Final
Focused Feasibility Study Report

Uravan Uranium Project
(Union Carbide Corporation)
Uravan, Colorado

EPA Contract No. EP-W-05-049
Work Assignment No: 354-TATA-0846

Prepared by:
CDM Federal Programs Corporation

October 2017

CDM Smith

RESPONSE ACTION CONTRACT
FOR REMEDIAL, ENFORCEMENT OVERSIGHT, AND NON-TIME
CRITICAL REMOVAL ACTIVITIES AT SITES OF RELEASE OR
THREATENED RELEASE OF HAZARDOUS SUBSTANCES
IN EPA REGION VIII

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Prepared for:
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Table of Contents

List of Exhibits

List of Figures

List of Tables

Appendices

Acronyms

ACL	alternate concentration limit
ARAR	applicable or relevant and appropriate requirement
BLM	U.S. Department of the Interior Bureau of Land Management
CD	Consent Decree
CDM Smith	CDM Federal Programs Corporation
CDOT	Colorado Department of Transportation
CDPHE	Colorado Department of Public Health and Environment
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
cm	centimeter
COC	contaminants of concern
CRR	completion review report
CSM	Conceptual Site Model
DOE	U.S. Department of Energy
E2	E2 Inc.
EC	environmental covenant
EPA	U.S. Environmental Protection Agency
FFRRO	Federal Facilities Restoration and Reuse Office
FFS	focused feasibility study
FS	feasibility study
ft	feet/foot
ft/day	feet per day
HI	hazard index
IC	institutional control
IEUBK	Integrated-Exposure Uptake Biokinetic
LM	Legacy Management
LTS	Long-Term Stewardship
LTSP	Long-Term Surveillance Plan
LUC	land use control
mg/kg	milligrams per kilogram
MMP	Material Management Plan
MOA	memorandum of agreement
mrem/yr	millirem per year
µR/hr	microroentgens per hour
NCP	National Oil and Hazardous Substance Pollution Contingency Plan
NPL	National Priorities List
NRC	U.S. Nuclear Regulatory Commission
O&M	operations and maintenance
pCi/g	picocuries per gram
pCi/L	picocuries per liter
P.L.	Public Law
PP	Proposed Plan
PRAO	preliminary remedial action objective

PRG	preliminary remediation goal
Ra-226	radium-226
RAO	remedial action objective
RAP	Remedial Action Plan
RBC	Risk-Based Concentration
RI	remedial investigation
RN	restrictive notice
ROD	Record of Decision
RP	responsible party
SDWA	Safe Drinking Water Act
Site	Uravan Uranium Project (Union Carbide Corporation) site
TBC	to be considered
TDS	total dissolved solids
Th-230	thorium-230
UCC	Union Carbide Corporation
UECA	Uniform Environmental Covenants Act
Umetco	Umetco Minerals Corporation
UMTRCA	Uranium Mill Tailings Radiation Control Act
U.S.C.	United States Code
UU/UE	unlimited use and unrestricted exposure
WA	work assignment

Section 1
Introduction

This Focused Feasibility Study (FFS) Report is for the Uravan Uranium Project (Union Carbide Corporation [UCC]) site (Site), a U.S. Environmental Protection Agency (EPA) Superfund Site located in Montrose County, Colorado. This FFS was prepared by CDM Federal Programs Corporation (CDM Smith) for EPA Region 8 in accordance with Task 1.9, Work Assignment (WA) 354-TATA-0846, EPA Contract EP-W-05-049. The document follows the requirements of Task Order 354 to prepare a FFS in support of future Proposed Plan (PP) and Record of Decision (ROD) documents.

