspecified. The historic sites include 11 railroad segments, nine trash scatters, five foundations, seven structures, 10 road segments, five ditch segments, two mineral bathes, two bridge remnants, one check dam, two abutments, two homesteads, one windbreak, one depression with associated trash, two ranches, and one mine. The multi-component sites include one prehistoric lithic and historic trash scatters, one prehistoric camp associated with a historic trash scatter, one prehistoric camp associated with a historic homestead, one prehistoric camp associated with a historic foundation, one prehistoric camp associated with a historic homestead, one prehistoric camp associated with a historic quarry, and seven unspecified.

3.17.5.2 Cumulative Effects

A description of reasonably foreseeable actions considered in this FEIS is presented in Section 3.1.3.1. Those actions and activities that are independent of the SDS Project but could result in cumulative effects when combined with the effects of the SDS Project include:

- Urban and Suburban Development in El Paso, Pueblo, and Fremont counties – Significant growth is anticipated in El Paso and Pueblo counties with expansion of growing populations and the need for housing developments and related facilities. Cultural studies for these developments are not available.
- Las Vegas Street Wastewater Treatment Facility Improvements (Colorado Springs Utilities) – A new lift station and force main may be constructed to convey wastewater from the Jimmy Camp Creek basin to Las Vegas Street Wastewater Treatment Facility. Specific plans for this facility have not yet been developed.
- City of Fountain Water Supply Project – The expansion of the Fountain Creek well field will involve the construction of 7 miles of pipeline, a new treatment plant, solar evaporation ponds, and other related facilities. Cultural studies for this facility are not yet available.
- Eastern Plains Transmission Project (Western Area Power Administration) – This proposed new transmission project will include about 1,000 miles of new lines and related facilities in eastern Colorado and western Kansas. One unevaluated site and two officially eligible railroad segments may be affected by this project as it crosses the SDS Project area.
- Transportation projects – CDOT plans numerous projects in Pueblo and El Paso counties that will focus on improving mobility in the region. Cultural studies for these projects are not yet available.
- Peak to Prairie Fountain Creek Conservation Project (Colorado Open Lands) – This project focuses on conservation efforts that will affect about 800 acres in El Paso County. Non-surface disturbance efforts should not result in impacts to cultural resources; however, if the conservation project area is available to the public, direct and indirect effects may occur to

cultural resources. A cultural study for this project is not yet available.

- Climate Change – Climate variability and change may create conditions that diminish the integrity of all cultural resource sites through increased water and wind damage.

Although detailed plans and/or cultural resources studied have not yet been developed for many of these reasonably foreseeable actions, it is likely that they would affect sites that are eligible or potentially eligible for inclusion in the NRHP. Some of those sites would likely be within the APE and possibly within the analysis area for the alternatives. All cumulative impacts such as ground disturbance and collection will result in the complete removal disturbance of nonrenewable cultural resources.

In the event that there is no federal involvement with regard to cumulative effects, historic properties would no longer be subject to the jurisdiction of preservation laws.

3.17.5.3 Resource Commitments

All alternatives would result in irreversible (i.e., permanent) impacts to nonrenewable cultural resources. As per Section 106 of the NHPA and the NAGPRA regulations, construction project facilities would result in effects on NRHP eligible or listed resources and possible inadvertent discoveries of concern to Native American tribes. There would be no irretrievable commitment of cultural resources.

3.17.5.4 Mitigation

Proposed Measures

The following mitigation measures would be implemented:

- Comply with the requirements of the Programmatic Agreement between Reclamation, the ACHP, Colorado Springs, and the Colorado SHPO (Appendix I)

Mitigated Effects

Development of the project alternatives will result in impacts to non-renewable historic properties. As a result, it will be necessary to implement a mitigation plan in an effort to resolve any adverse effects. Mitigation may be accomplished through avoidance, implementation of protective measures, or data recovery. If avoidance and preservation are not possible, a data recovery plan may be used to collect and analyze significant information, thus preserving that information. Data collection as a mitigation measure should only be implemented when other means to protect or preserve historic properties have been exhausted or are not feasible. Within the data recovery plan, specific research problems concerning scientific, humanistic, and cultural concerns will be developed. Research also will focus on problems in prehistoric and historic archaeological method and theory. Ultimately, the data collected likely will provide information regarding the cultures that have occupied the area in the past.

3.18 Indian Trust Assets

Indian Trust Assets (ITAs) are legal interests in assets held in trust by the Federal Government for federally recognized Native American tribes or nations or for individual Native Americans. Tribal groups were asked to identify ITAs in the analysis area.

3.18.1 Summary of Effects

No ITAs were identified in the SDS Project analysis area. Therefore, no effects would occur with any of the alternatives.

3.18.2 Regulatory Framework

Assets are anything owned that has monetary value. A legal interest refers to a property interest for which a legal remedy, such as compensation or injunction, may be obtained if there is improper interference. A trust has three components: the trustee, the beneficiary, and the trust asset. The beneficiary is also sometimes referred to as the beneficial owner of the trust asset. In the Indian trust relationship, the United States is the trustee and holds title to ITAs for the benefit of a Native American tribe or nation or for an individual Native American. The Secretary of the Interior manages ITAs in accordance with Principles for the Discharge of the Secretary's Trust Responsibility (DOI 2000).

Assets can be real property, physical assets, or intangible property rights. Examples include lands, minerals, water rights, hunting and fishing rights, other natural resources, money, or claims. They need not be owned outright, but can include other types of property interest, such as a lease or a right to use something. ITAs cannot be sold, leased, or otherwise alienated without federal approval. While most ITAs are on Indian reservations, they can be off reservations.

3.18.3 Analysis Area and Methods

Reclamation contacted representatives of tribal groups with historical ties to the Arkansas River Basin and tribal groups who had expressed interest in Reclamation activities to identify any tribal trust or treaty interests (see Chapter 4). Reclamation requested government-to-government consultation to identify any concerns about the potential effects of the proposed SDS Project on trust assets, cultural and biological resources, or tribal health and safety. In addition, Reclamation contacted various representatives and offices of the Bureau of Indian Affairs, informing them of the consultation and requesting any comment that the agency might have regarding the project and possible environmental effects, including the potential to affect ITAs or cultural resources.

3.18.4 Affected Environment

No ITAs were identified within the SDS Project analysis area to date.

3.18.5 Environmental Consequences

3.18.5.1 Direct and Indirect Effects

No direct or indirect effects on ITAs are expected for any alternative. Effects on other resources that may be of interest to tribes are described throughout Chapter 3 of this FEIS.

3.18.5.2 Cumulative Effects

No cumulative effects would occur with the No Action Alternative or the Action Alternatives because the SDS Project would not adversely impact ITAs.

3.18.5.3 Resource Commitments

The No Action and Action Alternatives would not result in an irreversible or irretrievable commitment of ITAs.

3.18.5.4 Mitigation

No mitigation measures are expected to be needed to minimize effects on ITAs or other tribal resources. Coordination on tribal and other cultural resource issues will continue among Reclamation, the Colorado SHPO, the City of Colorado Springs, and 15 tribes (the Apache Tribe of Oklahoma, Cheyenne and Arapaho Tribes of Oklahoma, Comanche Nation of Oklahoma, Fort Sill Apache Tribe, Jicarilla Apache Tribe, Kiowa Tribe of Oklahoma, Northern Arapaho Tribe, Northern Cheyenne Tribe, Pawnee Nation of Oklahoma, Shoshone (Eastern Band) Tribe, Shoshone-Bannock Tribe, Southern Ute Tribe, Ute Tribe (Uintah and Ouray Reservation), and Ute Mountain Ute Tribe through a Programmatic Agreement (Appendix I). Under that Agreement, Reclamation and the Project Participants will coordinate with the tribes to identify and mitigate impacts to any traditional cultural properties or resources. The Mescalero Apache Tribe indicated it is not interested in continuing consultation.

3.19 Noise and Vibration

Noise is measured in decibels (dB) scaled to approximate the hearing capability of the human ear (dBA). Common sound levels are 35 to 45 dBA for a quiet, peaceful setting; 60 to 65 dBA for normal city noise; and 85 to 90 dBA for heavy equipment. Noticeable vibrations occur from construction activities, construction equipment, excavation, and blasting. Effects on noise and vibration are being discussed because of the potential consequences on human health and the environment. The indicator of noise effects is increases of dBA above existing noise levels.

3.19.1 Summary of Effects

For all alternatives, short-term, minor to moderate noise and vibration impacts would occur during construction. During pipeline construction, noise and vibration effects for the Wetland and Arkansas River alternatives would be similar to the No Action Alternative. The Participants' Proposed Action, Fountain Creek, Downstream Intake, and Highway 115 alternatives would have fewer noise and vibration effects during construction because of the shorter length of pipe or fewer number of pump stations compared to the No Action. Short segments of the pipeline alignments, such as along Colorado 115 and on the southern segment of the Western Untreated Water Pipeline, may require blasting during construction, which would increase the short-term noise impacts for all alternatives except the Downstream Intake Alternative. Construction of two reservoirs in the No Action, Participants' Proposed Action, Fountain Creek, Downstream Intake, and Highway 115 alternatives would result in more noise and vibration impacts compared to alternatives with one reservoir. Alternatives with more pump stations would result in more short-term, minor impacts during construction. Once construction is complete, noise and vibration effects would cease along pipelines, around reservoirs, and for most project components. Minor, long-term noise effects would occur at pump stations from the outdoor air handling equipment.

3.19.2 Regulatory Framework

As a result of the Noise Control Act of 1972, the EPA developed acceptable noise levels under various conditions that would protect public health and welfare with an adequate margin of safety. The EPA identified outdoor day/night average noise levels less than or equal to 55 dBA as sufficient to protect public health and welfare in residential areas and other places where quiet is a basis for use (EPA 1979). Although the EPA guideline is not an enforceable regulation, it is a commonly accepted target noise level for environmental noise studies.

In urban areas such as Colorado Springs and Pueblo, the Participants would follow noise ordinances for allowable noise levels for construction and operation noises of pump stations and other facilities. County ordinances are similar to city ordinances. Table 137 lists the maximum noise levels for different land use zones according to Colorado Springs and City of Pueblo ordinances.

Table 137. Maximum Noise Levels for Land Use Zones.

Zones	Maximum Noise (dBA) 7 am to 7 pm	Maximum Noise (dBA) 7 pm to 7 am
Residential	55	50
Commercial	60	55
Light Industrial	70	65
Industrial/Construction	80	75

Source: Pueblo n.d.; NPC 2004.

3.19.3 Analysis Area and Methods

The SDS Project study area was assessed for possible changes in noise levels from existing levels. Effects were determined by reviewing types of potential activities and applying known decibel ranges for those activities. No quantitative analysis was conducted to determine effects on vibration. Effects on noise were classified into the following effects threshold categories:

- Negligible – new noise sources would be below existing levels
- Minor – new noise sources would be above existing levels but would be below 55 dbA (EPA 1979) at all receptor locations
- Moderate – new noise sources would be substantially above existing levels and would exceed 55 dbA at all receptor locations during construction
- Major – new noise sources would be substantially above existing levels and would exceed 55 dbA at any receptor locations on a permanent basis

3.19.4 Affected Environment

3.19.4.1 Reservoir and Water Treatment Plant Sites

The three reservoir sites and the Jimmy Camp Creek Water Treatment Plant site are used primarily for livestock grazing and currently have negligible vibration and low ambient noise levels (35 to 45 dBA). Some noise from traffic on U.S. 24 and Colorado 94 can be heard from the Jimmy Camp Creek Reservoir site. Several existing residences occur within or adjacent to the proposed reservoir footprint as well as more than 1 mile from where the Jimmy Camp Creek reservoir dam would be constructed. No houses occur near the Williams Creek Reservoir site. The Fountain Landfill is directly northwest of the Williams Creek Reservoir site, but noise from this facility does not affect the ambient noise at the reservoir site. The Upper Williams Creek Reservoir site is characterized by scattered ranch houses, often more than ½ mile from each other. Traffic along Bradley Road, a rural highway that currently bisects the reservoir site, increases the ambient noise level. Cars, trucks, or tractors using this road likely increase the ambient noise level from 45 to about 65 dBA for cars and trucks and up to 96 dBA for tractors. Traffic leading to the existing homes also increases the ambient noise level. Aircraft flying in or out of Colorado Springs Airport, Peterson Air Force Base, and Butts Army Airfield in Fort Carson increase ambient noise levels, especially at the Jimmy Camp Creek Reservoir site, which is within the flight path for the Colorado Springs Airport. Traffic from U.S. 24, Colorado 94, and Marksheffel Road contribute to the ambient noise and vibration levels of the undeveloped grassland at the Upper Williams Creek Water Treatment Plant site. The ambient noise level of this area likely ranges from 30 to 55 dBA. Vibration is negligible at all sites.

3.19.4.2 Pipeline Corridors and Pump Stations

Pipeline corridors and associated pump station sites are in residential, industrial, or undeveloped rural areas, or within urban, rural, or highway transportation corridors. Existing vibration along the pipeline corridors and at proposed pump stations is negligible. The corridors for the Central Untreated Water Pipeline and the northern portion of the Western and Eastern Untreated Water Pipelines and associated pump stations are in mostly open rangeland with low ambient noise levels (30 to 45 dBA). Bellowing cattle, overhead military fighter jets practicing maneuvers, commercial and private aircraft, or existing traffic may be the principal existing noise factors in these areas. The southern portion of the Western Untreated Water Pipeline and associated pump station is in Lake Pueblo State Park and sparsely populated areas of Pueblo West, both of which currently have low ambient noise levels (30 to 55 dBA). The southern portion of the Eastern Untreated Water Pipeline and associated pump stations is in developed portions of the City of Pueblo. Ambient noise levels range from 60 to 65 dBA, and vibration from large vehicles is typical of urban areas.

The northern portion of the Highway 115 Return Flow Pipeline and associated pump stations is along existing roads and through suburban areas. The ambient noise level of these areas is between 35 and 65 dBA. The southern portion of the Highway 115 Return Flow and Untreated Water Pipelines and associated pump stations occurs in undeveloped land with low ambient noise levels (35 to 45 dBA). Traffic along the Colorado 115 corridor increases the ambient noise level up to 65 dBA. Noise from the occasional military jet flying overhead and from practice missions involving ammunitions increases ambient noise level substantially for the portion of the Highway 115 Alternative within Fort Carson Military Base. Vibration may be noticeable at times during military practice maneuvers or when large trucks are traveling on the highway. Treated water pipelines for Colorado Springs, Fountain, and Security would be constructed through mostly suburban areas along existing roadways with relatively high ambient noise levels (60 to 65 dBA). The Ark-Otero Untreated Water Pipeline parallels the Arkansas River and Colorado 24. Ambient noise is fairly low in this part of Chaffee County, but traffic on Colorado 24 increases noise levels to 65 dBA in some areas. Vibration is negligible in this area.

The Denver Basin Ground Water System area would be in a mostly developed area of Colorado Springs with ambient noise typical of urban areas. The Fountain No Action Well Field is in a rural area with relatively low ambient noise, with traffic noise being the principal noise contributor.

3.19.4.3 Chilcotte Ditch

The Chilcotte Ditch Return Flow Conveyance corridor is through undeveloped open space and rangeland as well as residential areas. These areas are characterized by negligible vibration and relatively low ambient noise levels. Commercial or military aircraft increase the ambient noise level during flyovers.

3.19.5 Environmental Consequences

3.19.5.1 Direct and Indirect Effects

Noise evaluation criteria are based on land use compatibility and on the direction and magnitude of noise level changes. Annoyance effects are typically the primary consideration. Often, the magnitude of a noise level change is as important as the resulting overall noise level. A noticeable increase in noise levels often is considered a substantive effect by local residents, even if the overall noise level remains within land use compatibility guidelines or complies with local ordinances. Conversely, changes in noise levels that are unnoticeable but still above land use compatibility guidelines or ordinance-specified levels are not considered significant by most people. Direct and indirect effects may include noise from construction equipment, increased traffic noise from project vicinity roadways, and noise from operation of pump stations and the treatment plant. The noise would be loudest near the point of generation and would decrease with increased distance from the source. Frequently, many of the complaints about construction noise involve standard backup alarms, which are used on heavy equipment as a safety device. Backup alarms would be audible up to 3.2 km (2 miles) from their source. Noise from construction equipment can be up to 90 dBA, which would be a moderate noise impact close to the activity. Vibration would be felt close to construction equipment. Construction of project components would be phased depending on need. Once all components are constructed, construction noise and associated vibration would cease. Noise levels and vibration during operations would be negligible.

3.19.5.2 Effects from No Action Alternative

The greatest noise effect from the No Action Alternative would be within residential areas where ambient noise levels are lower and noise level increases may be perceived as negative by a greater number of people. Schools, libraries, hospitals, churches, and residences within 500 feet of construction activities are more sensitive to increases in noise and vibration. In rural areas and undeveloped rangeland where ambient noise levels are also low, fewer people would perceive increased noise levels. Industrial areas and transportation corridors have a higher level of ambient noise level and additional noise would not be as negatively perceived as in residential and rural areas.

In the No Action Alternative, construction of the Denver Basin Ground Water System would result in short-term noise and vibration effects during construction. Construction of the treated water pipelines within Colorado Springs would be mostly along existing roads and would not create noise substantially higher than existing traffic noise. For easily excavated areas along the pipelines, construction of a typical mile could take 2 to 4 weeks and would result in moderate, short-term noise and vibration impacts during that period. For more difficult areas of excavation such as along the Highway 115 Untreated Water Pipeline corridor, blasting may be required and construction of a typical mile could take between 8 and 10 weeks. Moderate, short-term noise impacts could increase to 110 dBA as a result of blasting.

Construction of a reservoir would take about 3 years to complete. Noise and vibration would result from construction of the dam, excavation, and the rumbling and other associated noises from heavy machinery. Noise from construction of Jimmy Camp Creek Reservoir may be heard from residences that are within ½ mile, but the distance would be great enough that noise impacts would be minor to moderate for those residences. Because residences within the proposed reservoir footprint and within 1,000 feet of the proposed reservoir would not be occupied during construction, noise effects during construction would be negligible. Noise from construction of Williams Creek Reservoir would not be noticeable at the nearby landfill because of high existing ambient noise level at the landfill.

After reservoirs are constructed, recreational access would be allowed at Jimmy Camp Creek Reservoir. Increased vehicle traffic would increase noise from existing levels. Because the Jimmy Camp Creek reservoir is proposed as a city park, these noise increases would be typical of a recreational area.

The water treatment plant would require about 30 months to construct; a typical pump station would take an average of 25 months to construct. Construction of those facilities would increase the ambient noise levels and result in moderate impacts on noise and vibration. For pump stations, the outdoor air handling equipment would contribute to exterior noise levels; however, the noise generated would not exceed 50 dBA at the property boundary, which is the nighttime noise allowance within residential areas for both Colorado Springs and Pueblo. This would be a minor noise impact. Once the pipelines and facilities are constructed, no noticeable long-term noise and vibration effects are anticipated.

Because the Fountain, Security, and Pueblo West No Action alternatives would be within residential or undeveloped areas, the ambient noise levels would be relatively low, and new construction would result in a moderate, short-term noise increase.

3.19.5.3 Effects from Action Alternatives

During pipeline construction, noise and vibration effects for the Wetland and Arkansas River alternatives would be similar to the No Action. The Participants' Proposed Action, Fountain Creek, Downstream Intake, and Highway 115 alternatives would have fewer noise and vibration effects during construction because of the shorter length of pipe or fewer number of pump stations.

Blasting may be required on the Western Untreated Water Pipeline north of Pueblo Reservoir and along portions of the Highway 115 Return Flow and Untreated Water Pipeline. Blasting, which may be required for the No Action, Participants' Proposed Action, Wetland, Arkansas River, Fountain Creek, and Highway 115 alternatives, would substantially increase noise levels in those areas. The noise increases would be short term and cease after blasting.

The No Action, Participants' Proposed Action, Fountain Creek, Downstream Intake, and Highway 115 alternatives would require construction of two reservoirs versus one reservoir for the Wetland and the Arkansas River alternatives. Construction of two reservoirs would result in more short-term construction noise than alternatives with one reservoir. The greatest noise and vibration effect compared to the No Action Alternative would be at Upper Williams Creek Reservoir (Participants' Proposed Action and Wetland alternatives) where adjacent residences would be moderately affected by construction noise. Recreation noise associated with Jimmy Camp Creek Reservoir for the Arkansas River, Fountain Creek, Downstream Intake, and Highway 115 alternatives would be the same for the Action alternatives.

The No Action Alternative would have six proposed pump stations compared to the Action alternatives, which range from three to seven proposed pump stations. A greater number of pump stations would increase the short-term noise effects during construction for a greater number of people. After construction is completed, the noise effects from pump stations would be minor for all alternatives.

Some moderate noise and vibration impacts will be associated with improvements to the Chilcotte Ditch as part of the Participants' Proposed Action, Fountain Creek, Downstream Intake, and Highway 115 alternatives, impacts that would also occur with the No Action Alternative. The northeastern portion of the Chilcotte Ditch flows through Fountain Creek Regional Park, and noise and vibration impacts would be a moderate, short-term impact to park visitors during construction.

3.19.5.4 Cumulative Effects

Reasonably foreseeable activities are assessed for cumulative noise effects if they would occur within the SDS Project area or adjacent to the project area. For example, noise associated with I-25 improvements through Colorado Springs will be too far away to result in cumulative noise effects.

For the No Action Alternative, construction of residential development around Jimmy Camp Creek reservoir would moderately increase short-term cumulative noise levels during construction. Similar cumulative noise effects during construction would occur under the Arkansas River, Fountain Creek, Downstream Intake, and Highway 115 alternatives. Less residential development is likely to occur around the Upper Williams Creek Reservoir (under the Participants' Proposed Action and Wetland Alternative), resulting in less cumulative effect. Improvements to the Las Vegas Street Wastewater Treatment Facility would result in moderate, short-term cumulative noise effects for the Wetland and Arkansas River alternatives. No long-term cumulative effects would occur with the No Action Alternative or the Action alternatives.

3.19.5.5 Resource Commitments

All alternatives would require an irretrievable commitment of resources during construction when noise levels and vibration would be higher at sensitive receptor locations. The quiet and subdued character of rural and other non-urban areas would be irretrievably lost under construction noise. None of the alternatives would result in an irreversible commitment of resources.

3.19.5.6 Mitigation

Proposed Measures

Implementation of the following measures, some of which have been proposed by the Participants, would be required to obtain construction permits:

- Construction equipment used by contractors would function as designed and would conform to applicable noise emission standards
- Generally adhere to project work hour restrictions (7 a.m. to 7 p.m.) within 500 feet of residences, hospitals, schools, churches, and libraries
- Access to construction areas would be restricted so that the public could not be in close proximity to loud equipment or blasting
- Project operating equipment (e.g., pump stations) would be housed in structures designed to minimize radiated noise outside the structure, and would meet local noise ordinance requirements

Mitigated Effects

By following existing standards, restricting work hours and access to construction areas, and insulating new noise within structures, noise effects would be minimized by maintaining acceptable noise levels and limiting the number of people exposed to increased noise levels.

3.20 Visual Resources

Aesthetic and visual resources effects are being assessed because during scoping, these resources were identified to be an important concern. The indicator used for aesthetic and visual effects is qualitative changes in the visible character of potentially affected landscapes.

3.20.1 Summary of Effects

All alternatives would have some effect on visual resources. For all alternatives, new reservoirs and dams, intake structures, aboveground pump stations, well facilities, and overhead powerlines would be visible from some observation points (refer to Section 3.20.3 for observation point definition). Underground pipelines would be visible at blowoff sites, air and vacuum valve vaults, and isolation valve vaults, which would protrude slightly above ground level. In all alternatives, all disturbed areas would be revegetated to replace plant communities, and graded to reclaim landforms. The colors, textures, and shapes of disturbed areas, particularly linear features such as pipeline corridors, would be noticeably different from the surrounding area.

Moderate to major visual effects may occur in the No Action Alternative and the Highway 115 Alternative along Colorado 115 where three new pump stations and associated powerlines would be built. Pump Stations No. 1 and 2 may be visible from the Colorado 115 corridor; Pump Station No. 3 would not. In all alternatives, new or relocated powerlines would have a moderate effect at some observations points. In all alternatives except the Wetland Alternative and the Arkansas River Alternative, the Chilcotte Ditch would be lined to convey flows from Fountain Creek to the Williams Creek Reservoir. The concrete-lined channel would be in contrast with most of the adjacent landscape. Visual effects would be major through the Fountain Creek Regional Park, where the ditch is adjacent to a park trail. The Upper Williams Creek Treated Water Plant associated with the Participants' Proposed Action and Wetland alternatives would be a moderate to major effect on visual resources because of the multiple observation points and high visibility.

