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DISTRICT COURT
PUEBLO COUNTY, COLORADO

CITY OF COLORADO SPRINGS V. WALKER RANCHES, LLLP
CASE NUMBER: 2011-CV-313

EXPERT REPORT
OF
EDWARD F. REDENTE, Ph.D.
AND
DAVID L. BUCKNER, Ph.D.

March 21, 2014

EXPERT REPORT OF E. F. REDENTE AND D. L. BUCKNER
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I. INTRODUCTION

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b. Evaluate pre-existing vegetation conditions along the portion of S3 alignment on the property of Walker Ranches

c. Evaluate first year plant growth along S3 easement on the property of Walker Ranches.

d. Evaluate the findings of Walker Ranches relevant to revegetation practices implemented by CSU and the current result of these practices.

e. Evaluate treatment recommendations proposed by Walker Ranches.

2. Steps to Accomplish the Stated Tasks

a. Site visits along the S3 easement to evaluate conditions with respect to revegetation practices, establishment and growth of seeded species, presence of weeds, erosion and sedimentation, and vegetation and soil conditions off and adjacent to the easement.

b. Vegetation sampling in 2011 for plant cover to document pre-existing plant community conditions along S3 alignment.

c. Vegetation monitoring in 2013 for seedling density and plant cover to assess first year plant growth along the S3 easement.

d. Review of findings presented by Walker Ranches with site visits to evaluate claims of inappropriate revegetation practices and environmental damage.

e. Prepare a report (on behalf of the City of Colorado Springs in City of Colorado Springs v. Walker Ranches, LLLP, Case No. 2011-CV-313) of our expert opinions concerning the revegetation of the S3 easement on the property of Walker Ranches.

3. Disclaimers

a. This report is preliminary and our opinions are based on information that is available to us at this time. We reserve the right to modify and supplement our opinions as further information comes to light, including but not limited to documents and other information produced in formal discovery and through the depositions of the Plaintiff and the Plaintiff's experts.

II. **QUALIFICATIONS**

1. Edward F. Redente, Ph.D.

a. My educational training is in the fields of Range Ecology, Restoration Ecology, Plant Ecology, Soil Science, and Geography. I earned a Bachelor of Arts degree in Geography and Biology from Western Michigan University (1972), a Master of Science in Rangeland Ecology from Colorado State University (1974), and a Doctor of Philosophy in Rangeland Ecology from Colorado State University in 1980.

b. I currently work as an independent consultant and have worked in this capacity since 2010. Prior to being self employed, I was a Vice President and Principal Ecologist for a large privately owned engineering and environmental consulting company called MWH, Inc. Between 2007 and 2010, I managed MWH's office in Fort Collins, CO. Before joining MWH, I worked the majority of my career at Colorado State University (CSU) as a professor and administrator. I began my career at CSU in 1976 when I was first hired as a research associate and later hired in a tenured faculty position in 1980. I taught undergraduate courses in ecology, restoration ecology, principles of range management, range improvements, range planning and management, rangeland ecosystem planning, and graduate courses in range habitat manipulation, ecology of disturbed lands and ecological risk assessment. During my tenure at CSU I maintained an active research program in mined land reclamation, restoration of disturbed lands, successional ecology, plant/soil interactions, plant/microbial interactions, heavy metal contamination, and ecological risk assessment. I was awarded over $10 million in contract and grant money from such funding sources as the National Science Foundation, U.S. Department of Energy, Department of Defense, EPA, National Park Service, U.S. Department of Agriculture, State of Colorado, U.S. Fish and Wildlife Service, and private industry. I successfully completed 68 graduate students and supported 6 post-doctoral candidates. I have been invited to several countries (Brazil, Peru, Guatemala, Dominican Republic, Australia, Japan, China, India, Germany, Austria, and Hungary) to present invited papers on findings from my research projects and to provide advice on disturbed land related issues. In 1994 I was hired by the World Bank and the Peruvian Ministry for Mining and Energy to write reclamation regulatory guidelines for the Peruvian government. I served as department head in the Forest, Rangeland and Watershed Stewardship Department and Director of the Center for Ecological Risk Assessment and Management. I also served as Associate Dean for research in the Warner College of Natural Resources, Associate Vice President for Research for the University, and the Dean of the Warner College of Natural Resources. I retired from CSU in December 2006.

c. I have published over 100 peer reviewed journal articles, 10 book chapters, and over 100 articles published as technical reports and papers in symposium proceedings. I have published in such journals as *Soil Science, Journal of*

Environmental Quality, Journal of Range Management, Journal of Soil and Water Conservation, Reclamation and Revegetation Research, Vegetatio, Applied Environmental Microbiology, Biology and Fertility of Soils, Soil Biology and Biochemistry, Arid Soil Research and Rehabilitation, Plant and Soil, Soil Science, Oecologia, Ecology, Ecological Applications, Ecological Modelling, Ecosystems, Restoration Ecology, and *Environmental Toxicology and Chemistry*.

d. I frequently serve as a peer reviewer for refereed journals and for national funding agencies. Those organizations and journals that most commonly request my services for peer review include the U.S. Department of Energy, EPA, National Science Foundation, U.S. Department of Agriculture, *Journal of Range Management, Ecology, Journal of Environmental Quality, Oecologia, Soil Science Society of America, Restoration Ecology, Arid Soil Research and Rehabilitation, and Soil Science*.

e. In 1994, I received the Outstanding Achievement Award from the Society of Range Management. This award is presented to researchers that have made significant contributions to their field of study. In 2003 I was awarded the title of University Distinguished Teaching Scholar. Only 12 active faculty at Colorado State hold this title at any one time. In 2007 I was awarded the Theodore M. Sperry Award by the Society for Ecological Restoration and in 2008 I was awarded the James A. Pendleton Award by the Colorado Division of Reclamation and Mining.

f. My resume, with list of publications, is attached as Appendix B.

2. <u>David L. Buckner, Ph.D.</u>

a. My educational training is in the areas of Plant Ecology, Restoration Ecology and Soil Science. I was graduated in 1970 with a Bachelor of Arts degree in Biology from the University of Colorado in Boulder. A Masters of Arts degree and a Doctor of Philosophy degree followed in 1973 and 1977, respectively, from the same institution.

b. I currently work for and own a consulting firm, ESCO Associates Inc. that has specialized in restoration ecology and quantitative monitoring of plant communities since its founding in 1986. Prior to that I worked for Camp Dresser and McKee as a plant ecologist (1975 to 1979; 1983 to 1986) and Western Resource Development also as a plant ecologist (1979 to 1983).

c. I have performed baseline vegetation analyses at sites of proposed development in Colorado, Wyoming, Montana, New Mexico, Arizona, and Utah, as well as Moqoequa Department, Peru. At sites where restoration efforts are to be quantitatively judged for adequacy, I have performed studies in Colorado, Wyoming, Montana, Arizona and New Mexico. In these studies, statistically controlled random sampling is used to establish objective and repeatable information on the abundance of vegetation and the component species in revegetated areas. These data are used to evaluate adequacy of reclamation under, for example, the requirements of the Surface Mine Control and Reclamation Act (SMCRA) and state laws operable under the provisions of SMCRA.

d. I have participated in representation of the U.S. Environmental Protection Agency at the Rocky Mountain Arsenal, in Commerce City, Colorado in oversight of the design, implementation and long-term monitoring of the vegetation portion of caps and covers.

e. I have represented USEPA interests in oversight of the closure, reclamation, and revegetation monitoring of portions of the Rocky Flats nuclear plant site in Jefferson County, Colorado.

f. My resume with details of projects and publications is attached as part of Appendix B.

III. DATA AND OTHER INFORMATION CONSIDERED

To the best of our knowledge, all of the information that we considered in developing our opinions is either contained or referenced in this expert report. We reserve the right to amend and supplement this report as new information is made available.

We visited the S3 easement to observe revegetation practices and to evaluate plant growth following revegetation on numerous occasions following pipeline construction.

<u>Establishment of Pre-Construction Conditions</u>

The S3 segment of the pipeline was visited in October 2011 at which time the nature of the vegetation existing prior to pipeline construction was determined using quantitative sampling. In as much as the operable performance standard under the Pueblo County 1041 permitting documents included percent cover, the sampling was directed at determination of the quantitative extent of plant cover prior to construction. A detailed protocol for the process of cover data collection was submitted to Colorado Springs Utilities prior to sampling. The method used is known as point intercept sampling. The method uses very fine points projected vertically from above to determine how much of the ground is covered by each plant species or by bare soil, standing dead plants, detached bits of plants (litter) or rock (fragments with a diameter of at least 1 cm). Points are defined by an optical instrument that is, prior to each observation, adjusted to assure vertical projection. Each sample is comprised of the results of projection of one hundred points evenly spaced along a 50 m transect. Should, for example, Species A be hit in 40 of the 100 projected points, then Species A is attributed 40% cover of the ground.

Point intercept sampling was chosen to maximize objectivity and repeatability of the observations. Other commonly used methods of cover assessment are simple ocular estimates. The results of ocular estimation have been found by experience to vary widely between observers.

Samples were located at intervals along the proposed right-of-way. Along the length of segment S3 the nature of the substrate varies. In order to identify revegetation goals that reflect the capabilities of the varying substrates (soils), data from similar soils were put together into groups of which four occur on the Walker Ranch portion of S3.