1.1 Purpose and Organization

The feasibility study (FS) is the typical mechanism within Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) for the identification, development, screening, and detailed evaluation of remedial alternatives capable of addressing unacceptable risks to human health and the environment from contaminated environmental media. Due to the completion of physical remedy components under the Remedial Action Plan (RAP) and determinations made in the consent decree (CD) and subsequent five-year site reviews reports, EPA identified a FFS as the pertinent CERCLA document for evaluating supplemental remedial alternatives in support of a ROD to achieve adequate protection of human health and the environment. The FFS was prepared in accordance with the requirements of the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) as well as guidance developed by EPA, specifically *Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA* (EPA 1988) and *A Guide to Developing and Documenting Cost Estimates during the Feasibility Study* (EPA 2000).

After the FFS is finalized, a preferred alternative for the Site will be presented to the public in the PP. The PP briefly summarizes the alternatives from the detailed analysis of the FFS and highlights the key factors that led to identifying a preferred alternative. The PP allows the state (represented by Colorado Department of Public Health and Environment [CDPHE]) and the community, as well as other stakeholders such as the U.S. Department of Energy (DOE) and Umetco, to comment on the preferred alternative. Following the receipt of public comments and in consultation with CDPHE, EPA will select and document the remedial decision for the Site in a ROD.

1.2 Site Description and History

This section provides an overview of the Site description and history, including a brief summary of climate, geology, and hydrogeologic information.

1.2.1 General Site Description

The Site is located in a rural part of Montrose County, Colorado, approximately 90 miles southwest of Grand Junction, as shown in Figure 1-1. The Site was proposed to the National Priorities List (NPL) in October 1984 and listed in June 1986. The approximately 700-acre Site is not divided into operable units nor were the Site boundaries ever formally defined. It includes the

former processing areas, the former Town of Uravan, and surrounding areas. Colorado Scenic Highway 141 is located along and partially within the eastern portion of the Site. The San Miguel River flows through the northern portion of the Site (See Figure 1-2).

1.2.2 Site History

Mining operations in this area of Colorado began in the early 1900s. Standard Chemical Company first acquired mining claims in the area and began mining radium bearing carnotite ore in approximately 1910. In 1912, the Standard Chemical Company built a radium mill, located on the valley floor along the San Miguel River at the site of what later became known as "A-Plant." The mill produced radium until 1919. From the 1930s until 1984, various plants operated as uranium and vanadium processing facilities. The former Town of Uravan was established to house workers and their families at the mill and mine facilities.

The mill was placed on standby status in November 1984, and operations were never resumed prior to closure. The facility was licensed, initially by the Atomic Energy Commission, then the U.S. Nuclear Regulatory Commission (NRC) and more recently by CDPHE in their role as an Agreement State. There is a CDPHE Radioactive Materials License currently in effect.

Since approximately the 1950's, aspects of the Site operations have been partially regulated by federal and State government permits and licenses. Additionally, until 1970, UCC produced uranium pursuant to contracts with the United States. Mining, milling and waste disposal practices have resulted in:

- Wind and surface water dispersal of the tailings materials and the uncontrolled release of radon from the Tailings Piles
- Seepage of contaminated liquids into soils and groundwater from several areas in the mill complex and waste disposal areas
- Concentrations of large quantities of wastes in locations that posed a risk to public health and the environment, based on considerations of the potential for release of hazardous materials to the environment.

Operations at the Site left a large volume of wastes, which contaminated air, soil, and groundwater near the plants and in the San Miguel River. Solid wastes totaled over 10 million cubic yards and contained radioactive elements, metals, and inorganic compounds. Liquid wastes from seepage collection and groundwater extraction systems totaled over 350 million gallons at the end of 2004. The contaminants included radioactive products such as raffinates (liquid wastes from the uranium processing operations), raffinate crystals (primarily ammonium sulfate compounds), and mill tailings containing uranium and radium. Other chemicals in the tailings and groundwater included heavy metals (lead, arsenic, cadmium, and vanadium), thorium, and residual salts.

As previously stated, EPA listed the Site on the NPL in 1986. A memorandum of agreement (MOA) signed in April 1986 between the State of Colorado and EPA Region 8 designated the State to be the lead agency for this Site (EPA 1986). In the MOA, the State agreed to follow the remedial process established under CERCLA. Accordingly, remedial activities at the Site was accomplished under a CD/RAP, which EPA is not a party to, and under a CDPHE Radioactive Materials License.