3.20.2 Regulatory Framework

The BLM has a visual resources evaluation system—the Visual Resource Management System (VRM)—for assessing impacts to visual resources. The VRM is applied to BLM management projects. Very limited areas of BLM land would be affected by the construction of project facilities in some alternatives. Additionally, no formal BLM recreation facilities would be affected by any of the alternatives. Consequently, the VRM was not used for the analysis area.

3.20.3 Analysis Area and Methods

The analysis area is an area surrounding proposed facilities in each alternative. The method used to determine potential effects on visual resources involved assessing the location of proposed facilities relative to views from observation points, and using professional judgment to estimate the resulting changes associated with each facility. Observation points are locations where facilities may be visible, such as residences, commercial businesses, roads, highways, and all types of recreation sites. Potential changes visible from observation points include increased visual contrast, any noticeable disruption or screening of existing views, and/or reduced opportunities to view scenic resources. Because the length of viewing time and manner of viewing determines the significance of visual resources, these aspects of the observation points also were considered. For example, views from observation points such as residences and businesses have long viewing times because the observer is stationary; conversely, views from roads and highways have relatively short viewing times because the observer typically is moving.

Effects were analyzed from observation points to determine potential visibility, distance from observers, extent of contrasts with subjects in the existing views, and the amount of potential contrasts created collaterally by vegetation removal, topographic changes, rock removal, and wetland impacts.

The thresholds to determine magnitude of effects for air quality were:

- Negligible – effects on visual resources would be within areas of noticeable existing disturbances or locations with very low or no visibility
- Minor – effects on visual resources would be within areas of some existing disturbances or locations with low visibility
- Moderate – effects on visual resources would be within areas of some few disturbances or locations with moderate visibility
- Major – effects on visual resources would be within areas of little or no existing disturbances with multiple observation points and high visibility

3.20.4 Affected Environment

Visual resources vary within the analysis area. Some facilities would be constructed in low mountainous regions with large rock outcrops and piñon-juniper forests, some facilities would be in urban and suburban areas, and other facilities would be in open prairies. The analysis area includes some high quality scenic locations based on the variety of visible landforms (mountains, mesas, and prairies), rock forms (red and tan-colored sandstone formations), and vegetation communities (piñon-juniper woodlands, sagebrush communities, and native shortgrass prairie). These features, called character regions, are the primary physical characteristics that determine a region's visual character. Three character regions—the high plains, foothills, and mountain valley—are found in the analysis area and are described in the sections below.

3.20.4.1 High Plains Character Region

The high plains character region is mostly east of the foothills between Colorado Springs and Pueblo West. Landforms are predominantly low-lying, long, subtle hills. The region is nearly void of visible rock outcrops and trees except along creeks and rivers. Vegetation is predominantly low-growing grasses, wildflowers, and cacti. This region contains numerous stream valleys, such as Fountain Creek, and many intermittent streams, with narrow, linear riparian areas composed of cottonwood and Russian olive trees, native willows, and saltcedars. The high plains character region also includes the urban and suburban areas of Colorado Springs, Widefield, Security, Fountain, Pueblo, Pueblo West, Penrose, and Florence.

The visual resources of the high plains character region are dominated by unobstructed views in any direction. Distant mountains are typically visible to the west, and large areas of the sky and changing weather conditions can be seen in all views. Views in this character region have only subtle variations in landform, color, and texture, except within or near the riparian corridors of creeks and rivers.

3.20.4.2 Foothills Character Region

The foothills character region includes the low mountains, shallow valleys, and shallow canyons of the Colorado 115 corridor. The region is characterized by piñon-juniper-covered foothills and low mountains. These landforms also are composed of highly visible, large rock outcrops and boulders on the ground surface.

About 2 miles northeast of Penrose, the Colorado 115 corridor passes through Salt Canyon, a shallow canyon with rock cliffs. The canyon is vegetated with piñon-juniper woodland except for the bare rock cliffs. Long distance views exist at both ends of the canyon. Views from the north end to the east are of the prairie, and from the south end to the south and west are of the Wet Mountains and the Arkansas River Valley. Views from the north end of the highway corridor also include the adjacent mountains and valleys. All views in this character region have appreciable variety in landforms, rock forms, color, and texture.

3.20.4.3 Mountain Valley Character Region

The mountain valley character region is along the Arkansas River and Colorado 24, north of the town of Buena Vista and near Clear Creek Reservoir. The region includes the Arkansas River with adjacent riparian vegetation, mostly ponderosa pine and Douglas-fir woodlands on rocky mountain slopes, and some open meadows on the valley floor. Water in the Arkansas River is visible for long distances to the north and south. Colors and textures vary greatly with the different landforms and changing vegetation communities.

3.20.5 Environmental Consequences

3.20.5.1 Direct and Indirect Effects

All alternatives would require construction of permanent project facilities such as reservoirs, a water treatment plant, pipelines, pump stations, and electric powerlines. Visual resources would change at all proposed facility locations. However, some facilities would be adjacent to, or within existing man-made facilities. Some facilities would be in locations with no observation points. These facilities would have no effect on visual resources. Impacts to visual resources would be similar for all alternatives, because proposed facilities are similar within all alternatives, including the No Action Alternative.

Some temporary construction impacts to visual resources would result from all the alternatives, except at facility locations with no observation points. These impacts would include the presence of construction vehicles and implements at all facility locations, some nighttime construction lighting, construction access roads, and fugitive airborne dust.

No Action Alternative

Constructed facilities would include Jimmy Camp Creek Reservoir, Williams Creek Reservoir, a water treatment plant, underground pipelines, aboveground pump stations, and relocated and new overhead powerlines. Three intake structures would be located on the Arkansas River, one near Florence, one north of Buena Vista, and one immediately downstream or Pueblo Reservoir dam. The No Action Alternative would have the largest pipeline length. Facilities in the No Action Alternative would be constructed in all three character regions.

Reservoirs and Water Treatment Plant

Jimmy Camp Creek Reservoir would be visible from residential and highway observation points. At least nine homes north and east of the reservoir would have views of the reservoir's surface water. These observation points would have additional visual resource variety of water form, color, and texture. A portion of the main dam's face would be visible from short segments of U.S. 24 and Colorado 94. Because these views would not be in line with the observer's direction of travel, the observation time would be relatively short from moving vehicles, and only a portion of the dam would be visible, which would result in a negligible or minor effect on visual resources.

A water treatment plant and associated untreated and treated water storage tanks would be constructed on a south-facing bench south of the Jimmy Camp Creek Reservoir and about 1 mile north of Colorado 94. Structure heights would be 20 to 40 feet above existing grade. These facilities would be visible from Colorado 94. The views would not be in line with the observer's direction of travel, and the observation time would be relatively short. The facilities would have a minor effect on visual resources.

Construction of Jimmy Camp Creek Reservoir would require relocation of three powerlines. The powerline structures would be large, steel-lattice structures. Residences east of the reservoir would have closer views of the overhead powerlines. The lines would be between the observers and the reservoir's water surface. Visual effects would be moderate.

Williams Creek Reservoir would not have any observation points. Changes to the visual resources would be non-existent.

Well Facilities

Ground water wells would be visible from some residential observation points in Colorado Springs, Fountain, and Security. Impacts to visual resources would be similar to existing well facilities in Colorado Springs. Visible existing well facilities include a metal well head less than 2 feet above the ground and about 2 feet in diameter, a flat aluminum cover at grade about 4 feet square covering an underground well facility, and a one-story building about 12 feet by 12 feet with a low-pitched roof, single door, and no windows.

Pipelines and Pump Stations

Installation of underground pipelines would include excavated trenches, which would be revegetated, and access roads. These disturbed areas would have a contrasting appearance to the adjacent undisturbed landscape due to changes in plant species, density, colors, and textures. Permanent maintenance roads adjacent to the pipeline alignments would be relatively narrow and unpaved. Most of the locations along the pipeline alignments would not have any observation points and, over time, the contrast would decrease. The visual resources effects would be negligible.

The proposed Reduced Northfield Booster Pump Station would be visible from U.S. 24, and two pump stations would be visible from Colorado 115. The visual effects of the Northfield Booster Pump Station would be minor. However, because the Highway 115 pump station and powerlines would be located in relatively undisturbed portions of the Salt Canyon, the visual effects would be moderate to major.

The proposed Ark-Otero Pump Station and intake would be visible to travelers on U.S. 24, boaters and anglers on the Arkansas River, and potentially to people on nearby BLM and National Forest System land. The pump station and intake would be located on an existing disturbed site. The site has some abandoned stone bridge support structures, concrete slabs at the river's edge, and a dirt road. Additionally the site is adjacent to an active railroad track with overhead utility lines. Effects to visual resources would be minor because of existing disturbances, and because travelers on U.S. 24 and boaters on the river would have very short time views of the proposed facilities. Other potential viewers would have partially obscured views from adjacent public lands and most locations along the river (anglers and gold panners).

In Florence, the intake structure would be located near an existing wastewater treatment plant and abandoned gravel pit. The only views of the intake structure site would be from a Colorado 115 bridge and perpendicular to the direction of travel. Based on intake structure location related to the observation points, a small number of observation points, and relatively short periods of viewing times, effects of the intake structure and return flow site would be negligible. An overhead powerline would be visible in Florence crossing the east end of Main Street (Colorado 115). However, due to the presence of other overhead utilities and an existing wastewater treatment plant at the location, effects would be negligible.

The intake structure below the Pueblo Reservoir dam would be highly visible from two roads and possibly a scenic overlook south of, and high above the dam. However, visual impacts would be negligible because the intake location includes the reservoir water discharge facilities such as large concrete structures, gravel parking areas, chain link fences, and a large open riprapped channel.

Return Flow Conveyances

The existing Chilcotte Ditch would be concrete lined for return flow conveyance. The Chilcotte Ditch is highly visible from some locations in Fountain, specifically a popular trail in the Fountain Creek Regional Park. This concrete-lined channel would be in contrast with most of the adjacent landscape. The contrast of the channel would be emphasized by long segments of straight alignment and concrete material unrelated to nearby Fountain Creek, and is adjacent to the park trail. Visual effects would be major through the Fountain Creek Regional Park.

Denver Basin Ground Water System

Observation points with visibility of wells and associated equipment of the Denver Basin Ground Water System north and east of Colorado Springs would be from homes, local streets, and small portions of U.S. 24 and Colorado 83. Effects from well locations near homes and local streets would be moderate due to close proximity of the facilities to the viewers, the potential visual contrasts of the facilities with nearby single-family houses and suburban streets, and the presence of overhead powerlines. Effects from wells visible from U.S. 24 also would be moderate for the same reasons. Effects from wells visible from Colorado 83 would be negligible due to the views not being aligned with the observer's direction of travel, having a relatively short observation time from moving vehicles, and the wells being mostly obscured by single-family houses, minimizing contrasts from a distance.

Fountain and Security Ground Water Systems

Observation points for Fountain's new wells would be along Old Pueblo Road. Effects from these wells would be negligible due to the views not being aligned with the observer's direction of travel, and having a relatively short observation time from moving vehicles. Potential effects of Fountain's expanded solar evaporation ponds can not be determined because the location has not been selected. Security would likely use existing well facilities. Visual effects would be non-existent.

Participants' Proposed Action

Constructed facilities would include the Upper Williams Creek Reservoir, Williams Creek Reservoir, Williams Creek Water Treatment Plant, underground pipelines, aboveground pump stations, and relocated and new powerlines. All facilities in the Participants' Proposed Action would be constructed within the high plains character region. The visual effects of the reservoir, Central Untreated Water Pipeline, pump stations, and treated water pipelines would be the same as the No Action Alternative. The Denver Basin Ground Water System would not be constructed, and the visual resources north of Colorado Springs would not be affected.

In the Participants' Proposed Action, the Upper Williams Creek Reservoir and Pump Station would have only one observation point from along a relocated segment of Bradley Road south of the reservoir. This view would be of the dam face and pump station only. No existing residences in the vicinity would have visibility of the reservoir, dam, or pump station because of topographic screening. Although these views would not be in line with an observer's direction of travel and the observation time is relatively short from moving vehicles, the effects would be minor to moderate due to visibility of the dam face and pump station, and not the reservoir's water surface.

The Upper Williams Creek Water Treatment Plant would be visible from about 50 homes north of the proposed plant site, and travelers on Marksheffel Road, and U.S. 24. Effects would be moderate to major. Moderate effects would be from travelers on the nearby roads and highway due to the visible presence of multiple existing roadways with relatively heavy vehicular traffic loads and traffic signals, existing fences and overhead utility lines, and short duration views. Major effects would be from homes north of the proposed plant site' north edge due to potentially long duration views of the proposed plant. Existing homes west of the proposed plant site, and the Space Village commercial area would not have any visibility of the water treatment plant due to topographic screening.

The Western Untreated Water Pipeline would parallel the existing Fountain Valley Conduit over most of its length. Visual effects would be negligible. Modifications to the Chilcotte Ditch would have major visual effects from the Fountain Creek Regional Park trail due to high visibility of the proposed concrete lined ditch adjacent to a substantial portion of the trail. The effects of the Williams Creek Return Flow Conveyance Pipeline would be the same as the No Action Alternative. Effects to visual resources in Pueblo West would be negligible due to the presence of the underground pipeline only. The overhead powerline would be visible from the recreational fishing area and local roads below and near the Pueblo Reservoir Dam. Multiple facilities are visible at this same location, and the overhead powerline would have few if any "skyline" observation points along the roads. Effects would be minor.

The effects of the Western and Central Untreated Water Pipelines would be non-existent to negligible. The effects would be non-existent for most of both pipelines because of the absence of observation points in much of the high plains character region. The effects would be negligible in suburban areas for reasons stated in the Pipelines and Pump Stations subsection above. The Western Untreated Water Intake, Juniper Pump Station, and Juniper Pump Station powerline (likely belowground) would be located near the Pueblo Reservoir spillway and the base of the dam. Views of the proposed Juniper Pump Station would include chain link fences, paved and unpaved roads, open meadows, the riprap face of the dam, large concrete reservoir spillway outlets, and some small buildings for operation of the dam. The presence of the water intake, pump station, and powerline (above ground or below ground) would not be in contrast with the surrounding landscape. Visual effects would be negligible.

Wetland Alternative

Constructed facilities would include the Upper Williams Creek Reservoir, water treatment plant, underground pipelines, aboveground pump stations, and relocated and new overhead powerlines. The effect of the Highway 115 Return Flow Pipeline would be similar to the Highway 115 Untreated Water Pipeline effects described for the No Action Alternative. In the Wetland Alternative, the effects of the Upper Williams Creek Reservoir, Pump Station, and Upper Williams Creek Water Treatment Plant would be the same as for the Participants' Proposed Action.

In the Wetland Alternative, overhead powerlines would be visible from Colorado 115 at two locations. The first location would be a 4-mile long portion of the highway from the Turkey Canyon Recreation Area entrance (Highway 115 Return Flow Pump Station 2) northeast to a Fort Carson housing complex. The line would be installed primarily on existing structures located near the south side of the highway between observers traveling in vehicles and views of forested foothills landforms. Some residences north of Colorado 115 would have similar views of the surrounding landscape and power lines. Effects would be negligible due to the presence of other existing overhead utilities.

The second location would be a portion of Colorado 115 from the north edge of the town of Penrose about 2 miles northeast to Pump Station 2 site. The lines would be located near the highway, mostly through dense piñon-juniper woodlands, and would cross the highway near the pump station. Observation points would include this segment of the highway and some residences north of the highway. The effects would be moderate due to the contrasts of a treeless corridor through the forest below the lines, and the "sky-lining" views of the lines from all observation points.

Arkansas River Alternative

Constructed facilities would include the Jimmy Camp Creek Reservoir, and Water Treatment Plant, underground pipelines, aboveground pump stations, and relocated and new overhead powerlines. The visual effects of the reservoir, Jimmy Camp Creek Water Treatment Plant, Central Untreated Water Pipeline, pump stations, and treated water pipelines would be the same as the No Action Alternative. This alternative would include a pipeline in close proximity to Colorado 115 between Colorado Springs and Florence. The effects of the Highway 115 Return Flow Pipeline and associated powerlines would be the same as for the Wetland Alternative and similar to the No Action Alternative (Highway 115 Untreated Water Pipeline).

One intake structure would be on the Arkansas River in Pueblo, and an untreated water pipeline would be east of Pueblo and Fountain Creek. Effects to visual resources in Pueblo would be minor due to the presence of an intake structure and overhead powerline located in an existing industrial area. Effects of the Eastern Untreated Water Pipeline and associated intake would be similar to the untreated water pipeline of the Participants' Proposed Action. The pipeline, however, would not follow an existing corridor, and the visual contrast would be greater. One of two Intermediate Pump Station powerlines would be wooden H-frame structures crossing over I-25 northeast of Pueblo West. Effects on observation points along a short distance of I-25 would be moderate due to the overhead powerlines crossing the highway near Pueblo West, and extending west about 4 miles, and east about 1 mile. The second Intermediate Pump Station powerline would be located south of the pump station and adjacent to the pipeline. Effects on observation points along I-25 would be negligible due to a relatively large distance between the highway and the powerline, views of the powerline perpendicular to both directions of travel, and partial screening of the powerline from the highway by trees along Fountain Creek.

Fountain Creek Alternative

Constructed facilities would include Jimmy Camp Creek Reservoir, Williams Creek Reservoir, a water treatment plant, underground pipelines, aboveground pump stations, and relocated and new overhead powerlines. In the Fountain Creek Alternative, the visual effects would be the same as the Participants' Proposed Action, except that the Eastern Return Flow Pipeline and the associated Fountain Creek Return Flow Site would replace the Williams Creek Return Flow Conveyance. The Eastern Return Flow Pipeline would have minor visual effects, the same as the Eastern Untreated Water Pipeline in the Arkansas River Alternative.

Downstream Intake Alternative

Constructed facilities would include the Jimmy Camp Creek Reservoir, Williams Creek Reservoir, water treatment plant, underground pipelines, aboveground pump stations, and relocated and new overhead powerlines. The effects of the reservoirs would be the same as the No Action Alternative.

One intake structure would be on the Arkansas River in an existing industrial area in Pueblo and the Chilcotte Ditch would be connected to Fountain Creek. Effects to visual resources of these facilities would be minor. The Eastern Untreated Water Pipeline would have the same effect as the Arkansas River Alternative. One of two Intermediate Pump Station powerlines would be wooden H-frame structures crossing over I-25 northeast of Pueblo West. Effects on observation points along a short distance of I-25 would be moderate due to the overhead powerlines crossing the highway near Pueblo West, and extending west about 4 miles, and east about 1 mile. The second Intermediate Pump Station powerline would be located south of the pump station and adjacent to the pipeline. Effects on observation points along I-25 would be negligible due to a relatively large distance between the highway and the powerline, views of the powerline perpendicular to both directions of travel, and partial screening of the powerline from the highway by trees along Fountain Creek.

Highway 115 Alternative

Constructed facilities would include the Jimmy Camp Creek Reservoir, Williams Creek Reservoir, underground pipelines, above-ground pump stations, and relocated and new overhead powerlines. The effects of the reservoirs, pump stations, powerlines, treated water conveyance, return flow conveyances, and most of the pipelines would be the same as the No Action Alternative.

3.20.5.2 Cumulative Effects

Cumulative effects for all alternatives would be similar. Future urban growth and development would alter the visual quality of the SDS Project area, particularly in the high plains character region. As urban growth and development occurs, the visual contrast of the SDS Project facilities would diminish. Future construction of the Eastern Plains Transmission Project would have minor cumulative effects with SDS Project facilities near it.

Residences and other suburban land development facilities, such as streets, street lighting, signage, and automobiles, would be located at the site of the proposed Jimmy Camp Creek Reservoir. In all other alternatives, the reservoir would provide views of a relatively large water body surrounded by some of the existing native landscape mostly of hills covered with trees and prairie grasses including some highly visible rock outcrops. Residential land development would significantly reduce the scenic quality of all areas with visibility of the proposed reservoir site.

3.20.5.3 Resource Commitments

Reservoirs, intake structures, pump stations, well facilities, and overhead powerlines would alter visual characteristics and would be an irreversible commitment of resources. Changes in visual resources from other facilities and the pipeline construction activities would be an irretrievable commitment of resources. Although all disturbed areas would be revegetated to replace plant communities and graded to repair landforms, the colors, textures, and shapes would be noticeably different.

3.20.5.4 Mitigation

Proposed Measures

The following proposed mitigation measures, some of which have been proposed by the Participants, would be implemented for potential permanent effects:

- Vegetate earthen dam faces with native herbaceous plants to match the adjacent undisturbed prairie plant communities
- Revegetate and/or landscape with plants, all disturbances associated with the construction of all facilities
- Restore as many existing grades as practicable following pipeline excavations
- Enclose pump stations and well equipment in structures matching the architectural characteristics of the surrounding structures
- Construct powerlines with non-specular (not shiny) wire, non-reflective and opaque insulators, and light-colored, non-reflective finished poles

The following proposed mitigation measures, some of which have bee proposed by the Participants, would be implemented for potential temporary effects during construction:

- Reclaim construction access roads and staging areas by restoring existing grade and revegetating the area of disturbance
- Apply water with standard construction practices to control airborne fugitive dust
- Install baffles on construction lighting fixtures to direct light onto the construction activity only in locations where safety is a concern, scenic

quality would be affected, or near occupied homes and businesses

Mitigated Effects

Restoring existing grades, revegetating disturbed areas, using architectural styles consistent with the area, and designing powerlines to have low visibility would minimize the visual contrast between the surrounding areas and would reduce the visibility of disturbance or new structures from observation points. Reducing airborne fugitive dust and construction lighting would reduce the area affected during construction.

3.21 Traffic

Traffic is being assessed because the alternatives would affect traffic through temporary closures of roadways for construction purposes or through increased traffic volume caused by construction equipment and construction or operations personnel. The indicators of traffic effects are increases in traffic volume and number of road closures.

Some tables and figures in this section use the following numbers to identify the alternatives:

- Alternative 1 (No Action Alternative)
- Alternative 2 (Participants' Proposed Action)
- Alternative 3 (Wetland Alternative)
- Alternative 4 (Arkansas River Alternative)
- Alternative 5 (Fountain Creek Alternative)
- Alternative 6 (Downstream Intake Alternative)
- Alternative 7 (Highway 115 Alternative)

3.21.1 Summary of Effects

Effects caused by construction would be short term, while effects of increased traffic volume from operations traffic would be long term. Effects on traffic volume due to operation of each alternative would be negligible. Effects on traffic volume due to construction of each alternative would range from less than 1 percent increase to 106 percent increase, dependent upon each roadway's existing traffic volume and estimated construction traffic. Roadways with the greatest increase in traffic volume due to construction are shown in Table 138. Figure 95 provides a comparison of the number of roads with at least a 5 percent increase in traffic volume due to construction.

The No Action Alternative would have the greatest number of roadways with a moderate to major increase in traffic volume. This is due to construction of the Denver Basin Ground Water System.

The No Action, Wetland, Arkansas River, and Highway 115 alternatives would have the most pipeline installed under roadways and would involve the most open-cut construction of pipeline crossings in roadways. These alternatives would cause more temporary traffic delays than the other alternatives. The Wetland, Arkansas River, and Highway 115 alternatives would use the Highway 115 Return Flow Pipeline alignments, which would involve extensive construction in roadways. The Denver Basin Ground Water System used in the No Action Alternative would involve extensive construction in roadways in northeastern Colorado Springs.

3.21.2 Regulatory Framework

There are no regulatory requirements that affect this resource.

3.21.3 Analysis Area and Methods

The analysis area includes the construction area for each alternative, as well as the surrounding area where traffic would likely access the SDS Project facilities.

The effect of the estimated increase in traffic volumes due to the project was calculated as the percent increase in traffic compared to the Average Daily Traffic (ADT). ADT counts were obtained from Colorado Department of Transportation (2004), El Paso County Department of Transportation (2006), City of Colorado Springs (2005), and City of Pueblo (2005). ADT ranges vary according to location. The maximum traffic increase from construction was compared to the lowest

Table 138. Estimated Increase in Traffic Volume due to Construction.