<u>Quantitative Evaluation of First-year Results</u>

During the last week of September 2013, the Walker Ranch portion of pipeline segment S3 was quantitatively sampled to assess progress of plant growth during the 2013 growing season. Seeding for the most part had been completed in 2012, but dry conditions and cold temperatures had precluded germination until 2013. Irrigation was initiated on the Walker Ranch portion of segment S3 during late June. Samples were placed at random points in conformance with the Technical Memo 1 (pages 7 and 8) associated with the Pueblo County Protocol (CNHP, 2012). Data collection was completed using the same methods used in pre-construction surveys. An additional sampling procedure was implemented during this sampling effort. This quantitatively assessed the presence of acceptable species (as set forth in the Pueblo County Protocol).

IV. **SUMMARY OF OPINIONS AND REASONS FOR OPINIONS**

1. Opinions of E. F. Redente

Techniques for Successful Revegetation

The following information is presented as a primer on appropriate techniques for revegetating surface disturbances associated with pipeline construction in semiarid regions of the western U.S., such as Pueblo County, Colorado. The techniques and concepts presented are considered the most appropriate for achieving revegetation success and can be used as a guide for evaluating revegetation techniques used by the City of Colorado Springs on disturbances located on the Walker Ranch. The techniques and concepts presented are not exhaustive, but do cover what would be considered most critical to revegetation success.

Site Preparation

Site preparation activities initiate the revegetation process and are essential to provide an environment which is conducive to plant establishment and plant community development. Site preparation can include both chemical and physical treatments which are a precursor to successful revegetation. The initial phase of preparation includes grading and shaping the disturbed area to approximate pre-existing topographical relationships, scarification to reduce compaction, topsoiling which renews the soil fertility status and initiates nutrient cycling processes, and the addition of amendments to improve soil physical and chemical properties, if needed.

a. *Topographic Relationships*—Revegetation success in any disturbed setting will be dependent upon abiotic and biotic characteristics of the environment. The abiotic factors that can be readily influenced by revegetation activities are soil and topographic conditions. Soil factors are important and should be considered because soil conditions will directly influence the rate and direction of plant community development. Topography interacts with macroclimate to produce the microclimate that influences plant community development at any specific site.

   Surface hydrologic characteristics are associated with macro and micro topographical variation. Disturbed sites are typically void of vegetation. These sites are subject to overland flow and sediment transport. On relatively level terrain, surface runoff is controlled by the infiltration rate of the soil surface. On steeper slopes, runoff is controlled by surface retention and storage characteristics of the soil surface.

b. *Tillage*—Before any planting can be done on a disturbed site, preparations need to be made to create an environment suitable for plant establishment. Physical site preparation is often referred to as tillage. Tillage provides: 1) a favorable environment for germination and seedling growth, 2) weed control, 3) erosion control, and 4) soil water conservation. Tillage improves soil aeration, reduces runoff, increases infiltration, reduces compaction, and produces conditions for good seed contact with the soil.

There are primary and secondary tillage methods. Primary tillage methods affect the soil to a relatively deep depth and leave the surface rough. The two most common methods of primary tillage are ripping and chisel plowing. Secondary tillage methods affect the soil to a relatively shallow depth and are used to prepare the seedbed prior to planting. Secondary tillage reduces the roughness of the soil surface, removes weeds, and helps conserve water. The most common method of secondary tillage is disking or harrowing.

Topsoil

a. *Importance*—Topsoil has been defined as the soil of the A and B horizons. Although not always applied to disturbed lands, the re-application of topsoil usually provides plant propagules, soil microorganisms that are key to nutrient cycling and soil building processes, organic matter, and nutrients not usually present in subsoils.

b. *Seedbed Relationships*—Topsoil provides a seedbed that is generally more favorable for germination and plant growth especially when seeding operations will be used for propagule introduction. A topsoiled area will usually enhance proper seed burial, ensure seed/soil contact, and ensure unrestricted root development, both physically and nutritionally.

c. *Soil Organic Matter*—Soil organic matter greatly influences the nutrient status and physical properties of most soils. Perhaps most importantly, organic matter serves as the carbon source supplying energy for microbial populations.

Disturbances can affect soil organic matter in several ways. The soil layer containing organic matter can be 1) removed by erosion, 2) buried by depositional processes or 3) become inactive by the removal of vegetation for an extended period of time. Reestablishing the organic matter layer thus becomes paramount in the revegetation process. Topsoil additions supply soil organic matter which renews microbial activity and subsequently influences fertility and plant growth.

d. *Soil Microbial Community*—Topsoil generally has an active soil microbial community. This community is responsible for decomposing plant and animal residues, supplying a source of CO_2 to plant roots, cycling nutrients from the atmosphere and soil organic matter, increasing moisture uptake, and influencing physical properties and development of the soil. Soils void of a microbial community tend to be unproductive and not capable of supporting a later successional plant community. Disturbance, in general, reduces microbiological activity and revegetation practices which promote microbial recolonization will greatly enhance site recovery.

Mycorrhizal fungi are symbiotically associated with certain plant species and aid in the uptake of nutrients and water. It has been well documented that the absence of these fungi will restrict a plant community from progressing to a later successional stage. Disturbed areas which have been void of vegetation for long periods of time typically lose mycorrhizal populations. The fungi will eventually invade from surrounding intact communities, however this is dependent upon the size and intensity of the disturbance and the species composition of the surrounding community.

Topsoil can serve as a viable inoculum for mycorrhizal fungi, specifically and other microorganisms in general. Replacement of topsoil will have a positive impact on the development of microbial populations and the subsequent development of plant communities that are self-sustaining.

e. *Topsoil Manipulation*—The potential benefits of topsoil reapplication depend on proper handling, storage, and reapplication of the topsoil. Topsoil removal and storage has received much attention due to its relative importance in the revegetation process. Primary concern centers on the effect of these activities on microbial populations, viability of inherent seed propagules, and the impact on soil physical characteristics. Generally, topsoil removal and storage methods are based on the type of activity and the duration of the construction project. Immediate respreading of topsoil, or minimal storage time is desirable for any salvaged material.

If salvaged topsoil is believed to contain a source of noxious weeds, it is important that efforts be made to prevent the spread of these plants. Sites should be managed for weed control by mechanical or chemical treatments. The exact approach will depend upon the species of concern and revegetation goals for the site.

Soil Physical and Chemical Limitations

a. *Soil Compaction*—Soil compaction may be defined as the act of moving soil particles closer together by external forces. These forces range from natural ones, such as falling raindrops to unnatural forces such as motorized vehicle activity. A certain amount of compaction or firmness may be beneficial, such as to establish seed-soil contact for proper germination, but when compaction is excessive, it may result in deleterious effects to the soil and to the growth of plants.

The most common approach to alleviate problems associated with compaction is through physical manipulation of the soil by deep ripping, chiseling, or disking.

b. *Slope Angle and Exposure*—The topography of a site, including slope angle, length of slope, and exposure may become a limiting factor to revegetation success if these features are extreme. Steep slopes (2h:1v and steeper and long uninterrupted slopes can be difficult to reclaim because of access, instability, and potential for erosion. In dry regions, slopes that are south and west facing are typically drier and more difficult to reclaim than north and east facing slopes because of lower soil water conditions and less soil development.

Where possible, slope angle and length of slope should be reduced as much as practicable when slopes exceed 3h:1v and slope lengths exceed 100 feet. Special mulch materials, such as erosion control blankets (e.g. jute and excelsior) should be used on slopes exceeding 3h:1v to properly control erosion until a plant community is established.

c. *Soluble Salts*—Saline soils are common features of semiarid environments. These soils are associated with climates in which potential annual evapotranspiration greatly exceeds annual rainfall. The result is that, although the lack of water reduces the intensity of soil mineral weathering, the products of the weathering that do occur, for example, salts, tend to accumulate in the soil. Because water is the vector for salt, salt accumulation in soil commonly reflects the relief and geomorphological conditions of the area. Salt accumulation also results from high water tables, lack of drainage, or movement of water through saline geologic deposits.

A salinity hazard exists when there is sufficient soluble salt in a soil to interfere with the growth of desired vegetation. The major adverse effect of soil salinity is to reduce the availability of soil water to plants. Plant species have different abilities to make osmotic adjustments in the direction of maintaining a constant water potential gradient between the plant and the soil solution. Plants that are able to make the physiological changes associated with this adjustment and tolerate higher internal salt accumulations are plants considered to be salt tolerant.

The most common approaches to mitigating salinity problems are to add organic matter to the soil to improve infiltration and natural leaching, irrigation to leach salts out of the root zone, or planting salt tolerant species.

d. *Nutrient Limitations*—Nitrogen (N) and phosphorus (P) deficiency on disturbed lands is generally one of the most limiting factors to revegetation success. Nitrogen deficiencies result from either low levels of plant-available N created by a disturbance or a lack of microorganisms to convert various compounds to nitrogen forms used by plants. The reestablishment of an active biological cycle of N turnover is a key to revegetation success on disturbed sites that have been severely impacted.

Phosphorus deficiencies occur primarily because of the insolubility of P and the fixation of P by clay minerals in the soil. When P is deficient, seedlings have a difficult time establishing because of a limited ability to access adequate amounts of P, due to restricted root development.

Nitrogen and phosphorus deficiencies can be overcome with inorganic or organic fertilizer. The primary concern is to limit the amount of N added because of the stimulation it causes in the growth of annuals, if annuals are a potential problem. Nitrogen amendments should be applied in very conservative amounts, if applied at all. Phosphorus is not known to stimulate weed growth and can be applied in more liberal amounts.