By stipulated agreement between the CD parties, Umetco (a wholly owned subsidiary of UCC) was added as a defendant in 1986. Umetco is the responsible party (RP) for Site work. The State continues to be the lead agency for the Site with EPA as the support agency, with the exception that EPA is the lead agency on the remedial investigation (RI)/FS/PP/ROD/Five-Year Review process.

The RAP required all residents of the former Town of Uravan to vacate their residences by December 31, 1986. The RAP stated that UCC/Umetco was not to permit any building or improvement at the Site to be constructed or occupied as a residence. Cleanup remedies initiated by the 1987 RAP (amended in 1999 and 2005) included the following:

- Capping and revegetating nearly 10 million cubic yards of radioactive tailings
- Onsite disposal of 530,000 cubic yards of radioactive raffinate crystals
- Eliminating process ponds
- Pumping and treating contaminated groundwater
- Securing 12 million yards of tailings waste along the San Miguel River
- Dismantling the two mills and placing all old building demolition materials in a secure area
- Excavating and disposing of contaminated soil in a secure location and replanting excavated areas
- Dismantling and cleaning up the former Town of Uravan

On February 18, 2005, EPA deleted a portion of the Site from the NPL. This partial deletion pertains to 9.84 acres previously containing two historic structures, the Boarding House and the Community Center. On September 4, 2007, EPA deleted a portion of the Site on Colorado Highway 141 from the NPL (EPA 2015).

1.2.3 Long-Term Stewardship

The Site is a Uranium Mill Tailings Radiation Control Act (UMTRCA) Title II site (DOE 2014). Congress enacted UMTRCA to provide for the disposal, long-term stabilization, and control of uranium mill tailings in a safe and environmentally sound manner and minimize or eliminate radiation health hazards to the public. UMTRCA established two programs to protect the public and the environment from uranium mill tailings. Title I of UMTRCA authorizes DOE to remediate "inactive" processing sites. Inactive processing sites are those that were no longer licensed under the Atomic Energy Act as of January 1, 1978. The UMTRCA Title II program is directed toward uranium mill sites licensed by NRC or Agreement States on or after 1978. Title II of the Act provides:

- NRC authority to control radiological and non-radiological hazards
- EPA authority to set generally applicable standards for both radiological and non-radiological hazards

- Eventual state or federal ownership of the disposal sites under a general license from NRC

Land transfer to DOE for long-term custody of the property is a statutory requirement for uranium mill tailings sites. The portions of the Site that require long-term care under the UMTRCA Title II program will transfer to DOE's Office of Legacy Management (LM) program along with a long-term care fee in accordance with Atomic Energy Act of 1954 (Public Law [P.L.] 83-703) – Section 83 (Ownership and Custody of Certain Byproduct Material and Disposal Sites) and UMTRCA (P.L. 95-604), Title II (Uranium Mill Tailings Licensing and Regulation, Section 202, Custody of Disposal Site).

The long-term care of land transferred to DOE will be herein referred to as Long-Term Stewardship (LTS). LTS potentially includes institutional controls (ICs) and engineered controls, as well as monitoring, maintenance, and information management and is applicable to sites which DOE has completed or plans to complete cleanup under UMTCRA as well as cleanup completed by parties other than DOE but which DOE will perform LTS (DOE 2001).

The land requiring long-term care under UMTRCA is herein referred to as property within the "future DOE transfer boundary." It is anticipated that areas not included in the future DOE transfer boundary will be owned by either Colorado Department of Transportation (CDOT), Montrose County, or the U.S. Department of the Interior Bureau of Land Management (BLM).

1.2.4 Climate

The annual mean temperature during the period of record (1960 through 2014) was 53.2°F (11.8°C). The annual mean maximum temperature at the Site was 69.1°F (20.6°C), and the annual mean minimum was 37.3°F (2.90°C).