Access Road	Maximum Percent Change in Traffic Volume	Project Component
Bradley Road	12 to 30	Upper Williams Creek Reservoir (Alternatives 2 and 3)
Squirrel Creek Road	48 to 106	Williams Creek Reservoir (Alternatives 1, 2, 5, 6, 7)
Bradley Road	20 to 50	Upper Williams Creek Reservoir Water Treatment Plant (Alternative 3)
Squirrel Creek Road	4 to 80	Central Untreated Water Pipeline (All Alternatives)
Drennan Road	8 to 80	Central Untreated Water Pipeline (All Alternatives)
Old Pueblo Road	5 to 50	Eastern Untreated Water Pipeline, Eastern Return Flow Pipeline, Fountain Creek Alluvial Wellfield (Alternatives 4, 6)
Hanover Road	4 to 80	Eastern Untreated Water Pipeline, Eastern Return Flow Pipeline (Alternatives 4, 6)
Squirrel Creek Road	18 to 40	Williams Creek Pump Station (Alternatives 2, 3, 4, 5, 6)
Powers Boulevard	5 to 50	Williams Creek Return Flow Pipeline (Alternatives 1, 2, 5, 6, 7)

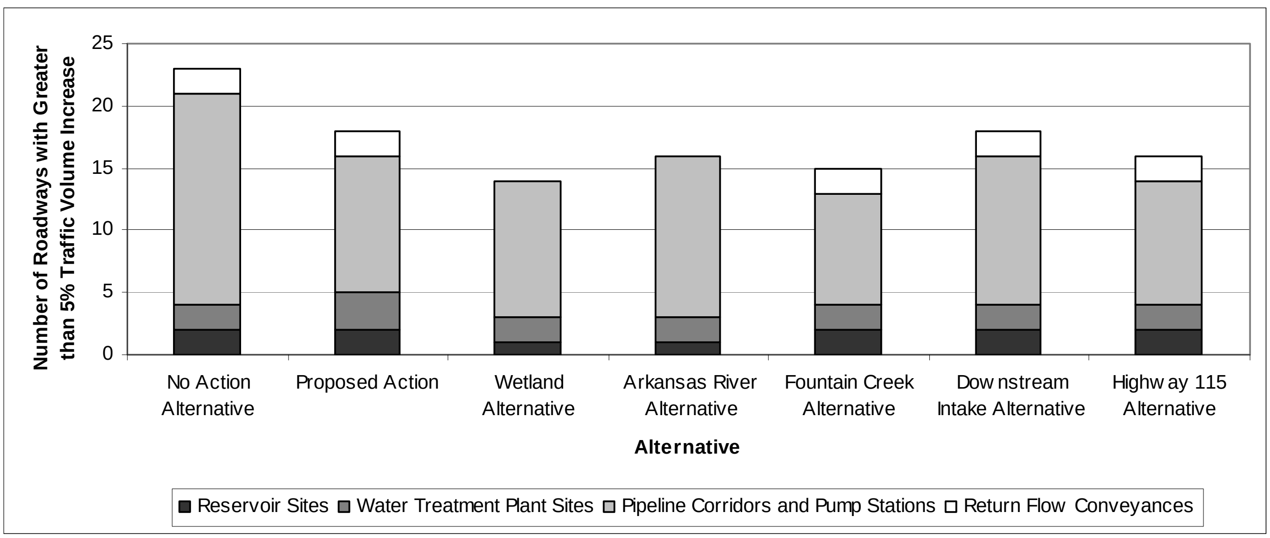


Figure 95. Number of Roadways with at Least 5 Percent Increase in Traffic Volume.

estimated existing ADT for major access roads for each project component.

Road closures caused by construction within the roadway were determined by looking at the amount of pipeline estimated to be installed under roadways. The number of roads affected by construction within the roadway was determined by comparing the proposed pipeline routes for each alternative to roadway data from the Colorado Department of Transportation (CDOT 2004). Pipelines that would cross only roadways may use trenchless technology rather than traditional open-cut methods. Trenchless technology would use an entrance and exit pit on either side of the crossing, and the pipeline would either be "pushed" or "pulled" through the ground under the roadway. This method is intended to eliminate traffic detours associated with traditional open-cut methods. The following types of crossings would likely use trenchless technology:

- Railroad crossings
- Interstates and U.S. highways
- State highways
- County highways and roadways
- Major roadways (arterials and collectors) in developed areas of any city
- Rivers and major streams

The number of roadways affected by open-cut construction was determined by comparing CDOT (2004) roadway data to the proposed pipeline routes to determine which roadways would use open-cut construction rather than trenchless technology. During final design, discussions with regulatory agencies will be required to establish the definite need for trenchless crossings.

Analysis methods are described in greater detail in a technical memorandum available in Reclamation's administrative record (MWH 2007e).

3.21.4 Affected Environment

Sections of pipeline corridors, reservoir and water treatment plant sites for each alternative would fall within road rights-of-way, intersecting roadways, Interstates, and railroad lines. Descriptions and figures of each alternative can be found in Chapter 2. Existing traffic volumes on roads are shown in tables in the Environmental Consequences section.

3.21.5 Environmental Consequences

3.21.5.1 Direct and Indirect Effects

All alternatives would increase traffic volumes on area roads and highways during construction and operations. During construction, temporary traffic delays and detours would be needed where facilities would require open-cut construction within existing roads, or where bridges would require reconstruction. Other roads may experience increased traffic from detours. The traffic disruption would be temporary and would cease on most roads after construction. Daily operations and maintenance traffic for all facilities would be less than 50 vehicles per day. This would have a negligible effect on local traffic. Traffic associated with each major project component is described in the following sections.

Water Treatment Plant Sites and Reservoir Sites

Each alternative includes a 50-mgd initial capacity water treatment plant, which would be expanded up to 109 mgd for demands through 2046, at the terminal storage location. Traffic effects would occur between 2009 and 2012 (initial construction) and again between 2021 and 2024 (expansion). For construction of the terminal storage reservoir, traffic effects would occur between 2015 and 2017. Up to 500 vehicles per day could enter each water treatment plant site, resulting in 1,000 trips per day, and 300 vehicles per day could enter each reservoir site, resulting in 600 trips per day (Table 139).

The Participants would expand Colorado 94 to accommodate construction traffic at the Jimmy Camp Creek Reservoir and water treatment plant site. A left-turn lane would be added to allow eastbound traffic turning left to access the water treatment plant. For westbound traffic, a deceleration lane would be added, along with an acceleration lane for traffic leaving the water treatment plant to merge with traffic on Colorado 94. Construction effects on traffic at Jimmy Camp Creek Reservoir and water treatment plant site would be minor to moderate.

Table 139. Existing and Anticipated Traffic on Major Access Roads to Reservoir and Water Treatment Plant Sites.

Project Component	Access Road	County	Existing Average Daily Traffic (ADT)	Estimated Daily Construction Trips	Maximum Percent Change in Traffic Volume
Reservoir Sites					
Jimmy Camp Creek Reservoir (Alternatives 1, 4, 5, 6, 7)	U.S. 24	El Paso	13,200	600	4
	Colorado 94	El Paso	12,000	600	4 to 5
Upper Williams Creek Reservoir (Alternatives 2 and 3)	Bradley Road	El Paso	2,000 to 5,000	600	12 to 30
Williams Creek Reservoir (Alternatives 1, 2, 5, 6, 7)	Squirrel Creek Road	El Paso	500 to 1,100	530	48 to 106
Water Treatment Plant Sites					
Jimmy Camp Creek Reservoir (Alternatives 1, 4, 5, 6, 7)	U.S. 24	El Paso	13,200	1,000	8
	Colorado 94	El Paso	12,000	1,000	8
Upper Williams Creek Reservoir (Alternatives 2 and 3)	U.S. 24	El Paso	13,200	1,000	8
	Colorado 94	El Paso	12,000	1,000	8
	Marksheffel Road	El Paso	6,000	1,000	17

Access road modifications similar to those at Jimmy Camp Creek Reservoir would be made to accommodate construction traffic to the Upper Williams Creek Reservoir site and water treatment plant, and Williams Creek Reservoir site. Currently, Bradley Road lies in the Upper Williams Creek Reservoir site.

In the Participants' Proposed Action and Wetland alternatives, Bradley Road would be realigned to the south of Upper Williams Creek Reservoir. Bradley Road was extended to its current location in 1999 using Defense Access Road funding. The road provides greater mobility for commuter traffic for employees at Schriever and Peterson Air Force Bases as well as specific defense purposes. The road currently has a posted speed limit of 65 mph. The new roadway alignment would be about 2 miles longer than the current alignment, resulting in slightly longer travel times. The realigned road would be designed and constructed in compliance with standards for Defense Access Roads (23 CFR 660.513) and approved in conjunction with the appropriate governing agency.

Construction of Williams Creek Reservoir would occur between 2021 and 2024. Construction of Upper Williams Creek Reservoir and water treatment plant would be the same as Jimmy Camp Creek Reservoir.

Construction effects on traffic at Upper Williams Creek and Williams Creek reservoirs and water treatment plant sites would be major, with traffic increases of 20 percent to 106 percent.

Conveyance Corridors and Pump Stations

The Participants would employ trenchless technology for many pipeline crossings. Trenchless construction methods would cause little or no disruption to traffic and would have negligible, short-term effects. Any roadway with a pipeline aligned longitudinally beneath it would use open-cut construction.

Open-cut construction of pipelines would require a trench to be dug along the length of the pipeline. The pipeline would then be laid in the trench and backfilled to pre-existing conditions. Roadways that would be open cut would need to be closed to traffic and pedestrians, and a detour route would be required during construction.

Up to 200 vehicles per day (400 one-way trips) would be needed during construction of water pipelines and pump stations (Table 140 and Table 141). Traffic effects would be short term because construction of each pipeline mile is expected to last between 2 and 10 weeks. Construction contractors would be required to develop traffic control plans for any construction within a roadway; traffic control plans would be subject to approval by the transportation agency responsible for the affected roadway. Consequently, short-term effects to traffic in local roadways during construction primarily would be minor to moderate.

Figure 96 shows the length of pipeline that would be installed under roadways. These installations would use open-cut construction methods. Major roadways include highways and arterials, which carry much of the traffic circulating in an urban area, and collectors, which collect and distribute traffic to and from highway and arterial systems.

The No Action, Wetland, Arkansas River, and Highway 115 alternatives would have the most pipeline installed under roadways and roadways affected by open-cut construction (Figure 97). The Wetland, Arkansas River, and Highway 115 alternatives would use the Highway 115 Return Flow pipeline alignments, which involve extensive construction in roadways. Construction of the Denver Basin Ground Water System for the No Action Alternative in northeastern Colorado Springs would contribute to many of the required open cuts in this alternative.

Construction vehicles using bridges would be limited to posted load limits, or bridges would be reconstructed per local governing agency standards when necessary to improve load limits. The construction contractor would determine access points to the pipeline corridor.

Construction effects on traffic near each pump station and intake would last about 2 years. Operation of each pump station would have a negligible long-term effect to traffic volume, because each pump station would be monitored remotely, inspected daily, and repaired as needed. Electricity would be supplied to each pump station via overhead electric lines. Construction of the Intermediate Pump Station power lines would require short-term lane closures of I-25. Lane closures of I-25 would require a CDOT permit and, therefore, in accordance with CDOT standards to minimize effects. These effects would be minor, and other power line construction would have negligible effects to traffic from construction access.

Table 140. Existing and Anticipated Traffic on Major Access Roads to Pipeline Corridors and Pump Stations.

Project Component	Alter-native(s)	Access Road	County	Existing Average Daily Traffic (ADT)	Estimated Daily Construction Trips	Maximum Percent Change in Traffic
Highway 115 Untreated Water Pipeline	1, 7	Colorado 115	Fremont, El Paso	7,700 to 21,500	40 to 400	< 1 to 5
Denver Basin Ground Water System	1	Voyager Parkway	El Paso	7,900	40 to 400	< 1 to 5
	1	Powers Boulevard	El Paso	7,800	40 to 400	< 1 to 5
	1	Woodmen Road	El Paso	8,000	40 to 400	< 1 to 5
	1	Briargate Parkway	El Paso	5,300	40 to 400	< 1 to 8
	1	Lexington Drive	El Paso	6,000 to 8,000	40 to 400	< 1 to 7
	1	Research Parkway	El Paso	11,300 to 14,700	40 to 400	< 1 to 4
	1	Union Boulevard	El Paso	4,600 to 12,600	40 to 400	< 1 to 3
	1	Black Forest Road	El Paso	6,500	40 to 400	< 1 to 6
	1	U.S. 24	El Paso	13,200	40 to 400	< 1 to 3
Central Untreated Water Pipeline	All	Squirrel Creek Road	El Paso	500 to 1,100	40 to 400	4 to 80
	All	Powers Boulevard	El Paso	8,100	40 to 400	< 1 to 5
	All	Bradley Road	El Paso	2,000 to 6,200	40 to 400	< 1 to 20
	All	Drennan Road	El Paso	500	40 to 400	8 to 80
	All	Colorado 94	El Paso	12,000	40 to 400	< 1 to 3
	2, 3	Space Village Avenue	El Paso	2,700	40 to 400	1 to 15
Western Untreated Water Pipeline	2, 3, 5	U.S. 50	Pueblo	40,300	40 to 400	< 1 to 1
	2, 3, 5	Purcell Boulevard	Pueblo	Not Available	40 to 400	—

Project Component	Alter-native(s)	Access Road	County	Existing Average Daily Traffic (ADT)	Estimated Daily Construction Trips	Maximum Percent Change in Traffic
	2, 3, 5	Platteville Boulevard	Pueblo	Not Available	40 to 400	—
Eastern Untreated Water Pipeline	4, 6	Old Pueblo Road	El Paso	800	40 to 400	5 to 50
	4, 6	Hanover Road	El Paso	500 to 1,100	40 to 400	4 to 80
	4, 6	Overton Road	Pueblo	Not Available	40 to 400	—
	4, 6	Colorado 47	Pueblo	10,900	40 to 400	< 1 to 4
	4, 6	Colorado 227	Pueblo	4,800	40 to 400	< 1 to 8
	4, 6	Portland Avenue	Pueblo	Not Available	40 to 400	—
Highway 115 Return Flow Pipeline	3, 4	Cheyenne Road	El Paso	7,500	40 to 400	< 1 to 5
	3, 4	Venetucci Boulevard	El Paso	7,000 to 10,800	40 to 400	< 1 to 6
	3, 4	Cheyenne Meadows Road	El Paso	6,400 to 8,500	40 to 400	< 1 to 6
	3, 4	West Meadow Drive	El Paso	3,600	40 to 400	1 to 11
	3, 4	Colorado 115	Fremont, El Paso	7,700 to 21,500	40 to 400	< 1 to 5
Fountain Creek Alluvial Wellfield	1	Old Pueblo Road	El Paso	800	40 to 400	5 to 50
Colorado Springs Treated Water Pipeline	1, 4, 5, 6, 7	U.S. 24	El Paso	13,200	40 to 400	< 1 to 3
	1, 4, 5, 6, 7	Colorado 94	El Paso	12,000	40 to 400	< 1 to 3
	All	Marksheffel Road	El Paso	7,000	40 to 400	< 1 to 6
	All	Constitution Avenue	El Paso	9,700 to 15,500	40 to 400	< 1 to 4
	1, 4, 5, 6, 7	Space Village Avenue	El Paso	2,700	40 to 400	1 to 15

Project Component	Alter-native(s)	Access Road	County	Existing Average Daily Traffic (ADT)	Estimated Daily Construction Trips	Maximum Percent Change in Traffic
Security Treated Water Pipeline	2, 3, 4, 5, 6, 7	Drennan Road	El Paso	19,000	40 to 400	< 1 to 2
Ark-Otero Facilities	1, 7	U.S. 24	Chaffee	3,400	200	6
Western Untreated Water Intake (Pueblo Reservoir)	2, 3, 5	Pueblo Reservoir Road	Pueblo	Not Available	200	—
	2, 3, 5	Colorado 96	Pueblo	3,100	200	6
Pump Stations at the Arkansas River, upstream and downstream of Fountain Creek	4, 6	Colorado 227	Pueblo	4,800	200	4
Intermediate Pump Station	4, 6	Overton Road	Pueblo	Not Available	200	—
Williams Creek Pump Station	2, 3, 4, 5, 6	Squirrel Creek Road	El Paso	500 to 1,100	200	18 to 40
Drennan Pump Station	4, 5, 6	Drennan Road	El Paso	1600	200	13
	4, 5, 6	Bradley Road	El Paso	2,000 to 5,000	200	4 to 10
Upper Williams Creek Pump Station	2, 3	Bradley Road	El Paso	2,000 to 5,000	200	4 to 10
Highway 115 Pump Station Nos. 1 and 2, Highway 115 Untreated Water Intake	1, 7	Colorado 115	Fremont, El Paso	7,700 to 21,500	200	< 1 to 3
Highway 115 Pump Station No. 2	1, 7	3rd Street	Fremont	Not Available	200	—
	1, 7	Fremont County Road 42	Fremont	Not Available	200	—
Reduced Northfield Booster Pump Station	All	US 24	El Paso	13,200	200	2
	All	Colorado 94	El Paso	12,000	200	2
FVA Connector Pump Station	1, 7	Interstate 25	El Paso	34,000	200	0.6

Project Component	Alter-native(s)	Access Road	County	Existing Average Daily Traffic (ADT)	Estimated Daily Construction Trips	Maximum Percent Change in Traffic
	1, 7	Clear Spring Ranch Service Road	El Paso	Not Available	200	—

Table 141. Existing and Anticipated Traffic on Major Access Roads to Return Flow Conveyances.

Project Component	Alter-native(s)	Access Road	County	Existing Average Daily Traffic (ADT)	Estimated Daily Construction Trips	Maximum Percent Change in Traffic
Chilcotte Ditch Return Flow Conveyance	1, 2, 5, 6, 7	U.S. 85	El Paso	9,700	40	< 1
	1, 2, 5, 6, 7	Link Road	El Paso	2,600	40	2
Highway 115 Return Flow Conveyance – See Highway 115 Untreated Water Conveyance (Table 140)	3, 4	—	—	—	—	—
Eastern Return Flow Pipeline – See Eastern Untreated Water Conveyance (Table 140)	5	—	—	—	—	—
Williams Creek Return Flow Pipeline	1, 2, 6, 7	Powers Boulevard	El Paso	800	40 to 400	5 to 50
Highway 115 Return Flow Pump Station No. 2	3, 4	Colorado 115	El Paso	7,700 to 21,500	200	< 1 to 3
Highway 115 Return Flow Pump Station No. 1	3, 4	East Las Vegas Street	El Paso	5,000 to 6,400	200	3 to 4

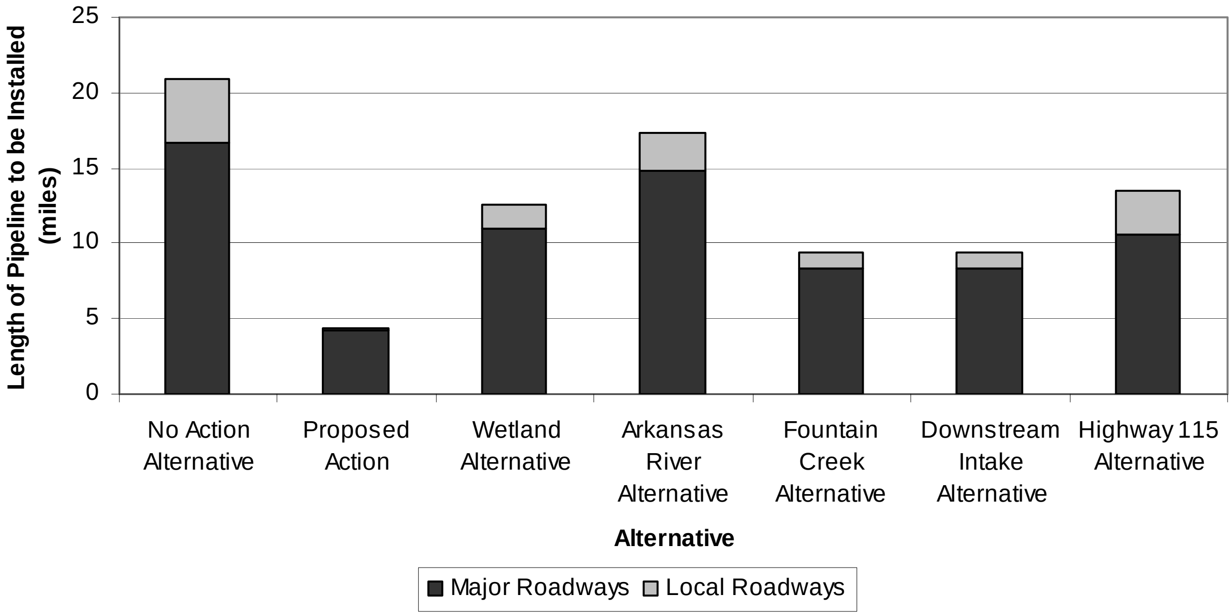
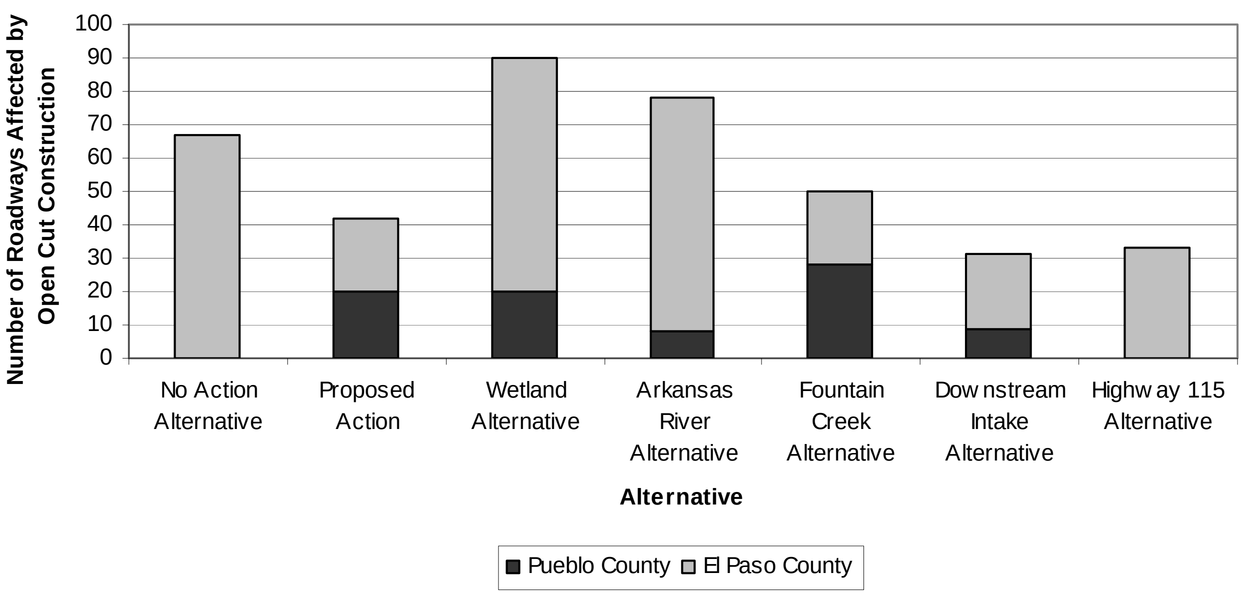


Figure 96. Length of Pipeline to be Installed Under Roadways.



Note: Roadways in Fremont and Chaffee counties are not expected to be affected by open-cut construction.

Figure 97. Number of Roadways Affected by Open-Cut Construction.

3.21.5.2 Cumulative Effects

The Pikes Peak Area Council of Governments, Pueblo Area Council of Governments and Central Front Range Regional Planning Commission have each prepared regional transportation plans through 2030 (PPACG 2004a; PACOG 2004; Central Front Range Regional Planning Commission 2004). Projects identified through these studies would be subject to separate NEPA analysis. Reasonably foreseeable activities that would contribute to cumulative effects include urban and suburban development, improvements to I-25 through Colorado Springs and Pueblo, replacement of the 4th Street Bridge over the Arkansas River in Pueblo, and the South Metro Accessibility Project (Section 3.12.3). Long-term traffic effects of the project would include increased traffic volume from operations and maintenance personnel. Because the increased traffic volume would be small, cumulative effects would be negligible. Growth would result in increased traffic that would reduce the relative impact of construction for project components that are anticipated after 2020.

3.21.5.3 Resource Commitments

Irreversible commitments of resources would be use of fossil fuels due to traffic congestion and detours during construction. These losses are expected to be negligible to moderate because effects on traffic congestion and number of detours as discussed in Section 3.21.5.1 are primarily negligible to moderate.

3.21.5.4 Mitigation

Proposed Measures

Compliance with the following recommendations would be required to obtain construction permits.