Selection of Plant Materials

a. *Plant Species Selection*—Plant distribution is a function of soil and climatic factors and plant growth is controlled by the range in biotic and abiotic conditions that characterize a site. The ultimate selection of plant materials should be based on climate, soil characteristics, elevation, exposure, and ecological and land use goals for the disturbed site.

Selected species should include some rapidly establishing species to control erosion and use site resources to inhibit the establishment of unwanted weeds. Species should be selected that have different rooting depths, that grow at different times of the year, and represent various reproductive strategies. The more successful the established community will be in using space, light, nutrients, and water, the less susceptible the community will be to invasion by undesirable species.

Developing seed mixtures with compatible species requires a comprehensive knowledge of ecological characteristics of the individual species of interest. It is not possible in a document such as this, to list potential plant species for revegetation or ecological characteristics of these species. The most that we can accomplish is to provide some discussions of basic principles for species selection. For example, when selecting species for revegetation, the following items should be considered, at a minimum: 1) life form types desired, 2) specific species within each life form, 3) availability of the species in the form of seed, and 4) identification of any existing habitat characteristics that would limit establishment of the species being considered.

It is common to group plant species into life forms such as perennial grasses, annual grasses, perennial forbs, annual forbs, biennial forbs, shrubs, and trees. These categories may be further subdivided into such groupings as cool and warm season. Within each category, specific species need to be selected to match the habitat characteristics and the plant community structure being proposed.

The growth requirements of each species in a mixture must match the texture, pH, salinity, nutrient levels, moisture conditions, temperature, and elevational ranges of the site. When selecting species, we need to be aware of the impact of all of these parameters on each seeded species and also understand the subtle variations of combinations of these parameters upon vegetation.

Seeding Rates and Planting Methods

a. *Seeding Rates*—It is important to use enough seed to get a good stand, but not more than necessary. Too much seed may produce a stand of vegetation with excessive competition among seeded species. On the other hand, seeding rates that are too low will not provide adequate erosion control or competition against undesirable invading species.

b. *Seeding*—The primary concern of seeding is to place the seed in the soil at the depth most favorable for its germination and establishment. The optimum depth of seed placement differs for each species, but in general, the smaller the seed the more shallow the placement in the soil and the larger the seed the deeper the placement.

c. *Drill Seeding*—Drill seeding uses an implement that places the seed at a specified depth in the soil. Since location of the seed in the soil profile should optimize its potential for contact with water, seeding depth will vary with soil water holding capacity, soil texture, site exposure, and other aspects that influence soil moisture.

d. <u>*Broadcast Seeding*</u>—Any method of seed dispersal which drops seed upon the ground and does not place it in the soil is referred to as broadcast seeding. Since the seed is deposited on the soil surface and not placed in the soil, some sort of device (e.g. harrow) is pulled over the site after seeding to cover the seed with soil.

e. <u>*Season of Seeding*</u>—The time of seeding or planting is influenced by such factors as climate and seasonal weather patterns, seasonal growth patterns and moisture requirements of the planted species. Usually the best times for planting precede or coincide with periods of precipitation that are of sufficient duration to allow the planted vegetation to become established. Late fall seedings are common and are referred to as dormant fall seedings. Seed is placed in the ground as late in the season as possible. The seed undergoes vernalization in the soil and is ready to germinate when temperature and moisture conditions are optimum in the spring. In general, cool season species tend to perform better when planted in the fall and warm season species tend to do better when planted in the spring or summer, depending upon the region and use of revegetation practices such as irrigation.

<u>Fertilization</u>

Nutrients are found in the soil in different pools. Part of the total soil nutrient pool is readily available to plants. This available pool is found in soil solution. A second portion of the total nutrient content of a soil is complexed in one form or another and slowly becomes available to the plant. These nutrients may be in organic form or on soil exchange sites. The third, and usually the largest soil nutrient pool, is insoluble and not available to plants. Only as soil minerals weather does this insoluble portion of the soil nutrient supply move into one of the other pools. Fertilizers are usually added to soils as additions to the available pool or to that pool of nutrients that is slowly becoming available.

a. <u>*Nitrogen*</u>—Nitrogen (N) is typically the most limiting nutrient in disturbed soils. If plant available forms of N (NO_3-N and NH_4-N) are deficient, the effect on plant growth will be seen within the first couple weeks after a seedling has emerged. It is relatively easy to overcome N deficiency during the short term. Inorganic forms of N, such as ammonium nitrate, are readily available to plants and can be applied to the soil surface and allow natural leaching to move the nutrient into the root zone. Nitrogen applied as inorganic fertilizer can be applied just prior to seeding or after initial emergence. If nitrogen is applied in an organic form or if applied with a wood waste product, the nitrogen should be mixed into the rooting zone prior to planting.

Nitrogen fertilization has been shown to stimulate the establishment and growth of annual species. It has also been shown to reduce species diversity by favoring rapid growing early seral species which competitively displace slower growing late seral plants. Because of these effects, caution must be used when fertilizing with N.

b. *Phosphorous*—Phosphorus (P) is most likely the second most limiting nutrient on disturbed lands. If P is limiting, it will be very difficult for most perennial seedlings to establish because of limited root development. Phosphorus is a highly immobile element and does not leach in the soil. In order for a plant to access P, it must come into contact with labile forms of P through root growth or limited P diffusion. Since young seedlings have very limited root development, growth on P deficient soils will be difficult.

Phosphorus fertilizer is commonly applied in an inorganic form. Because of its immobility, it must be incorporated into the root zone prior to planting, for maximum effectiveness. Phosphorus can be added to the soil in large amounts to provide a long-term source of P without fear of loss due to leaching.

c. *Potassium*—The final nutrient that will be discussed is potassium (K). Potassium tends to be limited on coarse textured soils but its deficiency is not as common as N or P. The mobility of K is less than N but greater than P. Potassium is most effective when incorporated into the root zone prior to seeding, but it will slowly move into the soil if surface applied after plant growth has begun.

Mulching

A mulch is non-living material placed or left on or near the soil surface for the purpose of protecting it from erosion or protecting plants from heat, cold, or drought. Mulches are used primarily to control wind and water erosion, facilitate infiltration, reduce evaporation, and moderate soil temperature. By fulfilling all of these objectives, the use of a mulch should improve overall germination and seedling establishment. One point that should be recognized is that the use of a mulch may not always be essential for controlling erosion or improving germination and establishment. There are many studies in the literature that report no differences in soil loss and plant establishment between treatments mulched and not mulched. Therefore, it is important that specific site conditions be examined before deciding on whether a mulch is needed. In general, if slopes are steep, if soils are highly erodible, if soil moisture is going to be limiting to plant establishment, if high winds are a common occurrence, or if soil crusting is a problem, then a mulch should be used. The most common mulches include straw, hay, wood fiber hydromulch, and fabrics and mats. All of these mulches are effective in improving soil moisture conditions, promoting plant growth and controlling erosion until initial plant growth occurs. The selection of a specific mulch depends on such factors as availability and site conditions such as access, slope conditions, and soil erosivity.

The Revegetation Process

The revegetation and reclamation of disturbed lands such as underground pipelines in semiarid regions is a dynamic process involving ecological succession. Ecological succession is the dynamic process in which plant communities evolve toward a state of equilibrium between living organisms and their physical environment. During this process, plant species composition gradually changes over time. There are a number of conceptual models that have been proposed to describe the successional process, but to date there is no single successional model that is universally accepted because of variables in site conditions and the complexity of the process of ecosystem development. In general, following soil disturbance, plant community development begins with colonization by early-successional plants that are typically annuals and biennials and this initial plant community is commonly referred to as the 'pioneer' community. The final community (if such a community exists) to develop on a site is referred to as the 'climax' community. The plant communities that develop during this successional sequence are referred to as 'seral' communities. Revegetation of disturbed lands is designed to accelerate the process of succession in order to reach a state of dynamic equilibrium in a shorter period than would be achieved if there were no anthropogenic inputs such as soil treatments, seeding, mulching, irrigation, etc. The revegetation process typically does not eliminate the establishment of various seral stages in the progression towards a climax community, rather the revegetation process may reduce the length of time that these seral stages occur. For example, without seeding of perennial species, the pioneer or weed stage may dominate a site for five to ten years, depending on environmental conditions. The successful introduction of perennial species through seeding would most likely reduce this time period by one-half or more.

The revegetation process occurring on the easement through the Walker Ranch is following the process described above. The first year of plant establishment following seeding in 2012 is showing favorable establishment of perennial species through the seeding process. These perennial species are establishing in combination with annual and biennial weeds that have naturally colonized the site from seed that was present in the seed bank. Over the next two to three years, most of the pioneer or weed species will be absent from the easement and the perennial species will continue to proliferate. Approximately one-half of the weeds that were present in 2013 are native to the area. The remaining species are introduced, but were either part of the original seed bank or colonized from sources of seed adjacent to the alignment. Some weeds that are present in a high enough density, such as Russian thistle (*Salsola kali*) will temporarily serve as a nurse plant for perennial species by providing shade and improving soil water content by capturing snow during the winter months. Most weeds that are present are not occurring at a high enough density to have either a positive or negative effect on the establishment and growth of perennials species. The nurse plant function of Russian thistle is similar to the role being fulfilled by shrubs and tree cholla (*Cylindropuntia imbricata*) in areas on the Walker Ranch where grasses are established under the protection of woody plants. This interrelationship between woody plants and herbaceous plants will develop on the easement as woody plants mature over time.