The annual average total precipitation received at the Site from 1960 through 2014 was 12.5 inches (31.8 centimeters [cm]). An annual maximum of 21.4 inches (54.4 cm) of precipitation was recorded in 1965, and an annual minimum of 7.1 inches (18.0 cm) was recorded in 1989.

Winds at the Site are strongly influenced by the San Miguel River Valley. The highest frequency wind directions generally parallel the river valley and are from the southeast. The annual mean wind speed is approximately 4.4 miles per hour (1.95 meters/second).

Studies in the Site area have shown the net potential evaporation rate for the entire year to be approximately 2 gallons per minute per acre or approximately 36 inches per year (91 cm/year) (Umetco 2005).

Severe weather in the area is usually in the form of intense rainfall or hail, both resulting from thunderstorms. The thunderstorm season occurs during late spring and summer (Umetco 2005).

1.2.5 Geology and Hydrogeology

Near-surface formations in the Site area are primarily Mesozoic-era sandstones, shales, and conglomerates.

A detailed description of site geology and hydrogeology is included in the RI Report (CDM Smith 2017). A brief summary of the hydrogeology of primary water-bearing formations and aquitards is provided below.

Hydrogeologic units of concern at the Site, from youngest to oldest, Salt Wash Member of the Morrison Formation, Summerville Formation, Entrada Formation, Kayenta Formation, Wingate Formation, and Chinle Formation. The San Miguel River Valley is located about 600 feet (ft) below the mesa areas and is directly sitting above the Kayenta Formation. Hydraulic properties of these hydrogeologic units are summarized below.

Salt Wash Member of Morrison Formation

The Salt Wash Member ranges in thickness from 0 to 300 ft in this area and is comprised predominately by sandstone. The average thickness beneath the disposal areas is about 100 ft. The sandstones have hydraulic conductivities that range from 0.051 to 0.027 feet per day (ft/day), an average porosity of 13.6 percent, and a moisture content of 4.4 percent. This stratigraphic unit provides much of the uranium ore in the Uravan mining district. The subsurface in the Club Mesa area contains extensive abandoned mine workings; however, the depth of mining was relatively shallow, 20 to 30 ft below the ground surface. The Salt Wash Member is a relatively stable roof rock, but there is evidence of subsidence and soil piping into these abandoned mines, which will probably continue (CDPHE 2015b).

Summerville Formation

The Summerville Formation is a 90-ft thick aquitard and is composed of alternating beds of siltstone and sandstone with shale and mudstone near the top. Permeability tests conclude that the hydraulic conductivity of the Summerville Formation is no greater than 2.8×10^{-5} ft/day. The laboratory tests also indicate a porosity of about 5.2 percent and a moisture content of 3.8 percent and show that this unit is not saturated. The Summerville Formation effectively confines water in the lower units (CDPHE 2015b).

Entrada Formation

The Entrada Formation has a thickness of approximately 160 ft and is predominately a fine- to very fine-grained sandstone. Regionally, the Entrada Formation is considered an aquifer; however, it is dry locally and throughout the entirely thickness below the Club Mesa area due to dissection by various canyons (CDPHE 2015b).

Kayenta/Wingate Formation

The Kayenta/Wingate Formation is the uppermost aquifer beneath the Club Mesa. The Kayenta and the Wingate Formations are in direct hydraulic connection and form a single aquifer unit here. Only the Wingate Formation is saturated beneath the Club Mesa. The aquifer is unconfined and at a depth of approximately 600 ft. The Kayenta-Wingate Formation sequence beneath the Club Mesa includes a 400-ft sequence of sandstones with interbedded shale of which the lower part is saturated. Permeabilities are generally very low beneath Club Mesa and at depth due to less fracturing while the upper portion of the Kayenta-Wingate Formation sequence in the San Miguel River Valley has a high permeability due to the fractured Kayenta Formation. Since the sandstones beneath Club Mesa are not extensively fractured, water is transmitted through the sandstones by primary porosity. These sandstones contain groundwater in storage but generally release only small amounts to wells. The Kayenta-Wingate Formation sequence has average hydraulic conductivities of 3 ft/day for Kayenta Formation in the San Miguel River Valley, 0.0004 ft/day in the Club Mesa area, and 0.12 ft/day for Wingate Formation; an average porosity of 12 percent; and a moisture content of 5 percent. Recharge to this aquifer occurs along the flank of