- Use trenchless construction when construction features cross railroad lines, state highways, county roadways in densely populated areas, and major city roadways in densely populated areas.
- Prepare traffic control plans for approval by state and local traffic authorities and followed by contractors during construction
- Construct traffic signage, signals, acceleration, and deceleration lanes as directed by state and local traffic authorities for access to reservoir sites, treatment plants, and pump stations
- Construct improvements to existing access roads or construction of temporary alternate access roads to reservoir sites, treatment plants, and pump stations as directed by state and local traffic officials
- Modify or reconstruct bridges when the load limits are not adequate and other access routes are not reasonable

Mitigated Effects

When implemented, these recommendations would mitigate potential adverse effects on traffic by minimizing delays and promoting traffic safety.

3.22 Geology and Paleontology

During the SDS Project scoping process, concerns about the impact of the project on existing and potential geologic and paleontological resources, including oil and natural gas, coal, minerals, construction materials, and fossil remains, were identified. In addition, concerns about the potential effects of geologic hazards on the proposed project, including landslides, faults and folds, corrosive soils, shallow bedrock, expansive soils and bedrock, seismicity, and soil stability were identified.

3.22.1 Summary of Effects

None of the alternatives would likely have any effect on existing or potential oil and natural gas, coal or mineral resources. Proposed project facilities in areas with major sand and gravel deposits, such as along the Arkansas River and Fountain Creek, would limit the future use of these resources.

Proposed project facilities in the Jimmy Camp Creek area in all alternatives would have the potential to encounter important paleontological resources such as fossil plants, invertebrates, and mammals. Important paleontological resources would be adversely affected by Jimmy Camp Creek Reservoir inundation in all alternatives except the Participants' Proposed Action and the Wetland Alternative. The Participants' Proposed Action and the Wetland alternatives would have the least effect on important paleontological resources because facilities would not be constructed in the Jimmy Camp Creek drainage. A proposed mitigation plan (Section 3.22.5.4) would identify and recover or preserve in place these resources if they were affected.

Geologic hazards with the potential to affect the proposed project facilities include landslides, corrosive soils, shallow bedrock, expansive soils and bedrock, faults and folds, seismicity and soil stability. A greater proportion of the pipeline corridors in the Wetland Alternative and the Arkansas River Alternative and a smaller proportion in the Participants' Proposed Action, the Downstream Intake and Highway 115 alternatives would be subject to geologic hazards relative to the other alternatives. Standard engineering practices would minimize the effects of geologic hazards on project facilities.

3.22.2 Regulatory Framework

Fossils are classified as nonrenewable scientific resources and are protected by various laws, ordinances, regulations, and standards across the country. Professional standards for the assessment and mitigation of adverse impacts to paleontological resources have been established by the Society of Vertebrate Paleontology (1995). The Colorado Historical, Prehistorical, and Archaeological Resources Act of 1973 (CRS 24-80-401 to 411, and 24-80-1301 to 1305) defines permitting requirements and procedures for the collection of prehistoric resources, including paleontological resources, on state lands, and actions that should be taken in the event that resources are discovered in the course of state-funded projects and on state-owned/administered lands.

3.22.3 Analysis Area and Methods

The potential for geologic and paleontological resources and geologic hazards was analyzed for all areas where project facilities are proposed. The method of analysis used to determine potential impacts on geologic and paleontological resources and the effects of geologic hazards on the project was to review existing geologic maps and other published materials. Important paleontological resources were based on publicly available reports, such as Madole and Thorson (2003). A paleontological assessment of Quaternary deposits in the Jimmy Creek Camp area was also completed (Rocky Mountain Paleontology 2005). This assessment focused on Quaternary deposits in the Jimmy Creek Camp area and did not include the Dawson formation. In addition, the physical characteristics of the surficial and bedrock geology of much of the project area were identified by geotechnical studies in strategic locations. The geotechnical studies involved the installation of boreholes and a visual examination of subsurface materials.

3.22.4 Affected Environment

3.22.4.1 Regional Geology

The analysis area is located along the eastern side of the Southern Rocky Mountains in a region known as the Colorado Piedmont. The Piedmont lies between the foothills of the Front Range to the west and the High Plains to the east and runs generally from Fort Collins in the north to Pueblo in the south. The region was formed about 28 million years ago during a regional uplift, or bowing, of the North American Plate, which caused increased streamflow and rapid erosion on the eastern side of the Rocky Mountains. Erosion removed much of the bedrock that still forms the top layer of the High Plains, exposing older rocks and forming a broad valley that is lower in elevation than the surrounding land (Chronic 1980).

The eastern portion of the analysis area consists of relatively flat-lying, structurally undisturbed sequences of sedimentary rocks of Cretaceous through Tertiary age, predominantly Pierre Shale in the south and sandstones and claystone of the Dawson Formation in the north (Tweto 1979). Much of the bedrock is overlain by Quaternary (recent) deposits of alluvial sand and gravel, wind-blown eolian sand and loess, and residual soils weathered from the underlying bedrock (Moore et al. 2002).

The western portion of the analysis area along the base of the foothills is a sequence of gently to steeply dipping sedimentary rocks of Pennsylvanian through Cretaceous age that were upturned during the most recent mountain-building event in the Rockies (Tweto 1979; Rowley et al. 2003). Differential erosion of the upturned rock groups has formed prominent narrow ridges, or hogbacks, and parallel valleys. In the valley bottoms, Quaternary deposits of alluvial sand and gravel and colluvium (sediment at the bottom of slopes transported by gravity) have accumulated on top of the bedrock (Moore et al. 2002).

Along the Arkansas River in the southern portion of the analysis area, the bedrock geology consists of structurally undisturbed sequences of marine-deposited sedimentary rocks of Cretaceous age, predominantly the Niobrara Formation (limestone and calcareous shale), but also including the Carlile and Graneros Shales and the Greenhorn Limestone (Scott 1964; Tweto 1979; Beach 1983; GEI 2005c). Much of the bedrock is overlain by Quaternary deposits of alluvial sand and gravel and residual soils weathered from the underlying bedrock (Moore et al. 2002).

The Ark-Otero Untreated Water Intake, Pump Station and Untreated Water Pipeline in Chaffee County are located on alluvial and colluvial deposits overlying granitic rocks of Precambrian age (Tweto 1979).

3.22.4.2 Reservoir and Water Treatment Plant Sites

The three reservoir sites and two water treatment plant sites are located in the northeastern portion of the analysis area. The Jimmy Camp Creek Reservoir and Water Treatment Plant sites are within the Upper Cretaceous/Lower Tertiary age Dawson Formation, which is composed of sandstones, conglomerates, siltstones and claystones formed of the eroded outwash materials transported from the mountains to the west (Madole and Thorson 2003). These rocks are often exposed as resistant ledges on the upper portions of the Jimmy Camp Creek valley and are overlain by deposits of locally derived alluvial and wind-blown silts, sands, and gravels on the valley floor (GEI 2005a). The Upper Williams Creek Water Treatment Plant site is about 2 miles west of the Jimmy Camp Creek Water Treatment Plant site within Quaternary eolian sands that may be underlain by rocks of the Dawson Formation. The Upper Williams Creek Reservoir site is located primarily within the Cretaceous age Fox Hills Sandstone, which is composed of marine-deposited interbedded sandstone and shale (Soister 1968). The sandstone layers are often exposed as thin resistant layers capping bluffs of softer shale layers. The Williams Creek Reservoir site is located within the Cretaceous-age Pierre Shale, which is composed of marine-deposited gray shale interbedded with thin layers of sandstone and bentonite (GEI 2005b). The Pierre Shale weathers into rounded soil-covered slopes and is not well exposed at the reservoir site.

3.22.4.3 Pipeline Corridors/Pump Stations/ Return Flow Conveyances

The Denver Basin Ground Water System, the Colorado Springs Treated Water Pipeline, and the Reduced Northfield Booster Pump Station are located in areas with alluvial sand and gravel deposits underlain by the Dawson Formation. The Fountain No Action Well Fields are located in areas with alluvial sand and gravel deposits underlain by Pierre Shale. The Central Untreated Water Pipeline is located in areas underlain primarily by the Dawson Formation in the northern portions and the Pierre Shale in the southern portions. The Fountain and Security Treated Water Pipelines and the Chilcotte Ditch and Williams Creek Return Flow Conveyance corridors are located in areas underlain by Pierre Shale. The Eastern and Western Untreated Water Pipelines cross through areas underlain by Pierre Shale in the northern portions and primarily interbedded shale, limestone and sandstone of the Niobrara Formation in the southern portions. The Untreated Water and Return Flow Conveyances in the Highway 115 pipeline corridor cross through the upturned sedimentary rock sequences draping the foothills in the northern portion and relatively flat-lying rocks of the Niobrara Formation in the southern portion. The Ark-Otero Untreated Water Intake, Pump Station, and Untreated Water Pipeline in Chaffee County are underlain by granitic rocks of the Precambrian Age. Substantial deposits of sand and gravel are found along portions of the pipeline corridors and conveyances, especially near the Arkansas River and Fountain Creek (Moore et al. 2002).

3.22.4.4 Paleontology

Portions of the analysis area for all alternatives are underlain by sedimentary rocks that potentially contain various types of paleontological resources. The Dawson Formation, which is exposed at the Jimmy Camp Creek Reservoir and proposed water treatment plant sites, contains the boundary between the Cretaceous and Tertiary periods. Proposed pipeline routes near Jimmy Camp Creek also would cross the Dawson Formation. A thin, rock layer called the "K-T boundary" separates the Cretaceous (age of dinosaurs) and the Tertiary (age of mammals) periods. This interval is often characterized by a ½-inch thick layer of debris that is the fallout from a massive comet or asteroid impact event in Mexico. Material resulting from the impact covered Earth with a mantle of dust and probably caused the extinction of the dinosaurs and their world. The approximate location of the K-T boundary is about ½ mile southwest of the Jimmy Camp Creek dam site (Madole and Thorson 2003). Dinosaur bones and fossilized leaves of the late Cretaceous age have been found near the dam site and the Jimmy Camp Creek treated water pipelines (Madole and Thorson 2003). The Jimmy Camp Creek Reservoir site has a high potential to contain important paleontological resources.

A paleontological assessment of Quaternary deposits in the Jimmy Creek Camp area identified three sites with important paleontological resources (Rocky Mountain Paleontology 2005). The three sites contained bison or unknown mammalian bone likely deposited during the early Holocene Epoch (older than 5,000 years).

The other two reservoir sites, Williams Creek and Upper Williams Creek, are underlain by either recent alluvium, or the Pierre Shale or Fox Hills Sandstone. Both the Pierre Shale and Fox Hills Sandstone have marine fossils, such as ammonites, in some beds. Pierre Shale is the dominant geologic formation that would be crossed by the Eastern and Western Pipeline Alignments and the Return Flow Conveyance corridors. Various marine invertebrate fossils, such as ammonites and baculites, are found at Baculite Mesa, about 2 miles east of the Eastern Alignment. The Williams Creek and Upper Williams Creek reservoir sites have a low potential to contain important paleontological resources.

The Highway 115 pipeline corridor crosses older rocks, such as the Fountain and Dakota Formations, in the northern portion, and younger rocks, such as the Niobrara Formation and the Pierre Shale, in the southern portion. The formations crossed by the Highway 115 pipeline corridor have marine fossils in some locations. The Highway 115 pipeline corridor also crosses small areas of the Morrison Formation, which has a high potential for important paleontological resources. The pipeline and powerline corridors and the pump station sites have a low potential to contain important paleontological resources.

The Ark-Otero Untreated Water Intake, Pump Station, and Untreated Water Pipeline in Chaffee County are located on alluvial and colluvial deposits that have a low potential to contain important paleontological resources.

3.22.5 Environmental Consequences

3.22.5.1 Direct and Indirect Effects

Mineral Resources

None of the proposed alternatives cross areas known to contain oil, natural gas, or metallic mineral resources. Coal has historically been mined in the Cretaceous age Laramie Formation exposed in the Colorado Springs area, including near the Jimmy Camp Creek Reservoir site. Compared to modern coal mines on Colorado's Western Slope and in Wyoming, the coal beds in this area are too thin and discontinuous to be mined economically (Keller et al. 2003). The only mineral resources that would be potentially affected by the proposed alternatives are non-metallic industrial minerals such as clay and gypsum, and construction materials such as sand, gravel, and stone (Keller et al. 2000, 2002a, 2002b, 2003). Soils derived from marine deposited sedimentary rocks of

Cretaceous age can contain elevated concentrations of selenium.

Deposits of fire clay and ordinary brick clay are mined near several alignments of the proposed alternatives, including in the Cretaceous age sediments exposed along hogback ridges in the Highway 115 pipeline corridor and in the Pierre Shale near Pueblo. Gypsum is currently being mined in Jurassic age rocks near Table Mountain west of the Highway 115 pipeline corridor.

All alternatives would cross areas with currently mined or potential sand and gravel deposits. Sand and gravel deposits are most abundant in the two major drainages, the Arkansas River and Fountain Creek, as well as in the northern portion of the analysis area where the Denver Basin Ground Water System and the Jimmy Camp Creek Reservoir site would be located (Schwochow et al. 2000).

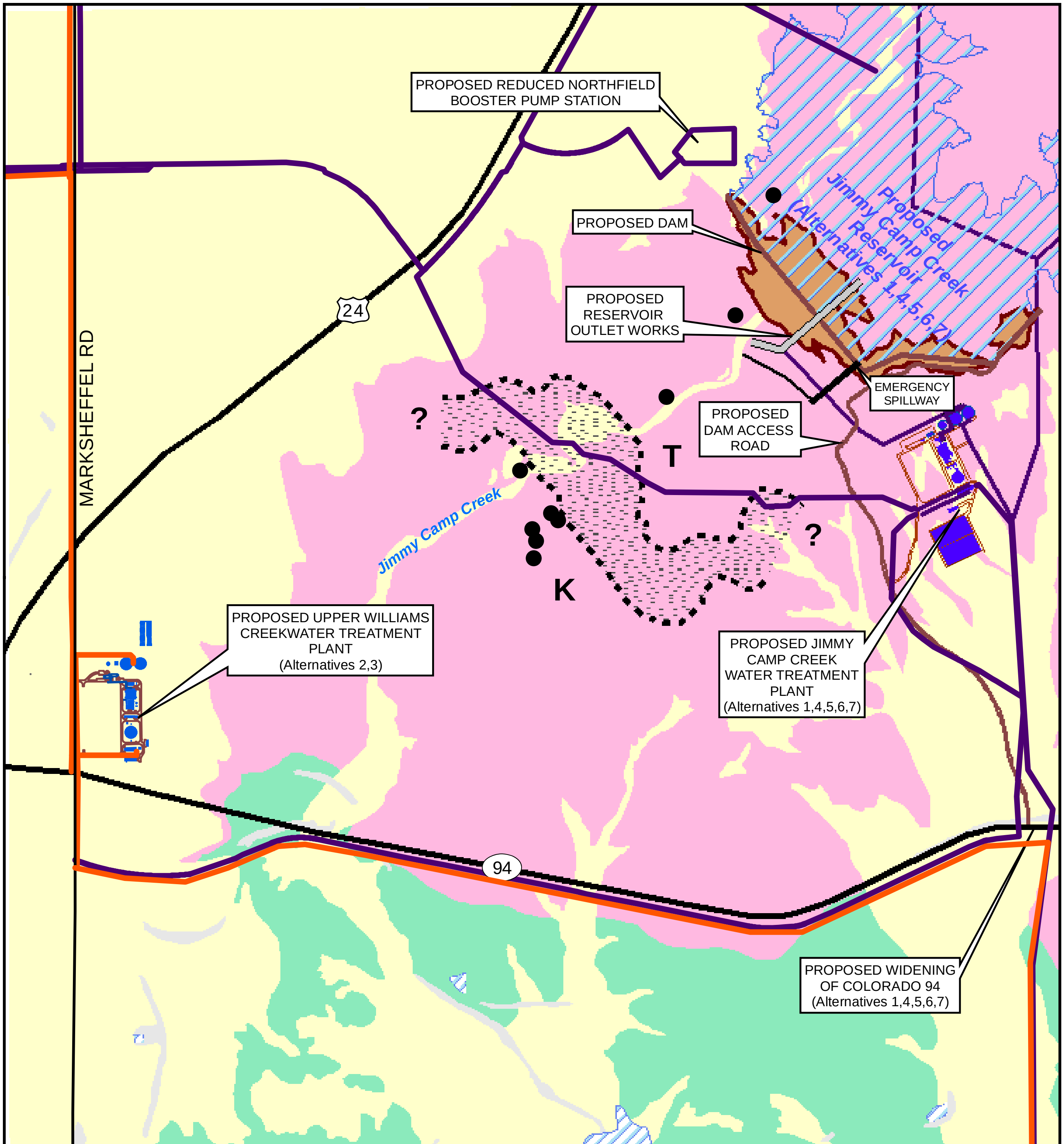
None of the alternatives would cross areas with active sandstone quarries (Keller et al. 2000, 2002a, 2002b, 2003). The primary source for crushed stone in the region, the Ordovician-age Manitou Limestone, is only exposed along the edge of the foothills to the west of the analysis area. The Highway 115 pipeline corridor passes through thin beds of Permian-age Lyons Sandstone, which is quarried elsewhere along the Front Range for building material.

Paleontology

No Action Alternative

In the No Action Alternative, Colorado Springs would use the Jimmy Camp Creek Reservoir site for terminal water storage and develop the Denver Basin Ground Water System northeast of Colorado Springs. Pipelines would convey ground water from the Denver Basin Ground Water System to the Jimmy Camp Creek Reservoir and water treatment plant. Pipeline corridors, such as along Woodmen Road, primarily would cross the middle of the upper part of the Dawson Formation (Madole and Thorson 2003). The middle of the upper part of the Dawson Formation has a lower potential for important paleontological resources than the base of the upper Dawson. Some segments of the Denver Basin Ground Water System pipelines would cross the base of the upper part of the Dawson Formation, which has a high potential for important paleontological resources (Madole and Thorson 2003).

The Jimmy Camp Creek Reservoir dam would be near the K-T boundary and the reservoir would inundate exposures of the Dawson Formation (Figure 98). The Jimmy Camp Creek Water Treatment Plant would be constructed near the K-T boundary where the potential for fossils is high. Colorado Springs' Treated Water Pipeline would cross areas containing fossils identified by Madole and Thorson (2003) and others southwest of the proposed dam. The Colorado Springs Treated Water Pipeline would cross the Dawson Formation. Of the seven alternatives, the No Action Alternative would have the highest potential to encounter and adversely affect important paleontological resources due to its inclusion of the Denver Basin Ground Water System.



Project: Southern Delivery System
Prepared By: CH2MHILL
Date: October 30, 2008
Source: Geologic Map of the Elsmere Quadrangle (Madole and Thorson)

Legend

- Proposed Pipeline (Alternatives 1,4,5,6,7)
- Proposed Pipeline (Alternatives 2,3)
- Location of Fossil Discovery
- Approximate Location of the K-T Boundary
- K Cretaceous Age Rock
- T Tertiary Age Rock
- ? Location of K-T Boundary Unknown
- Dawson Formation
- Laramie Formation
- Modern Alluvium or Eolian Sand Deposits
- Artificial Fill

0.5 0.25 0 Miles

Figure 98. Paleontological Resources and Proposed Project Facilities in the Jimmy Camp Creek Area.

Action Alternatives except the Participants' Proposed Action and Wetland Alternatives
All Action Alternatives except the Participants' Proposed Action and the Wetland alternatives would use the Jimmy Camp Creek Reservoir and water treatment site. The Jimmy Camp Creek Treated Water Pipeline and the Colorado Springs Treated Water Pipeline would convey treated water to Colorado Springs. As discussed under the No Action Alternative, these facilities would have the highest potential to encounter and adversely affect important paleontological resources.

The Participants' Proposed Action and Wetland Alternatives
The Participants' Proposed Action and Wetland alternatives would use the Upper Williams Creek Reservoir and Upper Williams Creek Water Treatment Plant sites. The Dawson Formation is not present at the Upper Williams Creek Reservoir site (Soister 1968) but may underlie Quaternary eolian sand deposits at the Upper Williams Creek Water Treatment Plant site (Madole and Thorson 2003). The thickness of the eolian sand deposits is estimated to be from 3 to 20 feet. These alternatives would have a low potential to encounter and adversely affect important paleontological resources.

Geologic Hazards
Geologic hazards with the potential to affect the proposed project facilities are discussed below and include landslides, corrosive soils, shallow bedrock, expansive soils and bedrock, faults and folds, seismicity and soil stability. Standard engineering practices would be incorporated into project facility designs to address these hazards.

Landslides
Landslides are the downward and outward movement of earth materials on a slope. The USGS delineated areas of historical landslide incidence and areas susceptible to landslides based on the topography and the geology of the surface and subsurface (Godt 2001). Because records for historical landslides are limited, the most important factor in evaluating the landslide hazard is susceptibility. The USGS ranked areas throughout the nation into low, moderate, and high susceptibility areas, based on the soil/rock types, slope angles, precipitation, and other factors (Radbruch-Hall et al. 1982).

According to the USGS map, areas with a high susceptibility for landslides are limited to the Highway 115 pipeline corridor. The alternatives that would cross through areas with a high susceptibility for landslides are the No Action Alternative, the Wetland Alternative, the Arkansas River Alternative, and the Highway 115 Alternative (Table 142). The remaining alternatives would be located in areas with a low incidence of landslides and a moderate susceptibility for landslides.

Faults and Folds
Active geologic faults and folds are of concern because of the risk of damage to pipelines, reservoirs, and structures caused by movement of the ground along faults or folds. The CGS created a database of faults and folds that are known or suspected to have moved during the late Cenozoic (about the last 23.7 million years), i.e., that cut Miocene or younger rocks (Widmann et al. 2002). The current tectonic environment of Colorado initiated near the beginning of the Miocene Epoch.

Table 142. Geologic Hazards along Pipeline Corridors.

Alternative	High Susceptibility for Landslides (ac.)	High Corrosivity to Steel (ac.)	Shallow Bedrock (ac.)	Expansive Soils and Bedrock (ac.)	Total Pipelines (ac.)
No Action Alternative	220	641	400	255	1,496
Participants' Proposed Action	0	632	291	301	965
Wetland Alternative	218	917	519	400	1,433
Arkansas River Alternative	221	795	471	438	1,488
Fountain Creek Alternative	0	811	349	434	1,336
Downstream Intake Alternative	0	530	249	339	1,038
Highway 115 Alternative	220	593	371	254	1,176

Acreage shown is based on each alternative's temporary pipeline construction easement; actual disturbed area would be less.

According to the CGS database, only the Ark-Otero Untreated Water Pipeline is crossed by a fault or fold that has moved or slipped during this period of time (Widmann et al. 2002). The fault is part of the Northeastern Boundary Fault System, a series of eight northwest-striking faults that form the northeastern margin of the upper Arkansas Valley graben between Leadville and Buena Vista, Colorado. These faults are thought to have last moved during the middle to late Quaternary (i.e., during the last 750,000 years). This fault would have a potential to affect the two alternatives using this pipeline corridor, the No Action Alternative and the Highway 115 Alternative.

The nearest fault in the database to any other facility is the Ute Pass Fault Zone, a series of north/south trending faults that terminate near Rock Creek Park along Colorado 115. This portion of the fault is shown on the database map server to be about 1,600 feet northwest of the Highway 115 pipeline corridor and is thought to have last moved between 125,000 and 300,000 years ago (Widmann et al. 2002). Based on this information, this fault has a low potential to affect the four alternatives using this pipeline corridor, No Action, Wetlands, Arkansas River, and Highway 115 alternatives.

Corrosive Soils

Corrosive soils are a concern because of their potential effects on buried pipelines and other infrastructure. Soil corrosion is an electrochemical process that is responsible for the corrosion of metals in contact with soil. Soils with high moisture content, high electrical conductivity, high acidity, and high dissolved salts will be most corrosive.

Potentially corrosive soils have been identified throughout the analysis area (GEI 2003b, 2003c, 2003d, 2005c; NRCS 2006). All alternatives would be affected in varying amounts by corrosive soils (Table 142). The Downstream Intake Alternative would encounter the least amount of corrosive soils, 111 acres less than the No Action Alternative. The Wetland Alternative would encounter the highest amount of corrosive soils, 276 acres more than the No Action Alternative.

Shallow Bedrock

Shallow bedrock in the analysis area is defined as competent bedrock (solid rock that underlies an unconsolidated deposit that displays limited evidence of weathering throughout the rock mass) that is less than 60 inches from the ground surface. Areas with shallow bedrock could create difficulties with excavating and trenching pipeline corridors and building foundations, potentially requiring excavation methods such as ripping or drilling and blasting.