Appropriateness of Revegetation along the S3 Easement on the Walker Ranch

<u>Revegetation Techniques</u>

The techniques used by the Colorado Springs Utilities to revegetate the S3 easement through the Walker Ranch were correct and appropriate for the site conditions created by construction activities and for the environmental conditions of the area. The revegetation specifications that were followed for seed bed preparation, seeding, mulching and irrigation represent the industry standard. The techniques used will result in the establishment of a diverse plant community along the S3 easement that is native to the area, will stabilize the soil from wind and water erosion, and will meet a land use goal of domestic cattle grazing.

Seed Mixtures

The seed mixtures used on the S3 easement through the Walker Ranch were comprised of grasses native to the area and adapted to the climatic and soil conditions of the site. Blue grama, galleta, alkali sacaton and western wheatgrass which form the core of the seed mix used are four species that are central to the Historic Climax Plant Communities (HCPC's) for the four Ecological Sites that occur in the Walker Ranch portion of the S3 easement. The mixtures did not include shrub species for two reasons. The first reason is that the plant community that existed in this area prior to settlement and intensive livestock use was a grassland community (BLM, 1866) and under proper range management would be maintained as a grassland (Archer et al., 1995; Van Auken, 2000). Second, with the presence of shrubs and cacti in areas adjacent to the easement, it is more likely than not that shrubs and cacti will colonize the easement through natural processes of seed dissemination and plant establishment. Visual observations in October 2013 along the S3 easement on the Walker Ranch showed numerous fourwing saltbush (*Atriplex canescens*) seedlings (many six to twelve inches tall) present and this observation is supported in plant cover data collected in September 2013 and presented in this report.

Mulch

The mulch used following seeding along the S3 easement on the Walker Ranch was a native hay mulch applied at a rate of 1.5 tons/acre and secured to the soil with crimping and a guar-based tackifier. Mulch is commonly used in arid and semiarid revegetation projects to moderate soil temperature, increase infiltration, reduce evaporation, and improve soil moisture content for seed germination, reduce raindrop impact on the soil surface, and reduce wind erosion. However its use does not always result in measurable improvements in plant establishment (Thornburg, 1982) and when irrigation is part of the revegetation process the use of mulch is not necessary for successful revegetation.

The mulch and mulching technique used on the S3 easement were appropriate for the project. There were locations where wind removed portions of the mulch from the soil surface but there is no evidence that this lead to an increase in erosion or that seedling establishment was impaired. The fact that irrigation was an integral part of the revegetation process made the use of mulch less important for revegetation success.

Irrigation

Irrigation is not a common practice for revegetating disturbed rangelands in semiarid environments. Even though it is almost always advantageous to the establishment of vegetation when revegetating dry sites, it is a highly unusual practice for revegetating linear disturbances such as pipeline easements and normally precluded by limited water availability, logistics associated with getting water to remote areas, and related costs. The use of irrigation by the Colorado Springs Utilities represents an extra effort to ensure revegetation success in a relatively short time frame. Revegetation would be successful along the easement without irrigation; the only difference is that plant establishment takes longer without supplemental water. The irrigation system that was designed, installed and used on the S3 easement was appropriate and highly effective. Visual observations made in October 2013 indicate that there were areas where water coverage was less in the center of the easement, but these areas were isolated and although plant cover was lower than in other areas, this result will not lead to revegetation failure. Over time, these areas of lower plant cover will continue to fill in and it is highly unlikely that any difference in plant cover will be observable between these areas in two to three years.

Additional Observations

Steele Hollow

The majority of the reconstructed crossing of Steele Hollow has slopes of approximately 3h:1v and only a very small segment has slopes that exceed 3h:1v. In addition, slope length in the one area with a steeper slope is not long enough to warrant the installation of a terrace or other techniques to reduce water flow on the slope. It is important to note that this site prior to pipeline construction was a natural drainage with steep side walls that were highly unstable based on drainage conditions immediate above and below the crossing (Photo 1). Following construction and revegetation of the easement, topographic conditions and erosional stability are much improved even though some rilling has occurred (Photo 2). The rilling that has occurred is limited in extent and resulted from overland flow of water over the tops of the slopes as opposed to water applied through irrigation. This observation is supported by the presence of rills running to the top of the slope where these erosional features began to develop. Overland flow of water and repair work on the rills need to be addressed. In addition, erosion control matting is in need of reapplication in areas where contact between matting and soil are inadequate. However, there is substantial establishment of seeded grasses on these slope and repair activities need to be conducted in a way to minimize disturbance to allow these species to continue their growth and natural expansion. As of this time, Colorado Springs Utilities has completed repairs in the Steele Hollow crossing and appropriate steps have been taken for erosion control and plant community establishment as discussed above.

Water Flow on the Easement and Plant Establishment

There is no validity to the concern raised by Walker Ranches that grooves or drill rows along the easement are preventing sheet flow and could create major erosion and prevent water from reaching certain areas to support plant establishment. In addition, a comparison of topographic contours between 2010 (pre-construction) and 2014 (Critigen 2014) along the S3 alignment on the Walker Ranches are not different enough to impede water flow across the easement or to negatively impact plant growth.

Drill seeding is the most common practice for seeding pipeline alignments and the process of drilling seed creates drill rows that fill in over time through the natural spread of vegetation. These drill rows are visually noticeable during the first one or two years after seeding but quickly fade away as plants spread beyond the drill rows through tillering and seed dispersal and new plant establishment. The notion that the presence of drill rows are preventing sheet flow and in some way this is preventing water from reaching certain areas either on or off the easement for plant establishment and growth has no merit. Plant establishment and growth is almost totally reliant on precipitation that reaches the soil surface and infiltrates in the area that it falls and not

Photo 1. Steele Hollow prior to construction 10/14/2011

on water movement across the soil surface from one area to another. Because the process of water infiltration is far more important than overland flow in support of soil moisture necessary for plant growth, the presence of drill rows or any type of groove has no negative effect on plant establishment and growth on or off the easement.

Erosion and Sedimentation

Drainage basins range in size from a few small hillslopes and short stretches of first-order channels to entire watersheds of hills and valleys containing second- or third-order streams. Both of these conditions exist along the easement on the Walker Ranch. These landforms are a result of thousands of years of natural processes of weathering, erosion, and deposition and these processes are continually occurring and usually not observable until extreme natural events, such as high intensity-short duration rainfall, occur and soils become saturated and overland flow drives the erosion and deposition process. The extreme precipitation events that occurred in the area in late summer/early fall of 2013 created drainage pathways in multiple places across the easement on the Walker Ranch that would have taken decades to establish under normal precipitation conditions. It is important to recognize that this process of channel development through erosion and sedimentation is a large-scale natural process and the presence of the easement is not the cause of erosion and sedimentation either on or off the easement. As a result of these precipitation events, we experienced the natural process of water identifying flow paths

Photo 2. Steele Hollow after construction and revegetation 10/30/2013

or channels for movement across the easement in areas where channels existed prior to pipeline construction. Colorado Springs Utilities has identified these flow paths of water across the easement and has conducted the engineering and construction work necessary for these drainages to function in a stable manner. The width of the easement is diminutive compared to the surrounding watershed and has therefore not added appreciably to sediment that may be found off site. Where sediment has moved off the easement, there is no evidence that the deposition of this sediment has negatively impacted native vegetation. The proposed repair work by Walker Ranches to plant grass tube stock in small channels adjacent to the easement is not needed and is highly unlikely to be successful because grass transplants in arid environments have a low rate of survival because of both low and highly variable soil moisture conditions (Munshower 1994).

Weeds and Weed Control

The presence of pioneer or ruderal species (i.e. plant species that are first to colonize disturbed land) along the easement during the first year of plant growth is a normal phenomenon as described under the above section on the Revegetation Process. The term weed is commonly defined as plants growing where they are not wanted and in competition with more desirable species. Noxious weeds are defined as non-native invasive plants that displace desirable vegetation and degrade natural and agricultural lands. One-half of the ruderal species that are present are native to the area and all of the ruderals that have propagated have done so through seed that was in the seed bank or from seed that naturally migrated on to the easement from plants surrounding the easement. Most of the ruderal species are not classified as noxious and those species that are classified as noxious would be classified as List C noxious weeds. In Colorado there are three categories of noxious weeds. List A species include plants designated for elimination on all County, State, Federal and Private lands. List B species include plants whose continued spread should be stopped and List C species are selected for recommended control methods. The only noxious weed identified along the easement in quantities justifying control measures is halogeton (*Halogeton glomeratus*). This species is found off the easement and was most likely on the easement prior to pipeline construction and has reestablished from seed in the seed bank. This species has been treated with a broadleaf herbicide in 2013 without any negative effects on adjacent grasses or other broadleaf species. In addition, the establishment of ruderals, whether classified as noxious or not, is a normal process of plant succession and does not appear to be limiting the establishment of seeded species as is evidenced by plant cover data collected in September 2013 and presented in this report.