the Paradox Valley, south of the Site and along the exposed margins of the Uncompahgre Uplift. Groundwater flows toward the north and northeast with low gradient and discharges to the San Miguel River (CDPHE 2015b).

Chinle Formation

The Chinle Formation is about 400 ft thick and consists of predominantly of soft red siltstone. It does not produce water in the Site area. The Chinle Formation is an aquitard to vertical groundwater movement due to its lithology and low permeability (CDPHE 2015b).

1.3 Land Use and Ownership

1.3.1 Current Ownership and Land Use

Based on online cadastral mapping provided by Montrose County, most parcels within the Site are currently owned by Umetco with a few exceptions (i.e., portions of Windblown Areas E and J [BLM ownership], the Upper and Lower Burbank Quarry [DOE ownership], and ancillary BLM withdrawal areas). The Nature Conservancy Visitor's Site is currently under ownership of the Nature Conservancy. The Town Area, the Ball Park, and a portion of Homer Woods is currently under Montrose County ownership. There are also CDOT Highway 141 as well as County Roads EE-22 and Y-11 within the Site. As mentioned in Section 1.2.2, two areas of the Site have been previously deleted from the NPL (EPA 2015), and CDOT Highway 141 is one of the deleted areas.

Umetco performs an annual survey of land use within 5 miles of the Site and reports findings annually pursuant to Radioactive Materials License No. 660-02, Amendment 14. Recreational activities in the area include, but are not limited to, hunting, fishing, camping, and rafting on the San Miguel River.

Limited mine reclamation and exploration drilling activities were observed from 2010 to 2014. No mining or drilling activities were observed within the 5-mile radius of the site during 2016. However, survey markers were restaked at a mine claim on the Dolores Bench. Only the Spring Creek Mesa Mine spoil piles have the potential to impact reclamation activities within the 5-mile radius of the Site.

Cattle, although not dairy cattle, graze during the spring and fall. There are no gardens or fruit trees in restricted areas of the Site. (Umetco 2017).

Within approximately a 10-mile radius of the Site, there are nine completed wells for domestic, municipal, or stock use:

- Five domestic wells owned by UCC with one onsite well and four off-site wells; the closest off-site well is approximately 6 miles away from the Site.
- One municipal well owned by UCC is approximately 3.80 miles away from the Site.
- Three privately-owned stock wells, with the closest well approximately 2.75 miles from the Site.

Umetco has and will continue to maintain existing water rights in the San Miguel River (in trust) and the F-Block Well (for construction water). No new water rights were filed during 2016.

1.3.2 Reasonably Likely Future Ownership and Land Use

Future ownership has not yet been finalized; however, Umetco proposes to transfer ownership of land to various entities, including DOE, Montrose County, and BLM. Figure 1-3, revised May 12, 2015, is the land status map that indicates the proposed land transfer boundaries. Within these transfer boundaries, various county and state roads have easements to enable long-term operations and maintenance (O&M) – these are likely to remain in place in the future.

For proposed transfer from Umetco to DOE, the primary areas are:

- Atkinson Creek Disposal Area
- Club Ranch Ponds Area
- River Ponds Area
- Tailings Piles Area
- Club Mesa Area
- Town Dump
- Mill Areas, including A-Plant and B-Plant (and Repository)
- Portions of the former Town of Uravan and Adjacent Areas

For proposed transfer from Umetco to Montrose County, the primary areas are:

- Portions of the former Town of Uravan and Adjacent Areas and part of Homer Woods

For proposed transfer from Umetco to BLM, the primary areas are:

- Upper Club Mesa Borrow Areas
- Portions of the A-Plant, the Gym Area, and the Water Storage Ponds
- Miscellaneous Mining Claim Areas West of the Site

Again, the future land use allowed and proposed ownership within each of the transferred Site lands is still under consideration between Umetco, CDPHE, DOE, EPA, Montrose County, and BLM.