Areas of shallow bedrock have been identified throughout the analysis area (GEI 2003b, 2003c, 2003d, 2005c; NRCS 2006). All proposed alternatives would be affected in varying amounts by shallow bedrock (Table 142). The Downstream Intake Alternative would encounter the least amount of shallow bedrock, 151 acres less than the No Action Alternative. The Wetland Alternative would encounter the highest amount of corrosive soils, 119 acres more than the No Action Alternative.

Expansive Soils and Bedrock

Expansive soils and bedrock are a concern because of their potential effects on buried pipelines, building foundations, and other infrastructure. Expansion is generally caused by wetting of certain clay minerals in dry soils and bedrock. Arid or semi-arid areas such as Colorado with seasonal changes in soil moisture experience a greater frequency of expansion than areas with higher rates of precipitation (Hart 1974).

Areas of expansive soils and bedrock have been identified throughout the analysis area (GEI 2003b, 2003c, 2003d, 2005c; NRCS 2006). The three sedimentary rock formations in the analysis area with the greatest potential for expansion are the Pierre Shale, the Laramie Formation, and the Dawson Formation (Hart 1974). Therefore, the alternatives that would cross through these formations and the weathered residual soils above them would have a higher potential effect from expansive soils and bedrock. All alternatives would be affected in varying amounts by expansive soils and bedrock (Table 142). The Highway 115 Alternative would encounter the least amount of shallow bedrock, 1 acre less than the No Action Alternative. The Arkansas River Alternative would encounter the highest amount of corrosive soils,183 acres more than the No Action Alternative.

Seismicity

The USGS has created a map that displays areas of equal seismic hazard that are defined by the probability of having a certain level of ground shaking, or horizontal acceleration, during an earthquake (USGS 2002). The map shows levels of ground shaking that have a 1-in-10 chance of being exceeded in a 50-year period. The data are presented as peak acceleration values in %g (percentage of g, where g is acceleration due to gravity, or 9.8 meters/second^2).

The analysis area is in a region with very low peak acceleration values. The reservoir sites in the eastern section of the analysis area are in a region with a peak acceleration value of 0.02g (or 2%g), the Highway 115 pipeline corridor is in a region with a peak acceleration value of 0.03g, and the Chaffee County facilities are in a region with peak acceleration values of 0.05g.

Dams and other high hazard structures are designed to withstand higher peak acceleration values than would be generated in a probable earthquake. Along the Front Range, design values used are generally in the range of 0.1g to 0.3g (GEI 2005a).

Soil Stability
Soil stability could be a concern if project facilities would be constructed in locations where existing unstable slopes are present, or where new slopes would be formed as part of the project.

All pipeline alternatives have the potential to require construction of pipelines in areas with localized slope stability problems (e.g., stream crossings). Standard engineering practice involves conducting geotechnical investigations prior to design and construction to ensure that appropriate engineering measures are incorporated into the designs to address any areas of instability. The No Action, Wetland, and Arkansas River alternatives may encounter more slope stability problems due to the greater total pipeline length. The Participants' Proposed Action has the shortest total pipeline length.

All alternatives would involve construction of new dams to create return flow storage and/or terminal storage reservoirs. Dams would be created by constructing embankments. Federal and state agency guidelines would be followed in design of all dams to assure adequate slope stability and other important design features related to public safety. The Colorado State Engineer's Office is responsible for approving design plans and inspecting construction for all new dams in the state.

Many locations along the Arkansas River, Fountain Creek and their tributaries are experiencing streambank instability under existing conditions. Streambank instability is addressed in the Geomorphology section (Section 3.9).

3.22.5.2 Cumulative Effects

Reasonably foreseeable actions would include continued urban development in the area of the proposed Jimmy Camp Creek Reservoir site. Development in areas underlain by the Dawson Formation would likely disturb or bury paleontological resources. No other reasonably foreseeable actions would have cumulative effects on geologic or paleontological resources nor would they affect geologic hazards or stability.

3.22.5.3 Resource Commitments

Geologic Resources
Acquisition of pipeline corridor and well field easements throughout areas with large sand and gravel deposits, such as along the Arkansas River, Fountain Creek, and in the northern portion of the analysis area, would be an irretrievable commitment of these resources. Mining of thinner sand and gravel deposits in the three reservoir sites is not economically feasible and reservoir inundation would not be considered a commitment of resources.

Paleontology
The proposed mitigation plan (Section 3.22.5.4) is designed to identify and recover or preserve in place important paleontological resources in the area surrounding the Jimmy Camp Creek Reservoir site. Important paleontological resources not discovered but affected by reservoir inundation or pipeline construction would be an irretrievable commitment of resources.

3.22.5.4 Mitigation

Proposed Measures
As currently formulated, Jimmy Camp Creek Reservoir site is not a component in the Participants' Proposed Action or Wetland alternatives, and mitigation would not be needed for these alternatives. In the alternatives with Jimmy Camp Creek

Reservoir as a terminal storage site, a plan would be developed by the Participants and approved by Reclamation to address the mitigation of construction-related adverse effects on paleontological resources. The mitigation plan would include the following components:

- A pre-construction survey and surface salvage
- Monitoring and salvage during any excavation
- Identification, cataloging, curation, and storage
- Reporting and documentation

The Participants may choose to enter into a collaborative program with the Denver Museum of Nature and Science, which has conducted prior paleontological research in the Jimmy Camp Creek area.

Mitigated Effects

Development and implementation of Paleontological Mitigation Plan would minimize the effects on important paleontological resources and would provide for curation of important paleontological resources unavoidably affected by the project.

3.23 Soils

Concerns about soil impacts identified during scoping included erosion (by wind and water), revegetation of disturbed areas, fugitive dust, and effects on important farmlands. Fugitive dust is discussed in the Air Quality section (Section 3.24). Erosion associated with stream channels is discussed in the Geomorphology section (Section 3.9). Three indicators were used to assess soil impacts:

- Susceptibility to wind and water erosion
- Suitability of topsoil for revegetation
- Important farmlands

3.23.1 Summary of Effects

In all alternatives, some loss of soil material from wind and water erosion would be likely during construction and until disturbed areas are revegetated. The Wetland Alternative and the Arkansas River Alternative have smaller analysis areas, and likely would have less soil disturbance and less erosion than the other alternatives. The No Action Alternative and the Fountain Creek Alternative would have more disturbance and soil erosion than the other alternatives. The Jimmy Camp Creek and Upper Williams Creek Reservoir sites would fluctuate about 8 feet (with the exception of the No Action and Highway 115 alternatives in drier years, which would fluctuate 30 and 24 feet, respectively), resulting in less than 100 acres of exposed shoreline that would be periodically inundated and then exposed. Given the shoreline length, the width of exposed shoreline areas at the Jimmy Camp Creek and Upper Williams Creek Reservoir sites would be small and likely would remain sufficiently moist to prevent substantial wind erosion. Fluctuations in Williams Creek Reservoir would average about 15 feet, resulting in exposed shoreline areas of about 240 acres on average. Wet years would provide greater exchange potential, resulting in more releases of return flows, less storage and more exposed shoreline in Williams Creek Reservoir. Potential erosion of exposed shoreline areas would be greatest during July through September. The exposed soils, along with accumulated sediments, would be subject to wind erosion.

Most of the soils disturbed by all alternatives except for the Participants' Proposed Action and the Wetland alternatives have poor suitability for topsoil. Soil suitability for topsoil is limited by clayey textures or shallow depth (less than 20 inches). The Participants' Proposed Action and the Wetland alternatives would disturb soils with a higher rating for topsoil; revegetation success probably would be better in the Participants' Proposed Action and the Wetland alternatives than the other alternatives.

The Arkansas River Alternative would not affect prime farmland. All other alternatives would affect prime farmland, ranging from 3.1 acres in the Wetland Alternative to 44.9 acres in the No Action Alternative. Permanent loss of prime farmland would be highest for the No Action and Highway 115 alternatives and least for the Wetland and Arkansas River alternatives. Although temporarily disturbed areas, such as pipeline corridors, would be reclaimed after pipeline construction, it is likely the disturbed prime farmland soils would have lower productivity than undisturbed soils (Mackintosh et al. 2000).

3.23.2 Regulatory Framework

Soil erosion is regulated in Colorado under air quality regulations addressing fugitive dust.

Fugitive dust is discussed in the Air Quality Section (3.2.3).

Important farmlands are defined in the regulations implementing the Farmland Protection Policy Act (7 CFR 658). The purpose of the Farmland Protection Policy Act is to minimize the extent to which federal programs contribute to the unnecessary and irreversible conversion of farmland to nonagricultural uses. The Farmland Protection Policy Act defines four types of important farmlands: prime farmland, unique farmland, farmland of statewide importance, and farmland of local importance. The Natural Resource Conservation Service (NRCS) identifies important farmlands in each county based on national regulations and state guidance. Two types of important farmlands, prime farmland, and farmland of statewide importance, are found in the SDS Project study area and are discussed in this section.

Prime farmland is land that has the best combination of physical and chemical characteristics for producing food, feed, forage, fiber, and oilseed crops, and is also available for these uses. It has the soil quality, growing season, and moisture supply needed to economically produce sustained high yields of crops when treated and managed, including water management, according to acceptable farming methods. In general, prime farmlands have an adequate and dependable water supply from precipitation or irrigation, a favorable climate and growing season, acceptable acidity or alkalinity, acceptable salt and sodium content, and few or no rocks. They are permeable to water and air. Prime farmlands are not excessively erodible or saturated with water for a long period of time, and they either do not flood frequently or are protected from flooding (7 CFR 657.5).

Farmland of statewide importance is land other than prime farmland that has a good combination of physical and chemical characteristics for the production of crops.

3.23.3 Analysis Area and Methods

The analysis area is all areas where project facilities are proposed. Tabular and spatial data for the analysis area were downloaded from the soils data mart web site maintained by the Natural Resources Conservation Service (NRCS 2006). Four NRCS survey areas encompass the SDS Project NEPA analysis area: Pueblo Area, Colorado; El Paso County Area, Colorado; Fremont County Area, Colorado, and Chaffee-Lake Area, Colorado. Soils information was not available for small areas (less than 40 acres) in Chaffee County along the Ark-Otero Untreated Water Pipeline. Data to assess susceptibility to wind and water erosion, suitability for topsoil, and important farmland in the analysis area were obtained from the NRCS (2006). The soil erodibility factor Kw was used to assess the susceptibility of soils within the analysis area to water erosion. The NRCS assigns a Kw to each major soil horizon of each named soil in each map unit. Because the Participants propose to salvage and replace surface soils prior to disturbance, only the Kw of the surface soil was used in the analysis. The wind erodibility group (WEG) was used to assess the susceptibility of soils within the analysis area to wind erosion. The NRCS assigns a WEG to each named soil in each map unit on the basis of the characteristics of the surface soil horizon. Values for Kw and WEG were placed in one of three categories: low, moderate, and high susceptibility to erosion (ERO 2007h).

NRCS' rating of each soil as a source of topsoil was used to assess the suitability of soils within the analysis area for reclamation and revegetation. The NRCS assigns a rating of good, fair or poor based on the characteristics of the top 40 inches of each named soil in each map unit. Soil properties the NRCS uses to rate topsoil are those that affect plant growth; the ease of excavation, loading, and spreading; and the reclamation of the borrow area. The acreage of each soil map unit within the analysis area for each alternative was calculated using a GIS analysis. Analysis methods are described in greater detail in a technical memorandum available in Reclamation's administrative record (ERO 2007h).

NRCS' farmland classification was used to assess effects on important farmland. NRCS provides a listing of map units in each survey area that are considered to be either prime farmland, unique farmland, or farmland of statewide or local importance. In the analysis area, all soils with suitable physical and chemical characteristics to be considered prime farmland must be irrigated to be prime farmland. A similar review was conducted of the two map units identified as farmland of statewide importance when cultivated. The acreage of prime farmland and farmland of statewide importance crossed by each alternative was calculated. The NRCS did not identify any map units that are unique farmland or farmland of local importance. These two types of important farmland are not discussed further. The thresholds to determine magnitude of effects for important farmlands were:

- Negligible – no important farmland would be taken permanently out of production
- Minor – less than 10 acres of important farmland would be taken permanently out of production
- Moderate – between 10 and 100 acres of important farmland would be taken permanently out of production
- Major – more than 100 acres of important farmland would be taken permanently out of production

3.23.3.1 Limitations

The analysis did not use detailed soils mapping of the analysis area, but used soil surveys completed by the NRCS. The NRCS soil surveys are designed for many uses within each survey area, which are considerably larger than the analysis area. Great differences in soil properties can occur within short distances. Contrasting soils with different properties may be present within the analysis area, but not mapped by the NRCS at the mapping scale used. The NRCS data and its interpretations are intended for planning purposes only.

3.23.4 Affected Environment

3.23.4.1 Dominant Soil Types

The northern portion of the analysis area (El Paso County) is dominated by the Bernal, Midway, Razor, Stapleton, and Wiley soil series. These soils occur on upland ridges and hills. The Bernal and Midway soils are shallow, with sedimentary bedrock at a depth of less than 20 inches. The Razor soils are similar to Midway soils, but have shale bedrock at a depth of less than 40 inches. The Stapleton and Wiley soils are deep, with bedrock greater than 60 inches. All of the dominant soils in the El Paso County portion of the analysis area have a moderate susceptibility to wind and water erosion, with the exception of the Wiley soils. Wiley soils are formed from silty, wind-blown deposits and have a high susceptibility to water erosion. The Midway and Razor soils are clayey, and have a high shrink/swell potential. The Bernal, Stapleton, and Wiley soils are loamy and have a low to moderate shrink/swell potential (NRCS 2006).

The soils in the southern portion of the analysis area (Pueblo County) are dominated by the Midway, Razor, and Limon soils. The soils are similar, and vary by depth to bedrock. As discussed previously, the Midway and Razor soils are less than 40 inches deep; the Limon soil is greater than 40 and typically at least 60 inches deep. All three soils have clayey textures, a moderate susceptibility to wind and water erosion, and a high shrink/swell potential (NRCS 2006).

In Fremont County, the dominant soils are the Minnequa, Penrose, and Travesilla soils. The Penrose and Travesilla soils have loamy textures and sandstone bedrock at a depth of less than 20 inches. The Minnequa soils have loamy textures and limestone bedrock at a depth of less than 40 inches. All of the dominant soils in the Fremont County portion of the analysis area have a moderate susceptibility to wind and water erosion (NRCS 2006). In Chaffee County, the dominant soils are the Pierian and San Isabel soils. The Pierian and San Isabel soils have sandy surface textures and are more than 60 inches deep. These soils have a low susceptibility to water erosion a moderate susceptibility to wind erosion and a low shrink/swell potential.

3.23.4.2 Important Farmland

Twelve soil map units in El Paso, Pueblo, and Fremont counties are prime farmland when irrigated. Photo-interpretation and field reconnaissance were used to identify those prime farmland soils in the analysis area. Two soil map units in Fremont County are farmland of statewide importance when cultivated. The soils in the Chaffee Country analysis area are not important farmlands.

3.23.5 Environmental Consequences

3.23.5.1 Direct and Indirect Effects

Soil Productivity

All alternatives would require construction of permanent project facilities, such as reservoirs, water treatment plant, and access roads. Soil productivity would be lost where permanent facilities are constructed. The Wetland Alternative and Arkansas River Alternative would have less permanent disturbance than the other alternatives (Table 143). Soil productivity would decrease temporarily in areas temporarily disturbed, and would slowly return to pre-disturbance productivity following construction and reclamation. The No Action and Arkansas River alternatives would have the greatest amount of temporary disturbance and the Participants' Proposed Action and Downstream Intake alternatives would have the least (Table 143).

Susceptibility to Soil Erosion

In all alternatives, some loss of soil material from wind and water erosion would be likely during construction and until disturbed areas are revegetated. Best Management Practices would be implemented to minimize soil loss. A short-term loss in soil productivity would occur from disruption of soil biological processes and changes in the soil physical properties from construction disturbance. Topsoil salvage, replacement, and revegetation would minimize the long-term effect on soil productivity and the loss of soil material.

Table 143. Permanent and Temporary Disturbance by Alternative.

Alternative	Permanent Disturbance (ac.)	Temporary Disturbance (ac.)
No Action Alternative	2,398	1,774
Participants' Proposed Action	2,684	965
Wetland Alternative	1,581	1,433
Arkansas River Alternative	1,309	1,637
Fountain Creek Alternative	2,460	1,490
Downstream Intake Alternative	2,343	1,192
Highway 115 Alternative	2,397	1,330

Analysis area totals among tables may vary due to rounding and lack of soils data in Chaffee County. All units are acres, rounded to the nearest 1 acre.

Generally, alternatives that would result in less surface disturbance would have a lower potential for soil erosion. The Wetland Alternative and the Arkansas River Alternative have smaller analysis areas, and likely would have less soil disturbance than the other alternatives, including No Action. These two alternatives likely would result in less soil erosion. The No Action and the Fountain Creek alternatives would have more disturbance and soil erosion than the other alternatives (Table 144).

Susceptibility to wind and water erosion is primarily a function of soil texture, vegetation cover, and slope. All Action Alternatives would have similar acreage with a high susceptibility to wind erosion (Table 144). All Action Alternatives have less acreage of soils with a high susceptibility to wind erosion than the No Action Alternative. The alternatives vary in their susceptibility to water erosion (Table 144). About 45 acres in the No Action and Highway 115 alternatives analysis areas would have a high susceptibility to water erosion. The Arkansas River Alternative and the Downstream Intake Alternative would have lower susceptibility to water erosion than the No Action Alternative and the Participants' Proposed Action, the Wetland Alternative, and the Fountain Creek Alternative would have greater acreage of high susceptibility to water erosion than the No Action Alternative.

Exposed Shoreline Areas at Reservoirs

All alternatives include new terminal storage reservoirs; some alternatives include a new return flow reservoir. Water levels in the terminal storage reservoirs would fluctuate considerably less than the Williams Creek return flow reservoir and would have less exposed shoreline areas. For example, the Jimmy Camp Creek Reservoir would fluctuate about 8 feet (with the exception of the No Action and Highway 115 alternatives in drier than average years), resulting in less than 100 acres of exposed shoreline that would be periodically inundated and then exposed. During dry years, water levels in the Jimmy Camp Creek Reservoir would fluctuate 30 and 24 feet in the No Action and Highway 115 alternatives, resulting in 191 and 177 acres of exposed shoreline, respectively. In the Participants' Proposed Action and the Wetland alternatives, fluctuations at the Upper Williams Creek Reservoir site would be about 8 feet and acreages of exposed shoreline would be less than 100 acres. Given the shoreline length, the width of exposed shoreline areas at the Jimmy Camp Creek and Upper Williams Creek Reservoir sites would be small and likely would remain sufficiently moist to prevent substantial wind erosion.

Table 144. Area with High Susceptibility to Erosion by Alternative.

Alternative	High Susceptibility To		Total Analysis Area (ac.)
	Water Erosion (ac.)	Wind Erosion (ac.)	
No Action Alternative	45	422	4,172
Participants' Proposed Action	73	302	3,649
Wetland Alternative	113	329	3,014
Arkansas River Alternative	43	267	2,946
Fountain Creek Alternative	75	261	3,949
Downstream Intake Alternative	12	242	3,535
Highway 115 Alternative	45	236	3,727

Analysis area totals among tables may vary due to rounding.
All units are acres, rounded to the nearest 1 acre.

Because it would be used for storage of reusable return flows, water levels in the Williams Creek Reservoir would fluctuate on average about 15 feet, considerably more than in the two terminal storage reservoirs. Exposed shoreline that would be periodically inundated and then exposed would be on average about 240 acres in the Williams Creek Reservoir. Wet years would provide greater exchange potential, resulting in more releases of return flows, less storage and more exposed shoreline in Williams Creek Reservoir. Potential erosions of exposed shoreline would be greatest during July through September. Soils surrounding the Williams Creek Reservoir are the Midway, Manzanola, Razor and Wiley soils. The Midway and Razor soils have a moderate susceptibility to wind erosion; the Manzanola and Wiley soils have a high susceptibility to wind erosion. These soils, along with accumulated sediments, would be subject to wind erosion.

Revegetation Potential

Suitable soils would be salvaged prior to construction for use in revegetating disturbed areas. The success of revegetation would depend in part on the quality of the soils salvaged and replaced. The NRCS established a rating of the suitability for topsoil for each soil type within the analysis area. Soils are rated good, fair, or poor; some miscellaneous soil types are not rated. Soils with good suitability for topsoil typically have loamy textures and few rock fragments, and are deeper than 20 inches.

Most of the soils disturbed by all alternatives except for the Participants' Proposed Action and the Wetland alternatives have a poor suitability for topsoil (Table 145). Soil suitability for topsoil is limited by clayey textures or shallow depth (less than 20 inches). The Participants' Proposed Action and the Wetland alternatives would disturb soils with a higher rating for topsoil; revegetation success probably would be greater in the Participants' Proposed Action and the Wetland alternatives than the other alternatives.

Important Farmland

The Arkansas River Alternative would not affect prime farmland. All other alternatives would affect prime farmland, ranging from 3.1 acres in the Wetland Alternative to 44.9 acres in the No Action Alternative (Table 146). The permanent effect of the Wetland and Arkansas River alternatives would be minor; the permanent effects of the other alternatives would be moderate. Although temporarily disturbed areas, such as pipeline corridors, would be reclaimed after pipeline construction, it is likely the disturbed prime farmland soils would have lower productivity than undisturbed soils (Mackintosh et al. 2000). Pipelines in the No Action and Highway 115 alternatives also would affect 0.6 acre of farmland of statewide importance. None of the other alternatives would cross farmland of statewide importance.

3.23.5.2 Cumulative Effects

All ground-disturbing reasonably foreseeable actions would result in cumulative soil erosion and loss, and loss of soil productivity. Any action, however, that would disturb more than 1 acre would require a stormwater management plan designed to minimize soil erosion. The cumulative effects of the proposed SDS Project and reasonably foreseeable actions would be negligible.

3.23.5.3 Resource Commitments

All Action Alternatives would result in an irreversible commitment of resources. Topsoil would be removed before construction for use in revegetation of disturbed areas, but some

Table 145. Topsoil Suitability Rating of Soils in Analysis Area.

Alternative	Good		Fair		Poor or Not Rated	
	(ac.)	(%)	(ac.)	(%)	(ac.)	(%)
No Action Alternative	722	17	471	11	2,979	72
Participants' Proposed Action	1,439	40	451	12	1,759	48
Wetland Alternative	1,371	46	494	16	1,150	38
Arkansas River Alternative	606	21	447	15	1,893	64
Fountain Creek Alternative	699	18	511	13	2,739	69
Downstream Intake Alternative	618	17	414	12	2,502	71
Highway 115 Alternative	669	18	387	10	2,670	72

Analysis area totals among tables may vary due to rounding.
All units are acres, rounded to the nearest 1 acre.

Table 146. Prime Farmland Affected by Each Alternative.

Alternative	Permanently Disturbed Areas (ac.)	Temporarily Disturbed Areas (ac.)	Total (ac.)
No Action Alternative	17.2	27.7	44.9
Proposed Action	11.0	2.3	13.3
Wetland Alternative	0.8	2.3	3.1
Arkansas River Alternative	0.0	0.0	0.0
Fountain Creek Alternative	11.1	2.3	13.3
Downstream Intake Alternative	10.7	0.0	10.7
Highway 115 Alternative	17.2	18.6	35.8

Analysis area totals among tables may vary due to rounding.
All units are acres, rounded to the nearest 1 acre.

irreversible soil loss due to erosion would occur. The productivity of disturbed sites and important farmland over the long term would be less than original undisturbed conditions, which would be an irreversible commitment of resources. Loss of soil productivity due to construction of permanent facilities would be an irretrievable commitment of resources.

3.23.5.4 Mitigation

Proposed Measures
The following proposed mitigation measures, some of which have been proposed by the Participants, would minimize effects on soil resources for all alternatives:

- Minimize the area of disturbance to defined construction limits and limit the time bare soil is exposed
- Contain soils within the analysis area through temporary sediment control measures such as silt fences, sediment logs, trenches, and sediment traps
- Remove woody vegetation prior to and, to the extent possible, salvage topsoil within tree stump roots
- Use topsoil salvage methods including windrowing topsoil at the limits of construction and pulling the soil back on slopes during reclamation
- Apply topsoil, soil amendments, fertilizers, and mulches as appropriate, and seed selectively during favorable plant establishment climate conditions to match site conditions and revegetation goals
- To the extent practicable, avoid irrigated lands during final design
- To the extent practicable, allow continued use of lands crossed by project facilities after construction
- Where the proposed pipeline crosses prime farmland soils, develop a soils handling plan that separates the top 6 inches and the soils between 6 and 36 inches for subsequent reclamation

Mitigated Effects
Proposed mitigation measures would reduce short-term and long-term losses of soil and soil productivity. Redistribution of topsoil to soil-deficient areas would increase soil productivity in those areas. Topsoil, soil amendments, fertilizers, and mulches would increase productivity and help establish cultivated vegetation and crops. A soils handling plan for prime farmland soils would ensure high quality topsoil is preserved and distributed properly.