2. <u>Opinions of D. L. Buckner</u>

Description of Pre-existing Conditions

Although soils vary, the vegetation of the Walker Ranch portion of the S3 segment was dominated by native grasses of which four predominated: blue grama (*Bouteloua gracilis*), galleta (*Pleuraphis jamesii*), alkali sacaton (*Sporobolus airoides*), and ear muhly (*Muhlenbergia arenacea*). These species are all warm season natives. Other warm season grasses that were locally found include sand dropseed (*Sporobolus cryptandrus*), burrograss (*Scleropogon brevifolius*), sideoats grama (*Bouteloua curtipendula*), purple threeawn (*Aristida purpurea*), and ring muhly (*Muhlenbergia torreyi*). Western wheatgrass (*Pascopyrum smithii*) a widespread cool season grass native to the North American grasslands was also present, primarily on soils subject to flooding. Grasses typically comprised from about two-thirds to well over three-fourths of vegetation cover. Total cover by vegetation ranged from as little as 14 percent (Heldt and Limon soils) to as much as 42% (Stoneham soils).

Native annual plants ranged from 1 to 4% cover in the pre-existing vegetation. Native perennial forbs were generally low in abundance providing less than 1% cover. Shrubs and subshrubs provided typically about 1% cover, consisting mostly of fourwing saltbush (*Atriplex canescens*) with smaller amounts of winterfat (*Kraschenninikovia lanata*) and shadscale saltbush (*Atriplex confertifolia*). Cacti, most conspicuously tree cholla (*Cylindropuntia imbricata*), typically comprised from 1 to 3% cover. The tall stature of the tree cholla (somewhat taller than one meter) in comparison to the short stature of the grasses and forbs make it seem to have much greater abundance than it does in vertical projection.

The lands in question here fall within Natural Resource Conservation Service Major Land Resource Area (MRLA) 69. Four ecological sites are encountered in the reach of pipeline segment S3 included on the Walker Ranch. With reference to the quantitative data collected on the portion of pipeline segment S3, the following evaluations of range condition are made in the context of Ecological Site Descriptions (ESD's) available for MLRD 69:

Loamy Plains Ecological Site, R069XY006CO (Stoneham soils). The Historic Climax Plant Community (HCPC) for this Ecological Site is dominated by blue grama, western wheatgrass, and varying amounts of fourwing saltbush. Given the very strong domination of blue grama, and the absence of cool season perennial grass on the Walker Ranch, it is concluded that continuous grazing has pushed vegetation composition to the state of Blue Grama / Buffalograss Sod; Broom Snakeweed Community (See State and Transition Model in the ESD) (Westoby et al., 1989). From this state a return to the Historic Climax Plant Community (HCPC) would take "a very long time" (longer than 40 years) according to the ESD. In this condition, the ESD describes desertification as "advanced." Desertification is the expansion of dry lands due to poor agricultural practices such as overgrazing. Desertification comes about by the interaction between the natural environment and human activities. Human activities that negatively impact vegetation, degrade soil structure and fertility, impede water infiltration, and cause soil drying promote desertification.

Salt Flats Ecological Site, R069XY033CO (Limon Soils). Plant cover in these areas on the Walker Ranch portion of pipeline segment S3 was very low, ranging from 9 to 18 %, and averaged 14% (Photo 3). Ungrazed areas on these same soils very nearby but outside the Walker property averaged 27% cover by live plants (Photo 4). Although the species present include both alkali sacaton and western wheatgrass, both indicators of the Historic Climax Plant Community (HCPC), their abundance is quite low. Besides continuous grazing, this site apparently experienced frequent flooding, judging from the presence of fresh alluvium on much of the extensive bare soil surface. It is worth noting that the percent live plant cover present in the Walker Ranch portion of pipeline segment S3 on Limon soils (average 13.8%) was deemed to represent such a low value that it would be professionally irresponsible to use it in generating the performance standard. Cover by live plants in areas of Limon soils outside the Walker property averaged 26.5% cover and this was used as the performance standard base value.

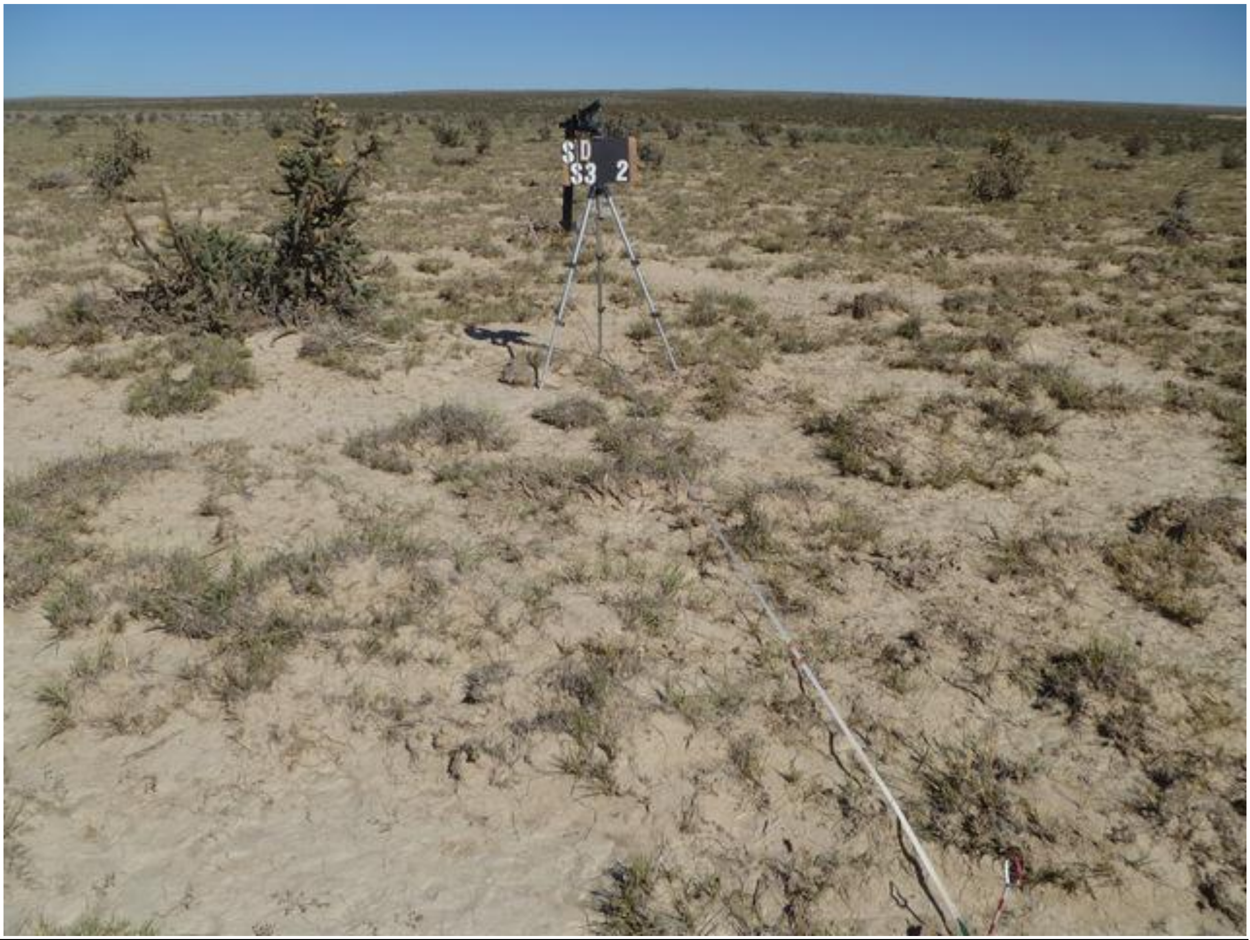

Photo 3. Vegetation on Limon soils (Soil group B) on Walker Ranch 10/13/2011

<u>Photo 4. Vegetation on Limon soils (Soil group B) immediately south of Walker Ranch 10/5/2011</u>

<u>Shaly Plains Ecological Site</u>, R069XY046CO (Midway and Shingle Soils). The Historic Climax Plant Community for this Ecological Site is dominated by blue grama, sideoats grama, galleta, alkali sacaton and western wheatgrass. Long-term continuous grazing has pushed these areas away from the Historic Climax Plant Community (HCPC) and into the state described in the ESD State and Transition model as the Increased Blue Grama/Galleta with Remnant Mid Warm/Cool Season Grasses and Shrubs Community. Galleta grass is by far the most abundant species and the mid-grasses alkali sacaton and western wheatgrass that would have been prominent in the HCPC are no longer present.

<u>Alkaline Plains Ecological Site</u>, R069XY047CO (Heldt and Razor Soils). The Historic Climax Plant Community for this Ecological Site is dominated by blue grama, galleta, alkali sacaton, and western wheatgrass. In the pre-construction inventory data, blue grama and galleta along with ear muhly are the dominants. Given this and the sparse presence of alkali sacaton and complete absence of western wheatgrass, it is apparent that conditions are somewhere between the state described in the ESD as Increased Blue Grama/Galleta with Remnant Mid Warm/Cool Season Grasses and Shrubs Community and the yet more deteriorated Blue Grama Sod Community. From this condition a return to the Historic Climax Plant Community (HCPC) would take "a

very long time" (longer than 40 years) according to the ESD. In this condition, the ESD describes desertification as "advanced."

Results from First Year Vegetation Monitoring in 2013

Cover

Percent plant cover by acceptable species is ultimately to be judged using the performance standard of 90% of pre-existing cover (see Protocol and Pueblo County 1041 permit language). Based on the September 2013 results, cover levels by acceptable species on the portion of pipeline segment S3 on which irrigation began in 2013 were greater than or statistically indistinguishable from the 90% performance standard.