1.4 Report Organization

This FFS is organized into the following sections:

- **Section 1: Introduction** – Discusses the purpose of the FFS report and presents the report organization. In addition, it describes the Site background information (location, description, operational history, and previous investigations), features and physical characteristics, and current and reasonably likely future ownership and land use.
- **Section 2: Summary of Remedial Action –** Provides a summary of the remedial activities performed by Umetco under the RAP as part of CD obligations.

- **Section 3: Rationale for Evaluation of Limited Action Remedial Alternatives –** Describes the rationale for the evaluation of limited action alternatives and the conclusions affecting development and analysis of the limited action remedial alternatives in the FFS.
- **Section 4: Remedial Action Objectives –** Describes the process for identifying preliminary remedial action objectives (PRAOs) and identifies potential applicable or relevant and appropriate requirements (ARARs) for the FFS.
- **Section 5: Identification of Remedial Components for Limited Action Alternatives Development–** Identifies the remedial components considered in the development of remedial alternatives for the FFS.
- **Section 6: Development of Alternatives –** Describes the development of limited action remedial alternatives.
- **Section 7: Detailed Analysis of Retained Alternatives –** Presents a detailed individual analysis of the limited action remedial alternatives with respect to threshold, balancing and modifying CERCLA evaluation criteria.
- **Section 8: Comparative Analysis of Alternatives –** Summarizes the comparative analysis conducted to compare and contrast limited action remedial alternatives to the CERCLA evaluation criteria.
- **Section 9: References** – Lists the references and documents referred to in the FFS.

The following appendices are included to provide additional information and summarize relevant data.

- **Appendix A:** Summary of Federal and State Applicable or Relevant and Appropriate Requirements (ARARs) and To Be Considered (TBC)
- **Appendix B:** Detailed Evaluation of Alternatives
- **Appendix C:** Cost Estimate Backup
- **Appendix D:** Review of Umetco Risk Assessment, Alternative Soils Standards, and Residual Contamination

Section 2
Summary of Remedial Action

Under the CD, Umetco was required to complete remedial activities specified in the RAP, as amended (Umetco 2005). To complete these activities, Umetco prepared construction, health and safety, and environmental documents. The following sections provide a summary of the CD and RAP, implementation of remedial activities, and residual contamination remaining at the Site.

2.1 Summary of Consent Decree and Remedial Action Plan

On February 12, 1987, the United States District Court for the District of Colorado lodged the CD; the RAP was included as Appendix I of the CD (Umetco 2005). The RAP, as amended, was considered the functional equivalent of a CERCLA RI/FS and ROD. The scope of this RAP was to describe the remedial activities to be conducted by Umetco. Remedial activities pertaining to removal of contaminated solids from certain discrete areas on the Site and to the tailings disposal areas were substantially based upon previous Umetco commitments in the 1984 Colorado Radioactive Materials Licensing proceedings and were required to comply with CDPHE's prescribed permitting, inspection, monitoring and certification requirements.

The RAP included general site information such as site history, site physical characteristics, endangered species, surface water hydrology, and groundwater hydrogeology. In addition, the remedial activities were categorized as solids and liquids and description work to be performed in each anticipated remedial area was summarized.

The RAP did not include final plans and specifications, which were developed by Umetco and submitted to CDPHE for approval prior to construction.