3.24 Air Quality

Air quality effects are being assessed because they are an important component of human health and the environment. The indicator of air quality effects is increases of air pollutants above existing levels.

3.24.1 Summary of Effects

Air quality impacts from the No Action and Action Alternatives would be similar due to the construction and operation of facilities. For all alternatives, impacts during construction would be primarily from vehicle and equipment exhaust emissions and from fugitive dust. These impacts would be minor and short term during construction. Negligible long-term air quality impacts are expected from operation of treatment plants and pump stations. Emissions associated with the No Action and Action Alternatives would not exceed any federal or state air quality standards.

Carbon dioxide emissions would be proportional to the amount of energy used by each alternative, which is discussed in Chapter 2. Estimated carbon dioxide emissions for the No Action Alternative are 239,710 tons per year at 2046 demands. The Participants' Proposed Action, Fountain Creek Alternative, and the Highway 115 Alternative would have slightly more carbon dioxide emissions than the No Action Alternative, ranging from an estimated 243,285 tons per year to 248,647 tons per year. The Downstream Intake Alternative would have the most carbon dioxide emissions, with an estimated 511,196 tons per year. The Wetland and Arkansas River alternatives would have about 50 to 60 percent more emissions than the No Action Alternative, but less than the Downstream Intake Alternative.

3.24.2 Regulatory Framework

The Clean Air Act was enacted to protect and enhance air quality and to assist state and local governments with air pollution prevention programs. The Clean Air Act requires the EPA to identify and publish a list of common air pollutants that could endanger public health or welfare. In Colorado, the EPA has delegated enforcement of the Clean Air Act to the Air Pollution Control Division of CDPHE. All state programs regarding the provisions and enforcement of the Clean Air Act are subject to oversight and approval by the EPA.

The EPA has established National Ambient Air Quality Standards (NAAQS) for six air pollutants—carbon monoxide, ozone, nitrogen dioxide, sulfur dioxide, particulate matter (particulates smaller than 10 microns in diameter (PM_{10}) but larger than 2.5 microns and those smaller than 2.5 microns ($PM_{2.5}$)), and lead—to protect the public from health hazards associated with air pollution. The State of Colorado has established similar standards (CDPHE 2006e). These pollutants are called "criteria air pollutants" because the EPA has regulated them by developing health-based criteria as the basis for setting permissible levels. One set of limits (primary standard) protects health; another set of limits (secondary standard) is intended to prevent environmental and property damage. A geographic area that has air quality equal to or better than a primary standard is called an attainment area; an area that does not meet a primary standard is a non-attainment area.

Colorado's air quality laws contain requirements for controlling fugitive dust emissions during construction activities. These requirements vary depending on the amount of land disturbed and the duration of the disturbance.

3.24.3 Analysis Area and Methods

The SDS Project analysis area for each alternative was assessed for air quality effects. Existing air quality standards were reviewed and potential air quality effects from the SDS Project were qualitatively assessed. Emission sources of pollutants are categorized as either stationary or mobile. Stationary sources of pollutants include combustion of fossil fuels for heat and power, emissions from industrial or commercial processes, fueling operations, and burning from natural fires or other activities. Mobile sources of pollutants include on-road (cars, trucks, and motorcycles) and off-road vehicles (aircraft, locomotives, farm equipment, and construction equipment), and fugitive dust from unpaved roads and construction activities. Fugitive dust can be generated by either earth-disturbing activities or by wind.

The thresholds to determine magnitude of effects for air quality were:

- Negligible – change in existing air quality or visibility would not be measurable or noticeable
- Minor – increased airborne pollutants would be low but measurable; changes in visibility would observable at local sites, and air quality standards would not be exceeded
- Moderate – increased airborne pollutants would be measurable, changes to visibility would be observable and widespread, and air quality standards would not be exceeded
- Major – one or more air quality standard would be exceeded

Indirect effects of energy use on annual CO_2 emissions were estimated for each alternative. Estimated daily energy use at 2046 water demands (CH2M HILL 2008b) was multiplied by the typical amount of CO_2 produced by generating 1 MW·h in Colorado (1,986 lbs. of CO_2) in 2004 (EPA 2008c). The daily emission values were then converted to tons per year.

3.24.4 Affected Environment

In rural areas of the study area, air quality is good (complies with federal and state health standards and poses little to no risk) with emissions occurring mostly from on-road and off-road vehicles and from fugitive dust. Concentrations of the six criteria air pollutants are well below federal and state air quality standards. The urban and residential areas of Colorado Springs, Fountain, Security, Pueblo, and Pueblo West have poorer air quality primarily due to vehicle emissions and stationary sources (PPACG 2004b). Concentrations of particulates are higher near unpaved roads, trails, and fallow agricultural fields compared to vegetated rangeland. Concentrations of the six criteria air pollutants in the study area are below federal and state air quality standards. All portions of El Paso, Pueblo, Fremont, and Chaffee counties are attainment areas (CDPHE 2007b). An attainment area is any area that meets the national primary or secondary ambient air quality standard for a specific pollutant. However, portions of El Paso County generally including the City of Colorado Springs and the area along I-25 to Fountain are classified as a maintenance area for carbon monoxide. A maintenance area is an area that was previously classified as a nonattainment area (any area that does not meet the national primary or secondary ambient air quality standard for a specific pollutant).

3.24.5 Environmental Consequences

3.24.5.1 Direct and Indirect Effects

For the No Action and Action Alternatives, air quality impacts during construction would be primarily from exhaust emissions of construction equipment, employee and delivery vehicles, and from fugitive dust. Fugitive dust would be generated from activities associated with soil disturbance and from equipment and vehicular traffic moving over the disturbed site. These emissions would be greatest during the initial site preparation activities and would vary from day-to-day depending on the construction phase, level of activity, and prevailing weather conditions. The amount of emissions of both fugitive dust and vehicle exhaust would depend on the number of vehicles used at specific sites and the extent of disturbed area.

Effects from No Action Alternative

Construction of the No Action Alternative, which would include well systems, pipelines, reservoirs, pump stations, a treatment plant, transmission lines, and other project components, would increase emissions from vehicle exhaust and fugitive dust. These minor increases would be localized and short term during construction and would occur in El Paso, Fremont, and Chaffee counties. Different portions of the project may be constructed simultaneously (i.e., up to eight pipeline sections could be active), resulting in greater emissions during a shorter period. It is unlikely that the increased pollutants from simultaneous pipeline construction would exceed NAAQS for any criteria pollutants because of the relatively localized nature of construction in comparison to regional construction activities simultaneously occurring throughout the Colorado Springs and Pueblo areas. The increased pollutants would not exceed applicable air quality standards; and the No Action Alternative would have negligible to minor impacts on existing air quality during construction. Increased emissions would cease after construction, but levels of fugitive dust may remain slightly elevated until sites are revegetated or inundated.

The No Action Alternative also would include operational activities associated with one treatment plant and six pump stations. Negligible long-term air quality impacts are expected from operation of the treatment plant and pump stations.

Although all alternatives would be in compliance with all air quality standards, all alternatives would increase the emissions of carbon dioxide. Carbon dioxide emissions would be proportional to the amount of energy used in each alternative, which is discussed in Chapter 2. Estimated carbon dioxide emissions for the No Action Alternative is 239,710 tons per year at 2046 water demands as shown in Table 147.

Table 147. Estimated Carbon Dioxide Emissions by Alternative at 2046 Water Demands.

Alternative	Estimated Carbon Dioxide Emissions (tons /year)
No Action Alternative	239,710
Participants' Proposed Action	243,285
Wetland Alternative	354,501
Arkansas River Alternative	380,418
Fountain Creek Alternative	248,647
Downstream Intake Alternative	511,196
Highway 115 Alternative	246,363

Effects from Action Alternatives

Air quality impacts from the Action Alternatives would be similar to the No Action Alternative and to each other. Air quality impacts would be limited to El Paso and Pueblo counties under the Participants' Proposed Action, Fountain Creek Alternative, and Downstream Intake Alternative. The Wetland Alternative and Arkansas River Alternative would result in air quality impacts in El Paso, Pueblo, and Fremont counties. The Highway 115 Alternative would result in air quality impacts in El Paso, Fremont, and Chaffee counties.

All Action Alternatives would result in lower fugitive dust emissions than the No Action Alternative because less area would be disturbed during construction (Table 143). The Wetland Alternative and the Arkansas River Alternative would have the least amount of surface disturbance and fugitive dust emissions. Similar to the No Action Alternative, the Participants' Proposed Action, Fountain Creek Alternative, Downstream Intake Alternative, and Highway 115 Alternative would result in slightly higher fugitive dust levels during seasonal dewatering of Williams Creek Reservoir. Implementation of all Action Alternatives would result in vehicle and equipment usage and generation of fugitive dust. Similar to the No Action Alternative, these minor increases would be localized and short term during construction. The impacts of construction equipment and fugitive dust would have a minor effect on air quality within the project area. Construction activities would not exceed federal and state air quality standards. Increased emissions and dust would decline after construction completion, but may remain slightly elevated until sites are revegetated or inundated. The operational activities associated with treatment plants and pump stations would result in negligible air quality effects. Emissions from facility operations would not exceed federal and state air quality standards. The Wetland, Arkansas River, and Downstream Intake alternatives would have higher energy use and greater emissions from stationary sources compared to the No Action Alternative. The Participants' Proposed Action, Fountain Creek, and Highway 115 alternatives would have similar energy use and emissions as the No Action Alternative.

The Participants' Proposed Action, Fountain Creek Alternative, and the Highway 115 Alternative would have slightly more carbon dioxide emissions than the No Action Alternative, ranging from an estimated 243,285 tons to 248,647 tons per year. The Downstream Intake Alternative would have the most carbon dioxide emissions, with an estimated 511,196 tons per year (Table 147). The Wetland and Arkansas River alternatives would have about 50 to 60 percent more emissions than the No Action Alternative, but less than the Downstream Intake Alternative.

3.24.5.2 Cumulative Effects

Increased residential development may occur simultaneously near the Jimmy Camp Creek Reservoir during its construction for all alternatives except the Participants' Proposed Action and Wetland alternatives. Increased residential development would require the use of motorized equipment, which would result in localized exhaust emissions. Construction activities associated with new development also would create short-term minor emissions of exhaust and fugitive dust. For the Participants' Proposed Action and Wetland alternatives, of which the Jimmy Camp Creek Reservoir is not a part, residential development throughout the area, including the area that is proposed as a reservoir for all other alternatives, would increase short-term cumulative air quality effects. A higher number of residences would increase the long-term air quality effects compared to the No Action Alternative. Additionally, long-term cumulative air quality impacts may result from visitor vehicles once a proposed reservoir on Jimmy Camp Creek or upper Williams Creek is open to the public. Overall, emissions from these sources are expected to be minor, particularly in comparison with regional emissions.

Global climate change has been attributed in part to emissions of the greenhouse gases such as CO_2 (Section 3.1.3.1). No procedures have been established to predict the potential climate effect of a single CO_2 emission source. Nonetheless, SDS Project alternatives that would use less energy and, thus, result in fewer CO_2 emissions would contribute less to climate change. The Participants' Proposed Action, Fountain Creek Alternative, and the Highway 115 Alternative would have a slightly higher contribution than the No Action Alternative. The Downstream Intake Alternative would have the greatest contribution. The Wetland and Arkansas River alternatives would have contributions that are 50 to 60 percent greater than the No Action Alternative, but less than the Downstream Intake Alternative.

3.24.5.3 Resource Commitments

The short-term increased emissions from the No Action and Action Alternatives would be an irretrievable commitment of resources. All alternatives would irreversibly increase CO_2 emissions.

3.24.5.4 Mitigation

Proposed Measures

The following mitigation measures, some of which have been proposed by the Participants, would be implemented:

- Develop and implement standard control practices, such as watering, to minimize particulate and dust emissions from construction work sites as specified in the fugitive dust control plan
- Ensure construction equipment (especially diesel equipment) meets opacity standards for operating emissions
- Promptly revegetate disturbances

Mitigated Effects

The proposed mitigation measures would reduce both short-term and long-term effects on air quality by following standards on construction equipment and minimizing fugitive dust.

3.25 Hazardous Materials

An assessment was conducted to evaluate the potential for proposed project facilities to be adversely affected by hazardous materials associated with soil and/or ground water contamination from known sites on or adjacent to project facilities (ERO 2007b, 2008b). Hazardous materials are defined in Section 3.25.2. Because hazardous materials are not a resource, the Cumulative Effects and Resource Commitments portions of the FEIS have been omitted from this section.

3.25.1 Summary of Effects

The review of reasonably ascertainable records maintained by the EPA, CDPHE, and the Colorado Department of Labor and Employment's Division of Oil and Public Safety (CDLE/OPS) did not identify any sites likely to have adversely affected the soil and/or ground water at any of the proposed project facilities. If the Wetland Alternative is selected, four solid waste disposal areas were observed in drainages leading to Williams Creek at the Upper Williams Creek Reservoir site, and would need to be removed and properly disposed. No other alternative is likely to be affected by hazardous materials.

3.25.2 Regulatory Framework

"Hazardous materials" is a generic term that encompasses the range of contaminants within the scope of the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) and petroleum products. CERCLA, commonly known as Superfund, was enacted by Congress in 1980. This law created a tax on the chemical and petroleum industries and provided broad federal authority to respond directly to releases or threatened releases of hazardous substances that may endanger public health or the environment. CERCLA established prohibitions and requirements concerning closed and abandoned hazardous waste sites, provided for liability of persons responsible for releases of hazardous waste at these sites, and established a trust fund to provide for cleanup when no responsible party could be identified. The EPA is the lead agency in addressing CERCLA sites.

Hazardous materials include hazardous waste regulated under the Resource Conservation and Recovery Act (RCRA). Passed in 1976, RCRA established the framework for managing both solid and hazardous waste. In 1984, Colorado was authorized by the EPA to administer the hazardous waste management programs in lieu of the federal RCRA program. The laws governing the management of hazardous waste in the State of Colorado are contained in the Colorado Hazardous Waste Regulations (CDPHE 2007c).

3.25.3 Analysis Area and Methods

The analysis area consisted of a ½-mile buffer around all proposed project facilities. The methods consisted of a review of reasonably ascertainable records maintained by the EPA, CDPHE, and CDLE/OPS, and site visits at the three proposed reservoir sites, Jimmy Camp Creek Reservoir, Upper Williams Creek Reservoir, and Williams Creek Reservoir.

The hazardous materials assessment was not exhaustive and does not eliminate the uncertainty that sites containing hazardous substances or petroleum products may be present within the SDS Project study area. Sites not listed in the reasonably ascertainable records maintained by the EPA, CDPHE, and CDLE/OPS, or sites that were not visually and/or physically observed during the site visits were not addressed by this assessment.

3.25.4 Affected Environment and Environmental Consequences

The records review identified the following sites within ½ mile of proposed project facilities: one site investigated under the CERCLA Information System, five RCRA Corrective Action sites, two Voluntary Cleanup sites, nine leaking underground storage tank sites, and five solid waste disposal facilities. The Voluntary Cleanup and Redevelopment Act (VCRA) is intended to permit and encourage voluntary cleanups by providing a method to determine clean-up responsibilities in planning the reuse of property. VCRA is intended for sites that are not covered by existing regulatory programs. Based on a review of agency files, none of the identified sites are likely to have adversely affected the soil and/or ground water at any of the proposed project facilities.

At the Jimmy Camp Creek Reservoir site, a high-voltage power line and a high pressure liquid petroleum gas pipeline run north/south through the site. The site reconnaissance did not identify any hazardous materials conditions that may have adversely affected the Jimmy Camp Creek Reservoir site. At the Upper Williams Creek Reservoir site, four solid waste disposal areas were observed in drainages leading to Williams Creek and three aboveground fuel storage tanks were observed at an operating ranch at the southern end of the site. At the Williams Creek Reservoir site, the Fountain Landfill, an active permitted solid waste disposal facility, was observed adjacent to the northwestern portion of the site. Based on a review of ground water monitoring reports, the contaminant plume flows eastward from the landfill and does not extend onto the reservoir site (ERO 2007b). A high-voltage power line running north/south crosses through the center of the site. A high pressure gas pipeline running northwest/southeast crosses through the site and a pipeline metering station was observed at the southern end of the site. These features are unlikely to adversely affect proposed project facilities.

3.25.4.1 Mitigation

Proposed Measures

The following mitigation measures, some of which have been proposed by the Participants, would be implemented:

- Prior to construction of project facilities at the site, solid waste disposal areas would be removed from the site and properly disposed at a permitted solid waste disposal facility
- The ground surface beneath the solid waste would be inspected for evidence of hazardous material or petroleum product spills such as soil staining and unusual odors or colors
- If evidence of a spill or spills is noted, the extent of the spill would be delineated by laboratory analysis and any contaminated soils would be excavated and properly disposed at a permitted waste disposal facility
- If soil and/or ground water contamination is encountered during construction of project facilities, mitigation procedures would be implemented to minimize the risk to construction workers and to the future operation of the project

Mitigated Effects

The proposed mitigation measures would identify areas of potential contamination from hazardous materials and would remediate the soil and ground water if any contamination was identified.

3.26 Other NEPA Required Disclosures

3.26.1 Unavoidable Adverse Impacts

Unavoidable adverse impacts are those environmental consequences of an action that cannot be avoided, either by changing the nature of the action or through mitigation if the action is undertaken (Reclamation 2000).

3.26.1.1 Air Quality

All alternatives would temporarily increase emissions from vehicle exhaust and fugitive dust. Emissions associated with the No Action and Action Alternatives would not exceed any federal or state air quality standard.

3.26.1.2 Aquatic Life

All alternatives would inundate portions of stream habitat within the proposed reservoir sites. These stream reaches contain limited communities of aquatic organisms that would be permanently lost and replaced with standing water reservoir communities. All alternatives would alter (i.e., increase or decrease) streamflows in the Arkansas River, Monument Creek, and Fountain Creek, which would affect the structure of the resident aquatic communities. These effects would vary by alternative.

3.26.1.3 Cultural Resources

All alternatives would adversely affect resources listed or eligible for listing in the NRHP. The type and number of affected resources would vary by alternative.

3.26.1.4 Geology and Paleontology

All alternatives would cross areas with currently mined or have potential sand and gravel deposits. Proposed project facilities in the Jimmy Camp Creek area in all alternatives except the Participants' Proposed Action and the Wetland alternatives would have the potential to encounter important paleontological resources, such as fossil plants, invertebrates, and mammals. Important paleontological resources would be adversely affected by Jimmy Camp Creek Reservoir inundation in all alternatives except the Wetland Alternative.

3.26.1.5 Land Use

All alternatives would result in an unavoidable change in land uses to accommodate new reservoirs, pump stations, treatment plants, and related facilities. Land acquired through fee title purchases would be cleared of existing structures and used exclusively for project facilities. Permanent easements would prevent property owners from constructing permanent structures or engaging in other land uses that would interfere with project operation and maintenance. Temporary easements would result in short-term loss of use or opportunity during project construction. All alternatives may result in the conversion of prime farmland and other agricultural land uses to non-agricultural uses.

3.26.1.6 Noise and Vibration

All alternatives would result in an unavoidable increase in noise levels during project construction. Increased construction noise levels would cease at the end of pipeline and facility construction. Increased noise levels around some project components, such as pump stations and water treatment plants, would continue through the planning period; such noise may not be audible beyond the property boundary of the facility. Vibration would be felt close to construction equipment.

3.26.1.7 Recreation

All alternatives would result in the temporary displacement of recreational use along pipeline and powerline corridors. The Downstream Intake and Highway 115 alternatives would result in adverse impacts on angling opportunities in Lake Pueblo State Park. The Highway 115 Alternative would decrease in the number of days that recreation-based targets of the PFMP are met, compared to No Action. The No Action, Wetland, Arkansas River, and Highway 115 alternatives would result in short-term impacts to an existing boat launch near Colorado 115.

3.26.1.8 Socioeconomics

All alternatives would result in temporary disruption of quiet enjoyment of properties along pipeline and powerline corridors and in proximity to other project features. Disruption would be greatest during construction with occasional minor disruption for routine maintenance after construction is completed. Payments to property owners for fee title purchases or easements for project facilities may compensate for all or part of this impact. All alternatives, including No Action, also would result in higher water service rates and/or connection charges for residents and businesses in the service areas of the Participants. The financial impacts would vary by alternative and the manner in which these impacts would be distributed among customer types and customer classes would depend on the specific ratemaking choices made by the Participants. Increases in salinity for certain alternatives could affect the cost of drinking water treatment for the Participants as well as other municipalities. The cost of drinking water treatment for municipalities obtaining drinking water from Pueblo Reservoir could be affected by the Wetland and Arkansas River alternatives. The Fountain Creek Alternative could result in increased salinity in the vicinity of Fountain, causing increased water treatment costs for those obtaining drinking water from the alluvial ground water in that vicinity.

3.26.1.9 Soils

All alternatives would result in some unavoidable loss of soil material from wind and water erosion during construction and until disturbed areas would be revegetated. A short-term loss in soil productivity would occur from disruption of soil biological processes and changes in the soil physical properties from construction disturbance. All alternatives may result in the conversion of prime farmland to non-agricultural uses.

3.26.1.10 Traffic

All alternatives would result in an unavoidable increase in traffic volumes during project construction. Increased construction traffic would cease at the end of facility construction. Increased traffic during operations would be minimal.

3.26.1.11 Vegetation

All alternatives would result in the loss of native plant communities and plant communities of concern along pipeline and transmission line corridors. All alternatives except for the Arkansas River and Downstream Intake alternatives would adversely affect small populations of species of concern. Vegetation communities at the reservoir sites, pump stations, and access roads would be permanently lost.

3.26.1.12 Visual Resources

All alternatives would alter the form, line, color, and texture of the SDS Project analysis area by the construction of permanent, man-made forms, such as reservoirs, powerlines, and pump stations. The underground pipeline corridors would alter the line and color of the landscape crossed by the pipelines.

3.26.1.13 Waste Generation and Handling

Construction of all alternatives would generate considerable quantities of waste soil, rock, and construction debris. Operation of water treatment facilities for all alternatives would generate treatment wastes, such as sludges. The Downstream Intake Alternative would generate a large amount of concentrated solids, such as salts, from reverse osmosis treatment. These wastes would require disposal in landfills or other specialized facilities.

3.26.1.14 Water Resources

Ground Water

All alternatives would result in unavoidable fluctuations in ground water levels in alluvial aquifers adjacent to Fountain Creek and the Arkansas River downstream of Fountain Creek. Fluctuations in stream stages in Fountain Creek and the Arkansas River would affect alluvial ground water levels due to the hydraulic connection between surface and ground water. Ground water levels would increase or decrease, depending on the alternative and the location of interest within the basin. Changes in water levels could affect alluvial ground water wells and basements constructed within the alluvium. Ground water levels in the No Action Alternative would be lower in the areas surrounding wellfields proposed for use by the Participants. Increased pumping of the Denver Basin aquifers under the No Action Alternative would deplete the Denver Basin aquifer in the area near the wells and reduce yields for other ground water users of the Denver Basin aquifers. Ground water levels would increase slightly in the alluvium near and downstream of the new reservoir on Williams Creek.

Surface Water Flow

All alternatives would alter the hydrologic regime in Fountain Creek and portions of the Arkansas River due to additional diversions and exchanges for municipal water supply and associated return flows. Flow in the Arkansas River would be affected between Lake Fork Creek and Las Animas, depending on the alternative. The timing, magnitude, and duration of the flow changes would vary by alternative. Reservoir water levels and storage volumes for all reservoirs within the surface water hydrology analysis area would be affected by future operations, regardless of the alternative. The direction and magnitude of the effects would vary by alternative and reservoir location.

Surface Water Quality

Because of changes in surface water flows, surface water quality would be affected in all alternatives. Concentrations of water quality parameters including nutrients, salinity, and emerging contaminants (i.e., endocrine disrupting compounds, pharmaceuticals and possibly personal care products), would increase in the Arkansas River between Colorado 115 and Pueblo Reservoir for the Wetland and Arkansas River alternatives. Increased nutrient concentrations would continue downstream to the Moffat Street Gage for the Wetland and Arkansas River alternatives. Selenium concentrations would increase in the Arkansas River for all alternatives except for the Arkansas River Alternative at Moffat Street and Catlin Dam.