Presence of Acceptable Species

As per the Protocol, an assessment of the presence of acceptable species was made based on the average number of acceptable species present per square meter. The performance standard was an average of 2.0 acceptable species per square meter. Based on 2013 sampling, average presence of acceptable species on the portion of pipeline segment S3 on which irrigation began in 2013 ranged from 3.5 to 5.2 acceptable species per square meter, well exceeding the performance standard.

Prospects for Restored Species Diversity

The approach to re-establishment of species diversity in the SDS pipeline revegetation was to plant adapted varieties of the important grass species and to rely on propagules from local sources that lie within the salvaged and replaced topsoil to address recovery of life forms other than grasses. Forbs were not included in the seed mix because of precaution to avoid introduction of genomes of native forbs that differ from the locally evolved genomes. Native forbs of the particular genomic makeup present before construction are not available commercially, but are present in the salvaged and replaced topsoil. Forb re-establishment as of the end of the first growing season is strong in the Walker Ranch portion of pipeline segment S3. Average density of native perennial forb species prior to construction versus September 2013 levels (end of first growing season after construction and seeding) is shown below.

Soil Group	2011 Pre-construction Density (number of native perennial forb species per 100 square meters)	2013 Density (number of native perennial forb species per 100 square meters)
B	0.25	5.3
C	4.0	4.2
D	2.3	4.6
E	2.9	4.9

Shrubs similarly were not included in the mix due to concern about introduction of foreign genomes. Shrub and cactus propagules present in salvaged and replaced topsoil were expected to be adequate to re-establish these life forms in the re-created plant communities. As of the

2013 quantitative data collection, shrub and subshrub density ranged from about 40 to 120 plants per acre, a level estimated to be comparable to pre-existing conditions. Seedlings of cactus species were present in similar amounts.

Ramifications of Reseeding the S3 Revegetation Areas

At the end of the first growing season all areas averaged at least 90% of pre-existing cover. If the S3 segment through the Walker Ranch were regraded and reseeded as requested by Walker, the outcome would be less satisfactory than the successful result that currently exists. This is true for two reasons: 1) as noted elsewhere in this document, the response of native species whose propagules were present in the seed bank has been very good. If the easement was regraded these established plants would be removed and there would be a much diminished abundance of their propagules left in the soil to sustain future establishment. These specific plants with local genetic adaptability are not available commercially. To kill them would materially damage future prospects for their presence. 2) Opportunistic or ruderal plants have established themselves through natural processes and have produced abundant seed in 2013. Left undisturbed, these seeds will find it difficult to produce new opportunist plants (weeds) because the competition from established perennial species will suppress their growth. If regrading is undertaken, killing all plants established in 2013, this high abundance of weed seed is likely to produce an overwhelming amount of weed cover that may severely suppress or even prevent establishment of desired species.

V. **DOCUMENTS SUPPORTING OPINIONS**

Documents supporting the opinions of Dr's. Redente and Buckner are included in the materials cited above and listed in Appendix A. Additional documents and exhibits may be used at the hearing, including photos from site visits that were used to support our opinions.

Dated this 21st day of March 2014

Respectfully submitted,

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Edward. F. Redente, Ph.D.

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David L. Buckner, Ph.D.

APPENDIX A

References

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APPENDIX B

EDWARD F. REDENTE
RESUME

CURRENT ADDRESS

Redente Ecological Consultants
1322 Alene Circle
Fort Collins, CO 80525
Phone: 970-492-5656
Email: Edward.Redente@colostate.edu

Forest and Rangeland Stewardship Dept.
Colorado State University
Fort Collins, CO 80523

PRESENT POSITION

University Distinguished Teaching Scholar Emeritus, CSU

ACADEMIC TRAINING

B.A.	Geography and Biology	Western Michigan University	1972
M.S.	Range Science	Colorado State University	1974
Ph.D.	Range Science	Colorado State University	1980

PROFESSIONAL EXPERIENCE

1974 – 1976	Environmental Engineer, Utah International Inc., San Francisco, CA
1976 – 1980	Research Associate, Range Science Department, Colorado State University
1980 – 1984	Assistant Professor, Range Science Department, Colorado State University
1984 – 1988	Associate Professor, Range Science Department, Colorado State University
1988 – 2007	Professor, Rangeland Ecosystem Science Department, Colorado State University
1996 – 2007	Director, Center for Ecological Risk Assessment and Management, Colorado State University
2002—2005	Head of Forest, Rangeland, and Watershed Stewardship Department, Colorado State University
2003—2006	Associate Dean for Research, College of Natural Resources, Colorado State University
2005—2006	Associate Vice President for Research, Colorado State University
2006—2007	Dean, Warner College of Natural Resources, Colorado State University
2007—Pres.	Professor Emeritus, Warner College of Natural Resources, Colorado State University
2007—2010	Vice President and Principal Ecologist, MWH Americas, Inc., Fort Collins, CO
2010—Pres.	President, Redente Ecological Consultants, Fort Collins, CO

AWARDS

Outstanding Professor of the Year	1982	Range Science Department, CSU
Outstanding Faculty Award	1992	College of Natural Resources, CSU
Outstanding Professor of the Year	1994	Range Science Department, CSU
Outstanding Achievement Award	1994	Society for Range Management
John E. Cermak Advising Award	1995	Colorado State University
Outstanding Faculty Award	1998	College of Natural Resources, CSU
Favorite Professor Award	2000	CNR College Student Council, CSU
Outstanding Professor Award	2000	College of Natural Resources, CSU
Outstanding Undergrad. Teacher	2001	Society for Range Management
Outstanding Professor of the Year	2002	Range Science Department, CSU
University Dist. Teaching Scholar	2003	Colorado State University
Theodore M. Sperry Award	2007	Society for Ecological Restoration
James A. Pendleton Award	2008	Colorado Division of Reclamation and Mining

HONORS

1989-1990	Governor's Commission on Mountain Scars to address issues of mining scars along front range of Colorado
1999	Nomination to the National Academy of Sciences' Committee on Hardrock Mining on Federal Lands

COMMITTEE ASSIGNMENTS

National

- U.S. Department of Energy Oil Shale Task Force, 1980-1985
- U.S. Department of Energy Oil Shale Executive Committee, 1980-85
- Soil Conservation Society of America, Native Plant Materials Committee, 1980-1983
- Executive Committee for DOE's Arid Lands Ecology Program, 1985-1990
- American Society for Surface Mining and Reclamation, National Meeting Organizational Committee, 1986
- Society for Range Management, Publications Committee, 1989-1992
- Society for Range Management, Annual Meeting Planning Committee, 1992-1994
- Editorial Board, Arid Soil Research and Rehabilitation, 1998-2001
- Society for Range Management, Annual Meeting Program Co-Chair, 2000
- Editorial Board, Arid Land Research and Management, 2001-2006
- Society for Range Management, Publications Committee, 2001-2006

INVITED PAPERS

1979	Ecological Society of America/AIBS Symposium, Tucson, AZ
1980	U.S. Department of Energy, Second US DOE Environmental Control Symposium, Reston, VA
1980	U.S. Department of Energy, Oil Shale Environmental Challenges I Symposium, Vail, CO
1981	U.S. Department of Energy, Oil Shale Environmental Challenges II Symposium, Vail, CO
1982	National Academy of Sciences, National Research Council, Workshop of Oil Shale Research Needs, Denver, CO
1983	American Association for the Advancement of Science, Annual Meeting, Detroit, MI
1984	2nd International Rangeland Congress, Adelaide, Australia
1985	American Society for Surface Mining and Reclamation, Denver, CO
1985	14th International Grassland Congress, Kyoto, Japan
1986	High Altitude Revegetation Workshop, Fort Collins, CO
1986	American Association for the Advancement of Science, Annual Meeting, Philadelphia, PA
1987	XIV International Botanical Congress, West Berlin, Germany
1988	III International Rangeland Congress, New Delhi, India
1990	George Wright Society, 6th Conference on Research and Management in the National Parks, El Paso, TX
1991	American Society for Surface Mining and Reclamation, Annual Meeting, Durango, CO
1992	Symposium on Ecological Management and Restoration of Intermountain Annual Rangelands, Boise, ID
1993	Symposium on Forest Research, Belo Horizonte, Brazil
1994	High Altitude Revegetation Workshop, Fort Collins, CO
1994	Peruvian Ministry of Energy and Mines, Cerro De Pasco, Peru
1998	Montana State University, Distinguished Scientists Series, Bozeman, MT
1999	6th International Rangeland Congress, Townsville, Australia
1999	Geological Society of America, Denver, CO
2000	High Altitude Revegetation Workshop, Fort Collins, CO
2000	Colorado Section, Society for Range Management, Annual Meeting, Fort Collins, CO
2001	Society for Range Management, Annual Meeting, Kona, HI
2003	Society for Range Management, Annual Meeting, Salt Lake City, UT
2004	EPA Hazardous Substance Research Center Meeting, Las Vegas, NV
2005	American Society of Mining and Reclamation, Breckenridge, CO

GRADUATE STUDENTS

Total number of graduate students advised to completion: 68
Total number of postdoctoral candidates mentored: 6