2.1.1 Remedial Action Objectives

Remedial action objectives (RAOs) documented in the Fourth Five-Year Review (E2 Inc. [E2] 2010) are as follows:

- Protect surface and groundwater resources
- Stabilize and control the tailings and other waste materials
- Minimize radon emissions from the tailings and waste repositories
- Conduct soil cleanup in a safe and environmentally sound manner

2.1.2 Remedial Action Goals

2.1.2.1 Remedial Action Goals for Soil

Table 4.1.2-1 of the RAP (Umetco 2005) established two criteria for contaminated soil removal. Criterion 1 required cleanup of sites to exposure rates (based on scintillometer investigations) of less than 20 microroentgens per hour (µR/hr). This criterion allowed for state approval of remedial alternatives with residual exposure rates between 20 and 30 µR/hr, based on a

comparative assessment of alternatives (Umetco 2005). Criterion 2 established cleanup objectives for radionuclides and metals, which were later incorporated into the Site-Specific Cleanup Objectives Report (Umetco 1999).

The Site-Specific Cleanup Objectives Report (Umetco 1999) and RAP (Umetco 2005) identified the following as soil contaminants of concern (COCs) for the Site: average radium-226 (Ra-226) (0-15 cm), average Ra-226 (>15 cm), average thorium-230 (Th-230) (0-15 cm), average Th-230 (>15 cm), natural uranium, arsenic, cadmium, lead, molybdenum, nickel, selenium, vanadium, and zinc. The RAP criteria for soil removal were designed to achieve cleanup of naturally occurring radioactive and metal constituent concentrations, which approximate the levels existing prior to operations at the Site. The attainment of these criteria would ensure that there would be no incremental risk to human health from inorganic constituents and that radiological doses would meet EPA standards for residential construction. Project area specific characterization plans and remedial action were designed to meet this goal, which were met in all areas except for in four inaccessible locations as described in the September 2007 Alternative Soil Standard Application (Mill Hillside, A-Plant North, River Ponds, and County Road Y-11 areas).

The Site-Specific Cleanup Objectives Report included a risk assessment and indicated that if soil cleanup goals could not be met in an area, then additional detailed soil risk assessments would be performed (Umetco 1999). This rationale document also presents a summary of the process to confirm that constituents of concern for soil meet the RAP criteria or soil cleanup objectives. Confirmation surveys for the Site were intended to provide high-quality data and information so that comparisons with Site criteria and cleanup objectives can be made. The confirmation process included the collection of representative soil data, the validation of that data and appropriate analyses to determine if the RAP criteria or soil cleanup objectives were met.

The following tiered approach (assessment categories) was used to develop soil cleanup objectives for the Site (Umetco 1999).

- Category 1 –RAP Soil Criteria
- Category 2 – Risk-Based Soil Cleanup Objectives for Residential Land Use Scenarios
- Category 3 – Site-Specific Risk and Dose-Based Objectives
- Category 4 – Alternative Concentration Objectives

These categories were developed to allow for the assessment of specific project areas on a constituent by constituent basis and ensure that cleanup activities are protective of human health given site-specific land uses and topographic constraints in the area.

Category 1 – RAP Soil Criteria

Category 1 soil cleanup objectives values are site-specific background concentrations (i.e., the background mean concentration plus 3 times the standard deviation).

Category 2 – Risk-Based Soil Cleanup Objectives for Residential Land Use Scenarios

Category 2 soil cleanup objective values for metals/metalloids (except for arsenic) are risk-based values that would result in a cancer risk of 1E-06 for carcinogens or a non-cancer hazard index

(HI) of 1 for non-carcinogens, assuming residential land-use. The cancer risk of 1E-06 is at the lower end of the EPA-acceptable target cancer risk range of 1E-06 to 1E-04, and is typically used to evaluate the need for remediation or mitigation at a site. For non-cancer hazards, EPA generally considers a target HI of one or less as acceptable. The Category 2 value for arsenic is the site-specific background value since exposure to levels below background result in a cancer risk greater than 1E-06, and cleanup to levels below background is not warranted. Category 1 and Category 2 values for Ra-226 are equivalent to background plus the health–based criterion specified in Subpart B of 40 Code of Federal Regulations (CFR) Part 192 for residential land use scenarios (e.g., for surface soil, the cleanup value is 7.1 picocuries per gram (pCi/g) or background (2.1 pCi/g + health-based criterion of 5 pCi/g). The Th-230 soil cleanup level represents the initial Th-230 concentration, which would decay to Ra-226 at 1,000 years. Meeting cleanup objectives based on residential land use may indicate that ICs, monitoring, and maintenance are not warranted. However, Category 2 values do not account for soil-to-groundwater or soil-to-surface water transport pathways and are based on the assumption that groundwater use will be prohibited.