Geomorphology

All alternatives would modify the geomorphic regime of Fountain Creek and the Arkansas River downstream of Colorado 115. Channel erosion, migration, and sedimentation during peak flows and baseflows would continue and may increase in all alternatives. Baseflows for Fountain Creek and the Arkansas River downstream of Colorado 115 would increase with additional return flows, which could result in erosion in Fountain Creek upstream of Williams Creek and sedimentation downstream of Williams Creek.

3.26.1.15 Wetlands, Waters, and Riparian Vegetation

All alternatives would result in the loss of wetlands and waters of the U.S. and their associated wetland functions and values. A temporary loss of wetland functions and values would occur between the time of the loss and the time the wetland mitigation sites offer the same functions and values. All alternatives would directly and indirectly adversely affect riparian vegetation.

3.26.1.16 Wildlife

All alternatives would result in the temporary loss of wildlife habitat and some displacement of wildlife along pipeline and powerline corridors. Wildlife movement corridors along drainages and other topographic features crossed by pipeline corridors would be temporarily disrupted. Wildlife habitat within the reservoir sites would be permanently lost, and wildlife using the reservoir sites would be permanently displaced.

3.26.2 Relationship of Short-term Uses and Long-term Productivity

The relationship between short-term uses of the environment and the maintenance and enhancement of long-term productivity is similar for all alternatives. All alternatives would enhance long-term productivity by using water resources to provide to the residents of areas served by the Participants, a water supply that will last throughout the contract period. The No Action Alternative, however, would use Denver Basin ground water for some of Colorado Springs' water supply through the planning period. Denver Basin ground water is a non-renewable resource. At some point beyond the planning period, the No Action Alternative would cease to provide a dependable water supply. None of the Action Alternatives would use Denver Basin ground water. In all alternatives, water from the Arkansas River would be used beneficially in municipal water systems in Colorado Springs, Fountain, Security, and, in some Action Alternatives, Pueblo West. This long-term productivity of the environment would continue through the contract period.

Construction of all alternatives would use considerable quantities of energy, labor, and materials such as steel, concrete, and aggregate. Additionally, large amounts of labor and natural resources would be used in the fabrication and preparation of construction materials. Operation of all alternatives would use considerable quantities of electrical energy, currently derived primarily from fossil fuels.

All alternatives would enhance long-term productivity by providing the Participants with redundancy to their water storage and conveyance systems. The No Action Alternative, however, would not provide redundant capacity to convey Fountain and Security's Arkansas River water rights to its service territory.

The short-term and long-term uses of the environment are discussed in the *Environmental Consequences* section for each resource. Unavoidable uses of the environment are summarized in Section 3.26.1.

3.27 Analysis Beyond 2046

3.27.1 Effects from 2046 to 2050

The Action Alternatives being analyzed in the FEIS include one or more contracts of up to 40 years to be issued by Reclamation to the Participants. Because a decision regarding the contracts was originally expected in 2006, the analyses performed as part of this FEIS consider potential effects through 2046. Currently, it is anticipated that Reclamation will issue a ROD in 2009, and, if an Action Alternative is selected, up-to-40-year contracts issued shortly thereafter. This section provides an evaluation of whether extending the potential term of those contracts from 2046 to 2050 would have substantial changes in the results of the effects analyses.

3.27.1.1 Direct and Indirect Effects

Extension of the potential term of the contracts to 2050 would alter the direct and indirect effects disclosed in the FEIS if it changed one of the following:

- The location, capacity, construction timing, or cost of one or more SDS Project components
- The annual volume of water delivered through the SDS Project between 2046 and 2050

An extension to 2050 would not change the location, capacity, construction timing, or cost of SDS Project components. Consequently, construction, land-based, and cost-based effects on the following resources would not be altered:

- Air quality
- Cultural resources
- Environmental justice (land- and cost-based)
- Flood hydrology and floodplains (incidental flood attenuation by proposed reservoirs)
- Geology and paleontology
- Hazardous materials
- Hydrology (alluvial ground water at proposed reservoir sites)
- Indian Trust Assets
- Noise and vibration
- Recreation (land-based)
- Socioeconomics (land- and cost-based)
- Soils
- Traffic
- Vegetation
- Visual resources
- Wetlands, waters, and riparian resources (land-based)
- Wildlife

An extension to 2050 would not result in changes in annual water deliveries through the SDS Project to Fountain, Security, or Pueblo West. Security and Pueblo West are expected to reach community buildout prior to 2046. Fountain's population and water demand may continue to grow beyond 2046; however, it would meet increasing water demands from sources other than the SDS Project.

Colorado Springs' population and water demand would likely increase between 2046 and 2050 and would change the annual volume of water delivered. However, because the assumptions used in the demand forecasting and hydrologic modeling are considered planning scenarios, or the highest possible estimated demand, it is likely that Colorado Springs' actual demand in 2050 will be less than the 2046 planning-level demand (high demand) used for the hydrologic modeling.

Based on the revenue forecast's 1.5 percent annual growth rate in the years leading to 2046, 2050 water demands would be about 178,548 ac-ft. The 2046 demand forecast used in the hydrologic modeling (from the planning forecast) was 197,512 ac-ft. Figure 99 shows Colorado Springs' planning and revenue forecasts with extension from 2046 to 2050 and compares them to the 2046 planning demand (197,512 ac-ft) that was used for hydrologic modeling in this FEIS.

All water demand forecasts are estimates. At 2050, the difference between the two forecasts is 30,259 ac-ft/yr. Actual demand in 2050 would likely fall somewhere within this range. The conservative demand at which the hydrologic model was run (197,512 ac-ft/yr) is 18,964 ac-ft/yr greater than the "median" or revenue forecast. This value falls within the upper half of the range between the forecasts. Therefore, the 197,512 ac-ft simulated demand can still be considered a reasonable estimate of the 2050 demand. Furthermore, an extension

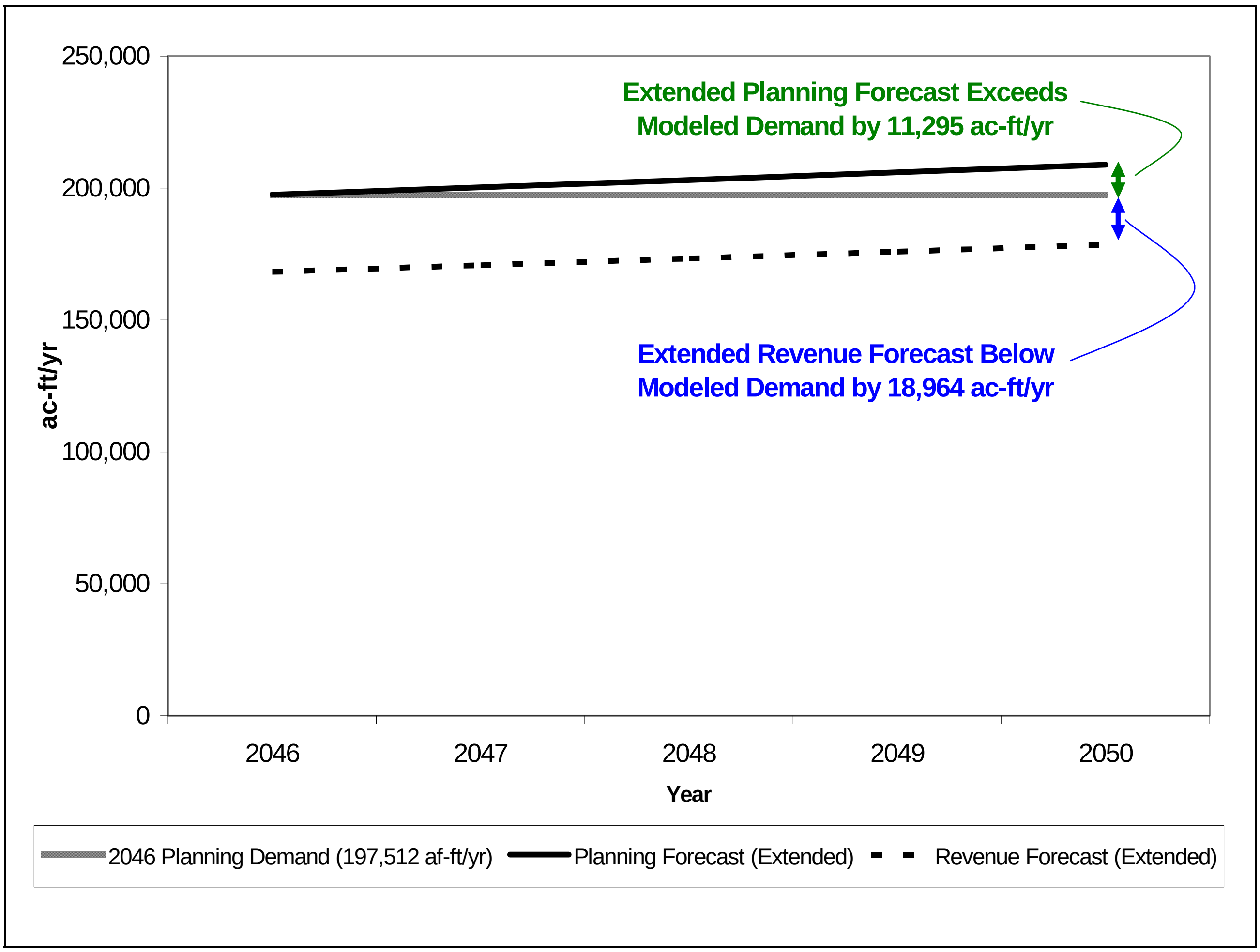


Figure 99. Comparison of Water Demand Used for Hydrologic Modeling and Extensions of Colorado Springs' Demand Forecasts from 2046 to 2050.

Source: Original forecasts from Colorado Springs Utilities 2005.

of the proposed contracts' term to 2050 would not likely result in substantial changes to the hydrologic characteristics of the alternatives. Consequently, hydrology-based effects for the following resources would not be altered substantially:

- Aquatic life
- Environmental justice (water-based)
- Geomorphology (non-peak flow)
- Hydrology (surface water and alluvial ground water not at proposed reservoir sites)
- Recreation (water-based)
- Socioeconomics (water-based)
- Water quality
- Wetlands, waters, and riparian resources (water-based)

3.27.1.2 Cumulative Effects

During the 4-year period from 2046 to 2050, the only reasonably foreseeable action (Section 3.1) that may change would be urban development and land use.

Although regional development will likely continue from 2046 to 2050, there are no population forecasts that extend beyond 2035 (Section 3.1.3.1). Growth-related cumulative effects, except for non-flood hydrology and effects on resources using non-flood hydrology as input (discussed below), for this FEIS were determined using the existing forecasts. Future land uses used to evaluate potential cumulative effects on flood hydrology and peak flow effects on geomorphology were estimated for 2046 using a combination of available data. Based on the current information, the analyses would not be able to show a meaningful difference between cumulative effects at 2046 and at 2050.

All projected water demands in the Arkansas Basin were included in the hydrologic modeling through 2046 for cumulative effects (MWH 2007c). With few exceptions, those projections were based on a "high forecast" that is analogous to Colorado Springs' planning forecast. For the Pueblo Board of Water Works, a "base forecast" that is comparable to Colorado Springs' revenue forecast was used because it best fits available population-based forecasts. Similar to the direct and indirect effects, the assumptions used in the demand forecasting and the hydrologic modeling for cumulative effects should account for the potential increase in actual water demand between 2046 and 2050. Consequently, an extension of the proposed contracts term to 2050 would not result in major changes in the combined hydrologic characteristics of the alternatives and reasonably foreseeable future water demands by non-SDS Project Participants.

Cumulative effects resulting from extending the term of proposed contracts from 2046 to 2050 would not differ substantially from those described through 2046.

3.27.1.3 Unavoidable Adverse Impacts

Unavoidable adverse impacts resulting from extending the term of proposed contracts from 2046 to 2050 would not differ substantially from those described through 2046. All of these impacts are reflected in the direct and indirect effects discussed above.

3.27.1.4 Relationship of Short-term Uses and Long-term Productivity

The relationship between short-term uses of the environment and the maintenance and enhancement of long-term productivity resulting from extending the term of proposed contracts from 2046 to 2050 would not differ substantially from those described through

2046. A notable exception is that the No Action Alternative may use more Denver Basin ground water, which is a non-renewable resource.

3.27.2 Contract Terminus

All Action Alternatives include contracts with terms up to 40 years, and could include storage in Pueblo Reservoir, conveyance of water through facilities associated with Pueblo Reservoir, and exchange of water between Pueblo Reservoir and Reclamation-operated reservoirs in the upper Arkansas River Basin. As stated in Section 3.4.6.1, effects throughout this FEIS were analyzed at the end of the proposed contract period (2046) when effects of SDS Project operations would be the greatest. Near the end of the proposed contract period, it is expected that the Project Participants would elect to request renewal of the contracts with Reclamation. Under current laws and regulations (i.e., NEPA and CEQ), Reclamation would undertake a new NEPA process for contract renewal, through which, environmental and socioeconomic effects of the proposed action and any alternatives would be analyzed and disclosed.

If, at the end of the proposed contract period, the Project Participants did not receive contract renewal or other type of authorization to use Fry-Ark facilities, SDS would not be able to use Pueblo Dam and Reservoir for conveyance or storage. For those alternatives that connect directly to Pueblo Dam outlet facilities, including the Participants' Proposed Action, Wetland, and Fountain Creek alternatives, the ability to use the Pueblo Dam outlet connection would be terminated. This would require the Project Participants to find new means to divert water for conveyance through SDS facilities. It is unknown at this time what types of alternatives the Project Participants would consider in this scenario.

Because the Project Participants have not requested, nor can Reclamation issue, contracts beyond the 40-year contracting period, and due to the large uncertainties in actions beyond the 40-year contract period, no effects were analyzed beyond the 40-year contracting period.

4.0 Consultation and Coordination

This chapter describes the consultation and coordination activities that have occurred during FEIS preparation and how the FEIS process complied with CEQ Regulations (40 CFR 1501.7). It summarizes the scoping process and results of scoping meetings, DEIS and Supplemental Information Report public reviews, and identifies the agencies and organizations consulted.

4.1 Initial Scoping

The scoping process was used to provide the general public, organizations, state and local governments, and affected federal agencies an opportunity to identify issues and concerns associated with the proposed project. Public scoping outreach activities included publication of a Notice of Intent in the Federal Register on September 8, 2003. The Notice of Intent (NOI) notified the public of the intent to begin the EIS process, provided project information and the dates for scoping meetings and receiving comments from the public about the project. To announce the SDS Project, 75 press releases were sent to local and national media organizations and any other interested parties. Colorado Springs placed paid advertisements announcing public scoping meetings and information of the project in various newspapers. Project information was published on the SDS Project web site (www.sdseis.com) and the Reclamation web site on October 31, 2003.

4.1.1.1 Scoping Meetings

Reclamation held five public scoping meetings to solicit issues and concerns about the project from the public. Location, date, venue, and time of each public scoping meeting are provided in Table 148. Each public scoping meeting was in an open house format.

Table 148. SDS Project Scoping Meeting Dates, Locations, and Attendance.

Meeting Date	Meeting Location	Number of Attendees†
Sept. 24, 2003	Buena Vista, CO	8
Sept. 25, 2003	Fountain, CO	14
Oct. 7, 2003	La Junta, CO	12
Oct. 9, 2003	Pueblo, CO	66
Oct. 15, 2003	Colorado Springs, CO	35

†A few attendees elected not to sign in and are not included in the counts.

Reclamation also held an agency scoping meeting on October 27, 2003. Letters were sent out to 107 local, state, and federal agencies inviting them to the meeting. The meeting was a slide presentation followed by a question and answer period.

Reclamation also asked to consult with 13 Native American Tribes to get their input for the scoping process. Reclamation sent letters out requesting a tribal scoping meeting and site visit regarding the SDS Project to discuss the SDS Project and answer concerns and questions. The 13 tribes that were consulted and their meeting attendance are listed in Table 149. The tribes did not participate as cooperating agencies in the EIS process.

4.1.1.2 Newsletters

Newsletters were periodically published and distributed to keep the public informed on the status and findings of the EIS effort. The newsletters were printed front and back.

Table 149. Native American Tribes Consulted during Scoping Process.

Tribe	Present at Tribal Scoping Meeting	Not Present at Tribal Scoping Meeting
Jicarilla Apache	√	
Kiowa Tribe of Oklahoma	√	
Northern Arapaho Tribe	√	
Northern Cheyenne Tribe	√	
Southern Arapaho Tribe	√	
Southern Cheyenne Tribe	√	
Southern Ute Indian Tribe	√	
Comanche Nation of Oklahoma		√
Northern Ute Tribe		√
Ute Mountain Ute Tribe		√
Cheyenne and Arapaho Tribes of Oklahoma		√
Pawnee Nation of Oklahoma		√
Comanche Tribe		√

Reclamation determined the quantity and schedule for publication. The first newsletter was distributed soon after the Scoping Report and was prepared in order to help inform the public about the scoping process results.

4.1.1.3 Web Site

A web site (www.sdseis.com) was created to help distribute information to the public and receive public input about the SDS Project. The web site was periodically updated. A portion of the web site was also available in Spanish.

4.1.1.4 Identified Issues

As discussed in Chapter 2, 10 significant issues were identified during the scoping process for detailed evaluation in the EIS. The 10 significant issues are those with environmental effects that warrant resolution (MWH 2004):

- Surface water flow
- Surface water quality
- Channel stability and morphology
- Sedimentation
- Water rights
- Fish and other aquatic life
- Wetlands and other waters of the U.S.
- Wildlife
- Socioeconomic conditions
- Recreational resources

Reclamation used information gathered during the scoping process in the development of alternatives for the EIS.

4.2 Review of Preliminary Alternatives

After an alternatives analysis was completed and preliminary alternatives to be analyzed in detail were developed, Reclamation solicited public input on the preliminary alternatives. Five public workshops were held to solicit additional alternatives that may address environmental issues (Table 150).

Table 150. Alternatives Workshop Meeting Dates, Location and Attendance.

Meeting Date	Meeting Location	Number of Attendees†
Oct. 11, 2005	Colorado Springs, CO	26
Oct. 12, 2005	La Junta, CO	21
Oct. 13, 2005	Pueblo, CO	66
Oct. 18, 2005	Cañon City, CO	35
Oct. 20, 2005	Pueblo West, CO	40

†A few attendees elected not to sign in and are not included in the counts.

Groups and individuals on the mailing list were notified of the workshops. In addition, 58 press releases and 17 paid advertisements announced the workshops and invited public comments on the alternatives.

The workshops followed the same general format and started with a presentation of the project, the process used to develop alternatives, and the seven alternatives that were proposed to be analyzed in detail. Following the presentation, 326 oral comments were recorded on easel not pads. A total of 217 written public comments also were received throughout the 30-day comment period.

The workshops resulted in realignment of the return flow pipeline in the Fountain Creek Alternative as analyzed in this FEIS.

4.3 DEIS Public Review

After publication of the DEIS on February 29, 2008, Reclamation solicited public input through June 13, 2008. Comments were accepted throughout the public comment period. Additionally, seven public meetings were held to solicit comments on the DEIS (Table 151).

Table 151. DEIS Public Review Meeting Dates, Location and Attendance.

Meeting Date	Meeting Location	Number of Attendees†
April 1, 2008	Buena Vista, CO	16
April 2, 2008	Pueblo, CO	127
April 3, 2008	La Junta, CO	36
April 8, 2008	Fountain, CO	55
April 9, 2008	Colorado Springs, CO	76
April 10, 2008	Cañon City, CO	83
May 29, 2008	Pueblo, CO	62

†A few attendees elected not to sign in and are not included in the counts.

Groups and individuals on the mailing list were notified of DEIS availability and the workshops. In addition, 210 press releases and 40 paid advertisements announced the release of the DEIS and invited public comments.

The April meetings were all open house format. At each meeting, comments were accepted in writing or orally to a court reporter. At the May meeting in Pueblo, CO, commenters were invited to deliver a short oral public comment, which was captured by a court reporter. Nearly 400 comment documents were received throughout the 105-day comment period.

Public comments were raised on a variety of topics. Comments related to water quality, dam safety, and the Western Slope, as well as changes to the alternatives prompted Reclamation to release a Supplemental Information Report after publication of the DEIS. Each public comment on the DEIS is addressed in Appendix B of this FEIS.

4.4 Supplemental Information Report Public Review

A Supplemental Information Report disclosed results of additional water quality, Western Slope, and dam failure analyses. Additionally, effects of physical changes to the alternatives and reasonably foreseeable actions were reviewed to identify substantial changes that may have notably altered previously described effects. The Supplemental Information Report was released for public review from October 3, 2008 through November 24, 2008. A public hearing attended by 23 people (based on sign-in sheets) was held October 29, 2008 in Pueblo, CO. At this hearing, commenters were invited to deliver a short comment, which was captured by a court reporter. A total of 34 public comments were received throughout the 52-day comment period. Each public comment on the Supplemental Information Report is addressed in Appendix C of this FEIS.

4.5 Agency Consultation

Table 152 lists the agencies and organizations consulted during preparation of this document.

Table 152. Agencies and Organizations Consulted.

Federal Agencies	State Agencies	Local Agencies
U.S. Environmental Protection Agency	Colorado Department of Natural Resources (CDNR), Division of Water Resources and State Engineer, Division of Wildlife	City of Pueblo
U.S. Army Corps of Engineers	CDNR, Division of Wildlife	City of Aurora
U.S. Fish and Wildlife Service	CDNR, State Land Board	Pueblo County Planning
U.S. Bureau of Land Management	CDNR, State Parks	Pueblo County Public Works Department
Peterson Air Force Base	Colorado Department of Transportation	Turkey Creek Soil Conservation District
Air Force Academy	Colorado Department of Public Health and Environment	Southeastern Colorado Water Conservancy District
U.S. Geological Survey	Colorado State Historical Society, State Historic Preservation Officer	Lower Arkansas River Water Conservancy District
Bureau of Indian Affairs		Colorado Aviation Historical Society Aviation Archaeology

4.6 Federal Register Notices

Reclamation published 10 notices about the proposed contracts with the Participants in the Federal Register. Notices were published on the following dates:

- February 28, 2003 (68 Fed. Reg. 9722)
- July 26, 2004 (69 Fed. Reg. 44548)
- October 4, 2004 (69 Fed. Reg. 59267)
- March 10, 2005 (70 Fed. Reg. 12017)
- March 11, 2005 (70 Fed. Reg. 12238)
- July 22, 2005 (70 Fed. Reg. 42379)
- February 29, 2008 (73 Fed. Reg. 11144)
- April 24, 2008 (73 Fed. Reg. 22164)
- August 25, 2008 (73 Fed. Reg. 50055)
- October 9, 2008 (73 Fed. Reg. 59670)

4.7 Libraries and Distribution List

Notice of availability of the FEIS was sent to area libraries, federal agencies, Native American Organizations, state agencies, county agencies, city agencies, elected officials, and private individuals. Libraries and Federal agencies received printed copies or compact disks of the FEIS. Native American Organizations, state agencies, county agencies, city agencies, elected officials, organizations, and private individuals were sent written notice of availability with instructions on how to download the FEIS from the internet, and instructions on how to request a printed copy or compact disc from Reclamation unless otherwise noted.