TEACHING EXPERIENCE

1978-1994	RS 478-Rehabilitation of Mined Lands
1994-2005	RS 478-Restoration Ecology
1983-2001	RS 578-Ecology of Disturbed Lands
1988-1993	BY 220-Ecology
1995-1997	EY 586-Ecological Risk Assessment Practicum
1997	RS 400 Rangeland Improvements
1997	RS 501 Range Habitat Manipulation
1998-1999	RS 280 Rangeland Ecology
1998-2002	RS 471 Range Planning and Grazing Management
1998-2002	RS 472 Rangeland Ecosystem Planning
2000-2002	RS 300 Principles of Range Management

CONTRACT AND GRANT FUNDING (abbreviated list)

1978-1990	U.S. Department of Energy
1978-1981	CF&I Steel Corporation
1980-1983	Mining and Minerals Resources Research Institute (USDI)
1984-1986	National Science Foundation
1988-1992	National Park Service
1991-1994	Pintlar Corporation/EPA
1991-1993	EPA
1991-1994	City of Fort Collins
1993-1995	Los Alamos National Laboratory
1993-1997	USDA-CSRS
1994-1996	EPA
1993-1997	Mesa Verde National Park
1994-2000	USFWS
1995-2004	Colorado Department of Health & Environment/EPA
1997-2000	USDA
1998-2002	EPA

CONTRACT AND GRANT FUNDING (continued)

2000-2003	DoD
2003-2005	EPA—Hazardous Substance Research Center
2004-2005	NPS/RMNP
2005-2009	Williams Co.
1985-2011	Newmont Mining
2003-2011	Molycorp and Chevron Mining, Inc.
2005-2010	PacifiCorp
2007-2010	AREVA, Inc.
2010-2011	Barrick Gold

COUNTRIES VISITED ON SHORT-TERM ASSIGNMENTS

Australia, Austria, Brazil, China, Germany, Hungary, India, Japan, Peru, and Dominican Republic

EXPERT TESTIMONY

U. S. Federal Court—State of Colorado v. Idarado, 1987 (CERCLA Litigation—Idarado Mine Site), including deposition and trial testimony.
U. S. Federal Court—U.S. v. Atlantic Richfield, 2003 (CERCLA Litigation, Natural Resource Damages—Anaconda Smelter Site), including deposition and trial testimony.
U.S. Federal Court—U.S. v. ASARCO and HECLA, 2005 (CERCLA Litigation—Bunker Hill Smelter Site), including deposition and trial testimony.

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DAVID L. BUCKNER
RESUME

CURRENT ADDRESS

ESCO Associates Inc.
5360 Manhattan Circle, Suite 200
Boulder, CO 80303
Phone: (303) 499-4277
Email: david@escoassoc.com

PRESENT POSITION

Senior Plant Ecologist, ESCO Associates Inc.

ACADEMIC TRAINING

B.A. - Environmental Biology, University of Colorado, 1970
M.A. - Plant Ecology, University of Colorado, 1973
Ph.D. - Plant Ecology, University of Colorado, 1977

PROFESSIONAL SOCIETIES

Society for Range Management
Society for Ecological Restoration
Ecological Society of America

CERTIFICATIONS

Certified Senior Ecologist, Ecological Society of America

PROFESSIONAL HISTORY

1986 to Date. Senior Plant Ecologist and Owner, ESCO Associates Inc., Boulder, Colorado. Serves in design and execution of baseline quantitative or qualitative vegetation and wetland studies, quantitative monitoring and bond release studies, restoration design and contractor oversight, threatened and endangered plant surveys, and studies addressing specific revegetation topics.

1985 to 1986. Plant Ecologist, Camp, Dresser & McKee Inc., Denver, Colorado.

1980 to 1985. Plant Ecologist, Western Resource Development Corporation, Boulder, Colorado.

1977 to 1980. Plant Ecologist, Camp, Dresser and McKee, Denver, Colorado.

1975 to 1977. Plant Ecologist, Genge Environmental Consultants, Denver, Colorado.

1970 to 1977. Graduate student, University of Colorado, Boulder, Colorado.

PROFESSIONAL SERVICE

Service on High Altitude Revegetation Workshop Committee (under the organizational umbrella of Colorado State University), helping organize biannual conferences and annual field tours. Has participated in all 38 conferences since 1974.

Service on John Marr Fund graduate research grant committee since 1995. Has served as Chairperson since 2008.

Presented eleven weekend workshops on the subjects of identification of grasses and sunflower family plants (1995 to 2012), as well as basic soils for the Colorado Native Plant Society and the Society for Ecological Restoration.

QUALIFICATIONS SUMMARY

Dr. Buckner has forty-three years of professional experience in the areas of applied plant ecology, plant taxonomy, reclamation, soils, and statistics. Project experience includes the design and execution of baseline vegetation and soils studies, evaluation of long-term natural and reconstructed plant community dynamics, development of reclamation plans for mine permit applications and hazardous waste covers, and analysis and reconstruction of wetlands. His projects have been performed in the states of Colorado, Wyoming, Montana, Utah, Arizona, New Mexico, California, and Texas, as well as Moquegua Department, Peru.

RECLAMATION/RESTORATION EXPERIENCE

Dr. Buckner has broad experience in the area of reclamation, revegetation, and restoration both from the standpoint of design and specification of materials and methods as well as the standpoint of evaluation of results in light of pre-construction performance standards.

He has been involved for the past twenty years in the detailed annual monitoring of revegetated surface coal mines in Routt County, Colorado (Seneca II, Seneca II-W and Yoast Mines), as well as mines in Rosebud County, Montana (Big Sky Mine), Campbell County, Wyoming (Cordero, Caballo, Belle Ayr and Eagle Butte Mines), and Navajo County, Arizona (Black Mesa and Kayenta Mines). Over the past ten years he has designed and implemented formal quantitative sampling in assessment of compliance with bond release standards at these mines also. He was senior author of a 1985 report to the U.S. Congress (Office of Technology Assessment) on the status of revegetation under state and federal regulations issued pursuant to the Surface Mine Control and Reclamation Act of 1977 (SMCRA).

He has been involved with the design, construction specifications, and monitoring procedures for RCRA – equivalent covers for various sites at Rocky Mountain Arsenal in Adams County, Colorado. Part of this work had entailed the evaluation of test plots to assess the effectiveness of "ET" (evapotranspiration-based) covers proposed at the RMA site. Recurrent observations of the vegetational cover of these plots were made over a five-year period. He has also participated in the review and construction oversight of site closure seedings at the Rocky Flats Nuclear Weapons Plant in Jefferson County, Colorado.

He has developed reclamation plans for several areas to be mined in the Rocky Mountain West in Carbon and Grand Counties, Utah, Mesa, Garfield, La Plata, Gunnison, and Routt Counties, Colorado, and Campbell and Carbon Counties, Wyoming. Dr. Buckner has also worked in the evaluation of reclaimability of coal, oil shale, and metal mill tailing projects through field plots and greenhouse studies, including those projects for AMAX Molybdenum, Anaconda, ARCO, Exxon, and Galactic Resources. Information from the above studies has been integrated into reclamation plans for permit applications. He has performed studies of natural rates of revegetation at historic mining sites near Bodie in Mono County, California and near Ely in White Pine County, Nevada.

Revegetation of pipeline rights-of-way has been a subject of applied research for more than thirty years. In 1969, he began long-term observations of a pipeline through alpine tundra vegetation on Rollins Pass in the Colorado Front Range. Observations on an alpine pipeline site near Fremont Pass in the TenMile Range were begun in 1970. From 1971 to 1973, he conducted analyses of rates of revegetation in varying vegetation types along gas and petroleum pipelines throughout western Colorado, southeastern Utah, and southwestern Wyoming.

More recently, he developed specifications in 1997 and 1998 for Public Service Company for the revegetation of a gas pipeline in Boulder and Jefferson Counties, including a reach across a sensitive area on South Table Mountain near Golden, Colorado. For City of Boulder Open Space Department, he has designed and overseen the implementation of more than ten revegetation projects between 1994 and 1998. He was involved with development of specifications for and oversight of contractors conducting revegetation of the three Phases of a high-pressure water pipeline from Silver Lake to the Betasso Water Treatment Plant near Nederland, Colorado for City of Boulder Public Works Department from 1997 to 2004. He oversaw design and field implementation of revegetation for an extremely steep installation of penstock and return pipe additions connecting the Betasso Water Treatment Plant to the Boulder Canyon and Orodell hydroplants.

PLANT GROWTH SUITABILITY AND TEST PLOT ANALYSES

Dr. Buckner designed and executed a 4x3x3 factorial test plot study to investigate factors involved with revegetation beneath photo-voltaic collectors at the National Renewable Energy Laboratory wind Test Site in Jefferson Co., CO. Analyses of growth media as to suitability for plant growth have been involved in several projects. Suitability of calcium carbonate-enriched subsoil materials has been explored as cover materials for use at Rocky Mountain Arsenal (Commerce City, Colorado) and at a limestone quarry in northern Boulder County. Suitability of nitrogen-enriched soils as environments for establishment for native seed mixes have been investigated at several sites in Boulder County. Suitability of soils affected by de-icing compounds has been explored during revegetation evaluations at Denver International Airport (DIA) in Adams County, Colorado.

VEGETATION BASELINE AND MONITORING STUDIES EXPERIENCE

Studies for the purpose of characterizing baseline vegetation conditions have been conducted for pipelines, coal surface and underground mines, gravel and limestone mines, powerlines, and recreational developments.