4.7.1 Libraries

Buena Vista/ North Chaffee County Library
131 Linderman Ave
Buena Vista, CO 81211

Cañon City Public Library
516 Macon Ave
Cañon City, CO 81212

Pikes Peak Library District – Penrose Library
20 N Cascade Ave
Colorado Springs, CO 80903

Pueblo City-County Library District
100 E Abriendo Ave
Pueblo, CO 81004

Woodruff Memorial Library
522 Colorado Ave
La Junta, CO 81050

4.7.2 Distribution List

4.7.2.1 Federal Agencies

Air Force Academy

Federal Aviation Administration

Peterson Air Force Base

U.S. Army Corps of Engineers

U.S. Army Fort Carson Military Reservation

U.S. Bureau of Land Management

U.S. Bureau of Indian Affairs

U.S. Environmental Protection Agency

U.S. Fish and Wildlife Service

U.S. Forest Service

U.S. Geological Survey

U.S. Department of the Interior, Office of Environmental Policy and Compliance

U.S. Department of the Interior, Natural Resources Library

4.7.2.2 Native American Organizations

Apache Tribe of Oklahoma

Cheyenne & Arapaho Tribes of Oklahoma

Comanche Nation of Oklahoma

Comanche Tribe

Eastern Shoshone Tribe (Wind River Reservation)

Fort Sill Apache

Jicarilla Apache Tribe

Kiowa Tribe of Oklahoma

Mescarelo Apache Tribe

Northern Arapaho Tribe

Northern Cheyenne Tribe

Northern Ute Tribe

Pawnee Nation of Oklahoma

Shoshone-Bannock

Southern Arapaho Tribe

Southern Cheyenne Tribe

Southern Ute Indian Tribe

Ute Indian Tribe (Uintah and Ouray Reservation)

Ute Mountain Ute Tribe

4.7.2.3 State Agencies

Colorado Department of Natural Resources (CDNR), Division of Water Resources and State Engineer

CDNR, Division of Wildlife

CDNR, State Land Board

CDNR, State Parks

Colorado Department of Agriculture

Colorado Department of Public Health and Environment

Colorado Department of Transportation

Colorado State Historical Society, State Historic Preservation Officer

Colorado State Soil Conservation Service

Kansas Department of Agriculture, Division of Water Resources

4.7.2.4 Local Agencies

Chaffee County Planning and Zoning

City of Aurora Planning

City of Aurora Water Department

City of Cañon City Community Development

City of Colorado Springs Planning

City of Florence Planning and Zoning

City of Fountain Planning

City of Fountain Utilities

City of Pueblo Department of Planning and Community Development

City of Salida Community Development

Colorado Centre Metropolitan District

Colorado Springs Airport

Colorado Springs Utilities

El Paso County Planning Department

Fremont County Planning and Zoning

Lower Arkansas River Water Conservancy District

Pikes Peak Area Council of Governments

Pikes Peak Regional Building Department, Floodplain Administrator

Pikes Peak Regional Water Authority

Pueblo Area Council of Governments

Pueblo Board of Water Works

Pueblo County Planning

Pueblo County Planning and Development

Pueblo County Public Works Department

Pueblo West Metropolitan District

Security Water District

Southeastern Colorado Water Conservancy District

Summit County Government

Turkey Creek Soil Conservation District

Upper Arkansas Water Conservancy District

4.7.2.5 Elected Officials

Honorable Bill Ritter – Colorado Governor

Honorable Wayne Allard – United States Senator, Colorado

Honorable Ken Salazar – United States Senator, Colorado

Honorable Diana DeGette – United States Representative, Colorado 1st District

Honorable Mark Udall – United States Representative, Colorado 2nd District

Honorable John Salazar – United States Representative, Colorado 3rd District

Honorable Marilyn Musgrave – United States Representative, Colorado 4th District

Honorable Doug Lamborn – United States Representative, Colorado 5th District

Honorable Tom Tancredo – United States Representative, Colorado 6th District

Honorable Ed Perlmutter – United States Representative, Colorado 7th District

Honorable Wayne Williams – El Paso Board of County Commissioners District 1

Honorable Amy Lathen – El Paso Board of County Commissioners District 2

Honorable Sallie Clark – El Paso Board of County Commissioners District 3

Honorable Dennis Hisey – El Paso Board of County Commissioners District 4

Honorable Jim Bensberg – El Paso Board of County Commissioners District 5

Honorable Jim Osborne – Chaffee Board of County Commissioners District 1

Honorable Jerry Mallett – Chaffee Board of County Commissioners District 2

Honorable Tim Glenn – Chaffee Board of County Commissioners District 3

Honorable Mike Stiehl – Fremont Board of County Commissioners District 1

Honorable Larry Lasha – Fremont Board of County Commissioners District 2

Honorable Ed Norden – Fremont Board of County Commissioners District 3

Honorable Anthony Nunez – Pueblo Board of County Commissioners District 1

Honorable John Cordova – Pueblo Board of County Commissioners District 2

Honorable Jeff Chostner – Pueblo Board of County Commissioners District 3

Honorable Matthew Heimerich - Crowley County Commissioner District 1

Honorable Kathleen Medina - Crowley County Commissioner District 2

Honorable T.E. (Tobe) Allumbaugh - Crowley County Commissioner District 3

Honorable Bob Bauserman - Otero County Commissioner

Honorable Kevin Karney - Otero County Commissioner

Honorable Harold "Jake" Klein - Otero County Commissioner

Honorable Lynden Gill - Bent County Commissioner

Honorable Bill Long - Bent County Commissioner

Honorable Thomas Wallace - Bent County Commissioner

Honorable Joe Marble - Prowers County Commissioner

Honorable Eugene “Gene” Millbrand - Prowers County Commissioner

Honorable R. Clede Widener - Prowers County Commissioner

Honorable John Tighe - Park County Commissioner District 1

Honorable Leni Walker - Park County Commissioner District 2

Honorable Lillian Wissel - Park County Commissioner District 3

Honorable Michael J. Hickman – Lake County Commissioner

Honorable Kenneth L. Olsen – Lake County Commissioner

Honorable Carl F. Schaefer – Lake County Commissioner

Honorable Lionel Rivera – Colorado Springs Mayor

Honorable Gabriel Ortega – City of Fountain Mayor Pro Tem

Honorable Cara Russell – Buena Vista Mayor

Honorable Michael Occhiato - Pueblo Mayor

Honorable Rick Klein - City Manager, La Junta

Honorable Frank J. Jacquez - Cañon City Mayor

Honorable Charley Rose - Mayor, Salida

Honorable Charmaine Tripp - City Clerk and Treasurer, Las Animas

Honorable Bart Hall - Florence Mayor

4.7.2.6 Organizations and Private Individuals

Notification of the FEIS's availability was sent via U.S. mail to about 2,300 recipients. A list of these recipients is maintained on file by Reclamation.

5.0 Environmental Commitments for the Preferred Alternative

This chapter summarizes the environmental commitments that would be a part of Reclamation's Preferred Alternative. These commitments would be incorporated during final design and project implementation. Reclamation would ensure that these measures are implemented through terms and conditions of any long-term contract between Reclamation and the Participants. Such contracts would, at a minimum, include a requirement for annual submittal of a compliance report and a signed certification of compliance to Reclamation.

The Participants must obtain other significant permits, approvals, and agreements for the SDS Project. These permits, approvals, and agreements include, as examples, a Section 404 permit under the Clean Water Act, a 1041 permit from Pueblo County, and consultation with the CDOW and the Colorado Water Conservation Board (Section 2.4.4). These permits, approvals, and agreements also include significant environmental commitments (mitigation) to be undertaken by Participants as part of the SDS Project.

The complete grouping of Participants' environmental commitments for the SDS Project would be coordinated between Reclamation, the Project Participants, and the authorities responsible for these additional, separate permits, approvals, and agreements. This coordination is the only way to avoid overlapping, inconsistent, or wasteful environmental commitments in the SDS Project. Reclamation would participate fully in this process of coordinating environmental commitments. A complete, detailed, and specific list of environmental commitments would emerge from this coordination process.

The timing of this process is important. Coordination of the complete grouping of environmental commitments would occur prior to executing any contracts for the SDS Project. Any long-term contract between Reclamation and the Participants would contain all detailed environmental commitments and obligations by Participants that are determined by Reclamation to be significant to the SDS Project. In the discussion below, significant environmental commitments by Participants and Reclamation are described in two forms. First, a set of environmental commitments that Reclamation already has decided it would require for the SDS Project are described as such. Second, a group of significant environmental commitments that would be required by Reclamation and that would be considered during the broader coordination process with other permitting and approving authorities.

5.1 Reclamation's Commitments

The following mitigation measures would be implemented:

- The amount of storage in Pueblo Reservoir allowable under temporary excess capacity contracts will be reduced by the amount contracted for as part of the Preferred Alternative consistent with mitigation measure number 3 in environmental assessment and Finding of No Significant Impact number EC-1300-06-02, Temporary Excess Capacity Contracts 2006-2010 dated April 3, 2006

- If Reclamation receives credible information that operations under the contract are causing a violation of the Arkansas River Compact, Reclamation will immediately initiate discussions among the parties, including the party alleging the Compact violation, to develop a solution and remedy the violation.

5.2 Participants' Commitments

5.2.1 General Commitments

The following mitigation measures would be implemented:

- Comply with all applicable permits, regulations, and laws
- Construct and operate the SDS Project in a manner that does not differ substantially from that evaluated in this FEIS, except under emergency conditions, and unless additional and appropriate environmental investigations are completed by Reclamation and approval is then given to Participants to alter construction or operation of the SDS Project
- Develop and implement a head pressure monitoring program on the Joint Use Manifold to isolate effects attributable to the SDS Project and to mitigate those effects if they were to occur. This program would be developed over a 3-year period from the date that water is first delivered from the Joint Use Manifold for the SDS project. Development of the monitoring program would include involvement of all other Joint Use Manifold users.
- Develop an integrated adaptive management program for the project that would be coordinated with the Participants' existing monitoring programs and the Environmental Management System discussed in Appendix F of this FEIS. The integrated adaptive management program would be finalized prior to executing any contracts for the SDS Project.

5.2.2 Surface Water

The following mitigation measures would be implemented:

- Comply with the UAVFMP except during emergency conditions as defined in Section 2.b. of the Memorandum Of Understanding for Settlement of Case No. 04CW129, Water Division 2 (Chaffee County Recreational In-Channel Diversion)
- Comply with the PFMP pursuant to existing intergovernmental agreements (March IGA 2004; May IGA 2004)
- If Reclamation and the Participants receive credible information that project operations are impairing physical diversion of a senior water right contrary to Colorado water law, the Participants will immediately initiate discussions among the parties, including the party alleging the impairment and Reclamation, to develop a solution and remedy the impairment in compliance with Colorado water law

5.2.3 Water Quality

The following mitigation measures would be implemented:

- Include water quality monitoring and adaptive management within the integrated adaptive management program (Section 5.2.1)
- Begin implementing water quality monitoring (Section 3.7.5.4) when construction of the project begins. This will allow about three years of baseline data to be collected before project operations begin.
- Submit water quality monitoring data, including trend analyses, for the preceding calendar year to Reclamation by January 31st of the subsequent year
- If CDPHE determines that operation of the SDS Project is causing significant adverse water quality effects, the Participants will coordinate with Reclamation, CDPHE, and other interested parties to evaluate and select measures to mitigate adverse effects
- In the event that operation of the SDS Project causes, or threatens to cause, streamflows in the Arkansas River or other waterways to diminish to low levels that would contribute significantly to elevated concentrations/densities of dissolved selenium, *E. coli*, or sulfate, the Participants will coordinate with Reclamation, CDPHE, CDOW, and other interested parties to evaluate and select measures to mitigate adverse effects.

5.2.4 Geomorphology

The following mitigation measures would be implemented:

- Prepare a geomorphic mitigation plan and secure Reclamation approval prior to executing any contracts for the SDS Project. This plan could include, but is not limited to:
  1. Evaluate and consider strategies to remove sediments that reduce the effectiveness of Corps levees located near Fountain Creek at its confluence with the Arkansas River
  2. Evaluate and consider strategies to increase the sinuosity of Fountain Creek at appropriate locations in order to reduce undesirable erosion and sedimentation
  3. Evaluate and consider strategies at appropriate locations along Fountain Creek to reduce undesirable erosion and sedimentation
- Select geomorphic mitigation measures for SDS Project effects that are, to the extent practicable, consistent with priority projects identified in the Corps' Fountain Creek Watershed Study and the Fountain Creek Corridor Master Plan. Locations where geomorphic mitigation projects could occur include, but are not limited to:
  1. Fountain Creek at the Clear Spring Ranch site, directly upstream and downstream of the confluence of Little Fountain Creek and Fountain Creek (approximately 4 miles)
  2. Fountain Creek from upstream of Fountain Boulevard to upstream of Colorado 85/87 at the Sand Creek confluence (approximately 3 miles)
- Complete pre-project geomorphic mitigation, including channel stabilization projects and non-structural options such as conservation

easements, before the project is operational. Channel stabilization could include, but is not limited to, increasing stream sinuosity, flattening of steep side slopes, installation of grade control structures, and use of buried riprap, erosion blankets, and/or vegetative cover for channel stabilization in areas of high and/or erosive velocities.

- Design and construct an energy dissipation structure that will protect against erosion at the outlet of the pipeline from Williams Creek Reservoir to Fountain Creek
- Evaluate and implement appropriate future geomorphic stabilization projects, if such future projects are determined to be necessary after the project is operational.

5.2.5 Aquatic Life

The following mitigation measures would be implemented:

- Submit a proposed wildlife mitigation plan to the Colorado Wildlife Commission (Wildlife Commission) pursuant to C.R.S. § 37-60-122.2. This proposal will include actions the Participants proposed to mitigate impacts that the SDS Project may have on fish and wildlife. As required by that statute, the Wildlife Commission will evaluate the probable impact of the project on fish and wildlife and, if the Participants and Wildlife Commission cannot agree upon reasonable mitigation, the Wildlife Commission will make recommendations to the Colorado Water Conservation Board (CWCB) regarding what it believes to be reasonable mitigation actions. If the Participants and the Wildlife Commission agree on a mitigation plan, the Wildlife Commission will submit that agreement to the CWCB, which must adopt the agreement as the state's official position. If the Participants and the Wildlife Commission do not reach agreement on a mitigation plan, the CWCB will consider the plan submitted by the Participants and the recommendations of the Wildlife Commission and either affirm the recommendations of the Wildlife Commission, which then becomes the State's official position, or submit its own recommendations to the Governor, who will ultimately determine the state's official position on the proposed wildlife mitigation plan.
- In the event that operation of the SDS Project causes, or threatens to cause, streamflows in Fountain Creek or the Arkansas River to diminish to low levels that could contribute significantly to impairment of aquatic life, coordinate with Reclamation, CDPHE, CDOW and other interested parties to evaluate and select measures to mitigate adverse effects
- Evaluate and consider participation in CDOW fish hatchery programs
- Monitor the effects of the operation of the SDS Project upon aquatic life in Fountain Creek and the Arkansas River between Pueblo Dam and the Las Animas Gage. Aquatic sampling will be conducted once per year at up to 10 locations. Monitoring methods and locations will be identified in the proposed wildlife mitigation plan that will be submitted to the Colorado Wildlife Commission pursuant to C.R.S. § 37-60-122.2. Use the information from this monitoring in the

adaptive management program for the SDS Project.

5.2.6 Wetlands, Waters, and Riparian Vegetation

The following mitigation measures would be implemented:

- Design final alignments and facilities to avoid and minimize wetland impacts
- Assess alternative construction methods for pipeline crossings (i.e., directional drilling v. open cut) to minimize wetland and stream impacts
- Mitigate impacts to jurisdictional and non-jurisdictional wetlands in areas of temporary, short-term effects such as pipeline crossings, on-site at the place of disturbance with similar wetlands and soils to replace existing wetland functions and values
- Mitigate all unavoidable, permanent impacts to jurisdictional and non-jurisdictional wetlands with compensatory wetlands that replace existing wetland functions and values. Compensatory wetland mitigation would likely occur at the Clear Spring Ranch site on Fountain Creek downstream of the city of Fountain. Conceptual mitigation options at this site are described in Section 3.11.5.4.
- Control tamarisk that may establish around newly constructed reservoirs
- Evaluate and consider a strategy to increase the sinuosity of Fountain Creek at appropriate locations in order to create wetlands areas
- Evaluate and consider the construction and maintenance of new areas of wetlands along Fountain Creek in order to participate in wetlands banking programs. Evaluate and consider cooperation with Colorado agencies to expand such a wetlands creation process

Mitigation plans for jurisdictional and non-jurisdictional wetlands will be submitted for approval by the Corps and Reclamation, respectively. All design and planning measures for wetlands, waters, and riparian vegetation would be completed before any contracts for the SDS Project.

5.2.7 Vegetation

The following mitigation measures would be implemented:

- Prior to final design, review locations of Needle and Threadgrass – Blue Grama Grasslands, high quality shrublands and woodlands, and other areas with desirable vegetation to determine design changes within the current study area that would avoid and minimize impacts
- Replace mature trees (diameter at breast height of 12 inches or greater) within construction areas at a 1:1 ratio with the same or similar native species with available nursery container stock or pole plantings as soon as practicable after construction activities have ended
- For 1 year after construction, monitor the construction areas to determine if appropriate native vegetation is establishing. If native vegetation is not establishing, the site would be reseeded with appropriate species
- In the appropriate season prior to construction, survey potential construction areas with known populations of dwarf milkweed and other plant species of concern, to locate areas where impacts can be avoided and minimized to the extent practicable

with design changes within the current study area. After identifying populations to avoid, mark populations within or nearby the construction easement as environmentally sensitive so that workers avoid inadvertent impacts.

- During construction, wash major construction equipment before it enters the site so that noxious weeds are not spread from other construction sites
- Use certified weed-free mulch after seeding construction areas
- Reseed construction areas with comparable native vegetation as soon as practicable after disturbance, using seed that does not contain any noxious weed seed
- Monitor construction areas for 3 years after construction to assess if noxious weeds have invaded the site. If noxious weeds are present, weed control plans would be formulated and completed.
- Because the project may indirectly increase the spread of tamarisk, the Participants would work with the Colorado Department of Agriculture's Colorado Noxious Weed Management Team on tamarisk issues in the Arkansas Valley including submitting a request for partnership evaluation.

5.2.8 Wildlife

The following mitigation measures would be implemented:

- Submit a proposed wildlife mitigation plan to the Colorado Wildlife Commission pursuant to C.R.S. § 37-60-122.2 as described in Section 5.2.5
- Promptly revegetate all disturbed areas with native species that provide species diversity and food and cover for large game and wildlife habitat
- Conduct clearance surveys in suitable habitat for state-listed species following standard protocols, as available, prior to construction (e.g., CDOW undated)
- Conduct raptor nest surveys prior to construction and impose seasonal restrictions to surface activity within recommended buffers (generally ¼ to ½ mile) (CDOW 2008; Service 2002) around active raptor nest sites and heron rookeries during construction
- Consult with CDOW and U.S. Fish and Wildlife Services' Migratory Permit Bird Office to develop mitigation for unavoidable loss of raptor nests. Options may include constructing artificial nests in suitable habitat or enhancing prey habitat
- Develop construction schedules to avoid impacts to nesting migratory birds. If construction is scheduled to occur during the nesting season (April 1 through August 31) in areas where migratory birds may nest, a qualified biologist would conduct a nesting bird survey prior to the commencement of construction activities to determine the presence of migratory birds and their nests. If an active nest is detected, a buffer zone between the nest and the limit of construction would be flagged and avoided during the nesting season, or construction would be scheduled outside of the nesting season.
- Conduct pre-construction surveys for swift fox den sites within appropriate habitat along the pipeline corridor and proposed reservoir sites. Avoid surface disturbance within ¼ mile of active den

sites while young are den-dependent (March 15 - June 15)

- Restrict pesticides for rodent control within swift fox overall range
- Mitigate impacts to state-listed amphibian species by avoiding, minimizing, and mitigating wetland effects as described in Section 5.2.6
- Impose seasonal restrictions on construction to avoid sensitive large game winter habitat (from first large snowfall to summer green-up (CNDIS 2007 metadata))
- Install wildlife crossovers (trench plugs) during pipeline construction with ramps on each side at a maximum of ¼ mile intervals and at well-defined game trails
- Create additional nesting habitat or nest boxes in nearby trees for the Lewis' woodpecker when nest trees are destroyed.

5.2.9 Recreation

The following mitigation measures would be implemented:

- During short-term construction activities that require trail closures of developed recreational trails, designate a safe and reasonable detour around the project site. Post signs directing trail users.
- Work with the local municipality to establish alternate trails with consistent width, surfacing, and signage
- Within developed parks with temporary effects, commit to full reclamation of the impact area by replacing turf, irrigation systems, and other facilities that could be affected. Provide follow-up monitoring and maintenance for 1 year to ensure that reclamation efforts are successful.
- In developed park areas with permanent, above ground SDS Project facilities, reconfigure park facilities that would be directly affected and visually screen SDS Project facilities from other park uses with vegetation, berming, or attractive fencing
- Seek opportunities to enhance angling, boating, or other recreation opportunities at Lake Henry, Lake Meredith, and Holbrook Reservoir so that they are less vulnerable to water level fluctuations. Work with the CDOW to identify priority projects and include them in a proposed wildlife mitigation plan to the Colorado Wildlife Commission pursuant to C.R.S. § 37-60-122.2 as described in Section 5.2.5.

5.2.10 Socioeconomics and Land Use

The following mitigation measures would be implemented:

- Acquire properties and easements through voluntary, willing participant agreements to the maximum extent practicable
- Develop a construction management plan to outline best management practices to minimize impacts to surrounding properties and submit plan to Reclamation for approval prior to construction.

5.2.11 Cultural Resources

The following mitigation measures would be implemented:

- Comply with the requirements of the Programmatic Agreement between Reclamation, the ACHP, Colorado

Springs, and the Colorado SHPO (Appendix I)

5.2.12 Indian Trust Assets

Continue consultation with Native American Tribes in accordance with the Programmatic Agreement.

5.2.13 Noise and Vibration

The following mitigation measures would be implemented:

- Construction equipment used by contractors shall function as designed and shall conform to applicable noise emission standards
- Generally adhere to project work hour restrictions (7 a.m. to 7 p.m.) within 500 feet of residences, hospitals, schools, churches, and libraries. Work hours may need to be extended from time to time in order to expeditiously restore traffic flow or public access.
- Restrict access to construction areas so that the public could not be in close proximity to loud equipment or blasting
- House project operating equipment (e.g., pump stations) in structures designed to minimize radiated noise outside the structure, and would meet local noise ordinance requirements.

5.2.14 Visual Resources

The following mitigation measures would be implemented:

- Vegetate earthen dam faces with native herbaceous plants to match the adjacent undisturbed prairie plant communities
- Revegetate and/or landscape with plants, all disturbances associated with the construction of all facilities
- Restore as many existing grades as practicable following pipeline excavations
- Enclose pump stations and well equipment in structures matching the architectural characteristics of the surrounding structures
- Construct powerlines with non-specular (not shiny) wire, non-reflective and opaque insulators, and light-colored, non-reflective finished poles
- Reclaim construction access roads and staging areas by restoring existing grade and revegetating the area of disturbance
- Apply water with standard construction practices to control airborne fugitive dust within construction areas
- Install baffles on construction lighting fixtures to direct light onto the construction activity only in locations where safety is a concern, scenic quality would be affected, or near occupied homes and businesses.

5.2.15 Traffic

The following mitigation measures would be implemented:

- Use trenchless construction to the extent practicable when construction features cross railroad lines, state highways, county roadways in densely populated areas, and major city roadways in densely populated areas.
- Prepare traffic control plans for approval by state and local traffic authorities and followed by contractors during construction
- Construct traffic signage, signals, acceleration, and deceleration lanes as directed by state and local traffic

authorities for access to reservoir sites, treatment plants, and pump stations

- Construct improvements to existing access roads or construction of temporary alternate access roads to reservoir sites, treatment plants, and pump stations as directed by state and local traffic officials
- Modify or reconstruct bridges when the load limits are not adequate for construction of the SDS Project and other access routes are not reasonable.

5.2.16 Soils

The following mitigation measures would be implemented:

- Minimize the area of disturbance to defined construction limits and limit the time bare soil is exposed
- Contain soils within the construction area through temporary sediment control measures such as silt fences, sediment logs, trenches, and sediment traps
- Remove woody vegetation prior to topsoil salvage and, to the extent possible, salvage topsoil within tree stump roots
- Use topsoil salvage methods including windrowing topsoil at the limits of construction and pulling the soil back on slopes during reclamation
- Apply topsoil, soil amendments, fertilizers, and mulches as appropriate, and seed selectively during favorable plant establishment climate conditions to match site conditions and revegetation goals
- To the extent practicable, avoid irrigated lands during final design
- To the extent practicable, allow continued use of lands crossed by project facilities after construction
- Where the proposed pipeline crosses prime farmland soils, develop a soils handling plan that separates the top 6 inches and the soils between 6 and 36 inches for subsequent reclamation

5.2.17 Air Quality

The following mitigation measures would be implemented:

- Develop and implement standard control practices, such as watering, to minimize particulate and dust emissions from construction work sites as specified in the fugitive dust control plan
- Ensure construction equipment (especially diesel equipment) meets opacity standards for operating emissions
- Promptly revegetate disturbed areas

5.2.18 Hazardous Materials

The following mitigation measures would be implemented:

- Remove solid waste and properly dispose of at a permitted solid waste disposal facility prior to construction of project facilities at the site
- Inspect the ground surface beneath the solid waste for evidence of hazardous material or petroleum product spills such as soil staining and unusual odors or colors
- If evidence of a spill or spills is noted, delineate the extent of the spill by laboratory analysis and excavate any contaminated soils and properly

dispose of at a permitted waste disposal facility

- If soil and/or ground water contamination is encountered during construction of project facilities, implement mitigation procedures to minimize the risk to construction workers and to the future operation of the project.

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