Projects within the past ten years: Baseline and monitoring studies have been conducted in the past ten years for Peabody Western Coal Company, Alpha Coal West (formerly Foundation Coal West, AMAX Coal West, Cyprus Energy, and RAG Coal USA), Barrick Gold, and Cloud Peak Energy (formerly Rio Tinto Energy America and Kennecott Energy)

Quantitative monitoring of revegetated areas has been undertaken on mine and pipeline reclamation sites, reconstructed wetlands, and native sites with plant communities of special concern. Data collected from these sites are often used to assess trends in vegetational development and to compare to performance standards that may be applicable on particular sites.

Inventories of open space lands for purposes of developing management plans were conducted for the City of Louisville Open Space Department. These inquiries consisted of floral inventories and plant community mapping with concentration on special interest issues of wetlands and prairie dogs. Quantitative vegetation monitoring of special interest sites on City of Boulder Open Space has gone forth annually on City of Boulder Open Space since 1990. He has contributed plant community monitoring data to on-going University of Colorado studies on the bio-control of diffuse knapweed (*Acosta diffusa*).

VEGETATION MAPPING

Vegetation baseline studies referenced above have all incorporated vegetation mapping. In addition, other projects centered explicitly on mapping have also been done. These include City of Boulder Open Space and Mountain Parks lands field mapped and classified to Alliance level (ca. 1200 acres), Honeycomb Project (ca. 1500 acres, Rio Blanco Co., CO), Central Plains Experimental Range (Weld Co, CO), and Horse Canyon (ca. 800 ac., Eureka Co., NV). Where available, the use of stereo photo pairs in discerning vegetation and landform variation has been critical to this work.

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THREATENED AND ENDANGERED SPECIES EXPERIENCE

Dr. Buckner has assisted clients in determination of the presence or absence of plant species listed as threatened, endangered, or otherwise of special concern by federal, state, or other agencies. In addition to searches for plant species of special concern as part of all the above-mentioned vegetation baseline studies, projects with the sole purpose of assessing presence/absence of threatened or endangered species have been completed in Grand County, Utah, Grand and Eagle Counties, Colorado, Mesa County, Colorado, and La Plata County, Colorado, and Campbell County, Wyoming. He has most recently completed a survey of and status report on *Penstemon harringtonii* in Eagle, Grand, and Routt Counties, Colorado for the U.S. Fish and Wildlife Service, and has conducted inventories of project sites for the presence of Ute Ladies'-Tresses Orchid (*Spiranthes diluvialis*) and/or Colorado Butterflyweed (*Gaura neomexicana* ssp. *coloradensis*) in Boulder, El Paso and Jefferson Counties, Colorado and Campbell County, Wyoming. He has been project manager for inventories of rare plant species along the Guanella Pass Road between Georgetown and Grant in Clear Creek and Park Counties, and along the west side of Cottonwood Pass and Taylor River Canyon in Gunnison County. He recently has overseen the inventory of sites in Rio Blanco County for the presence of federally listed and BLM sensitive plant species.

WETLAND EXPERIENCE

Wetland studies for the purpose of inclusion in Army Corps of Engineers "404" permit applications have been completed for Peabody Western Coal, AMAX Molybdenum, Alpha Coal West (AMAX Coal West), AMAX Resource Conservation Company, Gannett Fleming, Inc., Chicago South Shore Railroad, Muller Engineering, Myers Engineering, Rocky Mountain Consultants, for several Texas Utilities Mining Company projects, the U.S. Federal Highway Administration, and several municipalities. Surveys of the extent of wetlands on the Rocky Mountain Arsenal were conducted for the U.S. Environmental Protection Agency. Most of the studies have included determination of extent and type of wetlands present as well as development of mitigation plans. A detailed study of the wetlands surrounding a Boulder County reservoir resulted in an analysis of specific impacts of proposed increased water levels in the reservoir; this work was followed by design and supervision of construction of 12 acres of new wetlands intended to replace those eventually to be lost. Another 12 acres of wetland was created through his design and was planted by Dr. Buckner in El Paso County (Colorado Centre Metropolitan District), Colorado.

OTHER EXPERIENCE

Dr. Buckner has provided technical input on the design of long-term care plans and vegetation specifications at the Rocky Mountain Arsenal.

Dr. Buckner has provided services in aerial photo interpretation for the purpose of vegetation mapping and evaluation of possible effects of scattered industrial facilities in landscapes of Colorado, Wyoming, Utah, Texas, Illinois, and Indiana.

His experience includes several years of monitoring the vegetational recovery of pipeline rights-of-way in Utah, Wyoming, and Colorado, especially the alpine zone of Colorado. Other research conducted has concerned the effects of high snowfall on forest patterns in the central Rocky Mountains.

PUBLICATIONS/PRESENTATIONS

Buckner, D.L. 2012. Cover -- the Misunderstood Plant Measure. Proceedings of the 20th High Altitude Revegetation Workshop. Colorado State University, Fort Collins. Proceedings in preparation.

Buckner, D.L. and C. Vandervoort. 2012. Long-term Dynamics of Cheatgrass Abundance as Related to Combined Effects of Climate Variation and Plant Competition. Poster presented at the 20th High Altitude Revegetation Workshop. Colorado State University, Fort Collins.

Buckner, D.L. and L. Riedel. 2010. Reclamation of a Sandstone and Clay Quarry with no Topsoil: Use of Filter Fines as a Growth Medium. Proceedings of the 19th High Altitude Revegetation Workshop. Information Series No. 111, Colorado State University, Fort Collins.

Buckner, D.L. And S. Downey. 2009. Patterns Of Annual Brome Abundance In Reclaimed And Native Rangelands In The Northern Great Plains: A Case Study From The Big Sky Mine, Southeastern Mt Proceedings Paper Of A Presentation At 2009 Billing Land Reclamation Symposium, June 1-4, Crowne Plaza Hotel, Billings, Mt. Joint Meeting With The American Society Of Mining And Reclamation.

Buckner, D.L. 2008. Vegetational future of Colorado mountain vegetation – recovery following an infestation of trees. Proceedings of the 18th High Altitude Revegetation Workshop. Information Series No. 107, Colorado State University, Fort Collins.

Bush, R.T., T.R. Seastedt and D. Buckner. 2007. Plant Community Response to the Decline of Diffuse Knapweed in a Colorado Grassland. *Ecological Restoration 25(3): 169-174.*

Buckner, D.L. 2006. Alternative Performance Standards for Species Diversity. Proceedings paper of a presentation at 2006 Billing Land Reclamation Symposium, June 4-8, Sheraton Hotel, Billings, MT. Joint Meeting with the American Society of Mining and Reclamation.

Buckner, D.L. 2006. Correlation of Plant Cover and Production with Annual Climate Parameters: An Example with implications for Bond Release Technical Standards.

Proceedings paper of a presentation at 2006 Billing Land Reclamation Symposium, June 4-8, Sheraton Hotel, Billings, MT. Joint Meeting with the American Society of Mining and Reclamation.

Buckner, D.L. 2004. The ecological balance of restored area plant cover and diversity: Implications for mined land bond release. Proceedings of the 16th High Altitude Revegetation Workshop. Information Series No. 99, Colorado State University, Fort Collins.

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Buckner, D.L. 2003. Reclamation of a Sandstone and Clay Quarry with no Topsoil: Use of Filter Fines as a Growth Medium. Presentation at 2003 Billing Land Reclamation Symposium, June 3-6, Sheraton Hotel, Billings, MT. Joint Meeting with the American Society of Mining and Reclamation.

T.R. Seastedt, N. Gregory, and D. Buckner. 2003. Effects of biocontrol insects on diffuse knapweed in a Colorado Grassland. Weed Sci. 51: 237-245.

Buckner, D.L. 2002. Long-term effects of tordon control of diffuse knapweed on plant community characteristics and the dynamics of knapweed. In: Proceedings of the 15th High Altitude Revegetation Workshop.

Buckner, D. L. 1998. History of Revegetation in the Western U.S. -- How the Way We Were Affects the Way We Are. In: Proceedings of the 13 th High Altitude Revegetation Workshop. Colorado Water Resources Institute, Information Series No. 91. Colorado State University, Fort Collins.

Buckner, D. L. 1996. Revegetation Rates on Copper Mine Wasterock in White Pine County, Nevada. **Poster presentation:** 12th High Altitude Revegetation Workshop.

L. Riedel and D. L. Buckner. 1996. Interim Results from Reclamation of a Rock Quarry Near Eldorado Springs, CO: Talus Buttress Slope Topdressed with Water Treatment Plant Filter Fines. **Poster presentation:** 12th High Altitude Revegetation Workshop.

Buckner, D. L. 1992. Revegetation Patterns and Rates at the Bodie Mining Area, Mono County, California. **Poster presentation** In: Proceedings of the 10th High Altitude Revegetation Workshop. Colorado Water Resources Institute, Information Series No. 71, Colorado State University, Fort Collins.

Buckner, D. L. 1992. <u>Penstemon harringtonii</u>, Rare Plant of Central Colorado. **Poster presentation** In: Proceedings of the 10th High Altitude Revegetation Workshop. Colorado Water Resources Institute, Information Series No. 71, Colorado State University, Fort Collins.

Buckner, D. L. 1990. Use of quantitative performance standards in revegetation of coal mines in the western U.S. In: Proceedings of the 1st Annual Meeting of the Society for Ecological Restoration, Oakland, California, Jan. 1989.

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