Category 3 - Site-Specific Risk and Dose Based Objectives

Category 3 values are dose- and risk-based soil cleanup levels derived for recreational receptors, monitoring workers, and ranchers based on site-specific exposure assumptions. Category 3 risk-based values for metals were based on a non-carcinogenic HI of 1; Category 3 values for arsenic, a carcinogen, were not developed. The only bioaccumulative exposure pathway included in Category 3 values was beef ingestion in the rancher exposure scenario. Doses for individual radionuclides correspond to an annual dose of 25 millirem per year (mrem/year). Acceptable doses were estimated so that the cumulative dose for site-related exposure was less than 100 mrem/year, which is the total acceptable effective dose established by EPA for members of the public exclusive of background radiation or medical administration.

Category 4 - Alternative Concentration Objectives

Alternative site-specific standards (Category 4) may be established under Subpart C of 40 CFR Part 192 under some special circumstances that allow the selection of remedial actions that come as close as reasonably achievable to meeting UMTRCA standards. Circumstances in which alternative standards may be considered include: situations in which worker safety would be adversely impacted, or clearly greater environmental harm would result from remedial action necessary to attain the standards; and for situations in which the materials do not pose a clear or present or future hazard and improvements could be achieved only at an unreasonably high cost. If alternative standards (also referred to as supplemental standards) are used, ICs, monitoring, and maintenance are generally included as a component of cleanup alternatives to ensure the response will be protective over time. For areas where cleanup-up values could not be achieved for various reasons (e.g., environmental hazards such as steep slopes, excessive costs in relationship to risk reduction) alternate soil standards (Category 4) were developed or proposed. Since there were no remediation areas at the Site where residual contamination exceeded any Category 3 criteria, the Category 4 risk assessments weren't necessary.

Category 1, 2, and 3 soil cleanup objectives are presented in Exhibit 2-1.

Exhibit 2-1 Summary of Soil Cleanup Objectives

Parameter	Category 1 RAP Objective	Category 2 Risk Based Objective (Residential)	Category 3 (Dose/Risk) Recreational Visitor	Category 3 (Dose/Risk) Monitoring Worker	Category 3 (Dose/Risk) Rancher
Radium-226 (0-15 cm)	7.1 pCi/g	7.1 pCi/g	58 pCi/g	100 pCi/g	170 pCi/g
Radium-226 (15-30 cm)	17.1 pCi/g	17.1 pCi/g	58 pCi/g	100 pCi/g	170 pCi/g
Thorium-230 (0-15 cm)	7.1 pCi/g	14 pCi/g	58 pCi/g	100 pCi/g	170 pCi/g
Thorium-230 (15-30 cm)	17.1 pCi/g	43 pCi/g	58 pCi/g	100 pCi/g	170 pCi/g
Natural Uranium	8.4 mg/kg	220 mg/kg	5,600 mg/kg	31,000 mg/kg	3,800 mg/kg
Arsenic	21.4 mg/kg	21.4 mg/kg	Site-specific[1]	Site-specific[1]	Site-specific[1]
Cadmium	2.0 mg/kg	75 mg/kg	1,900 mg/kg	10,000 mg/kg	61,000 mg/kg
Lead	164 mg/kg	400 mg/kg	Site-specific[2]	1,500 mg/kg	1,500 mg/kg
Molybdenum	2.3 mg/kg	370 mg/kg	9,400 mg/kg	51,000 mg/kg	310,000 mg/kg
Nickel	25.1 mg/kg	1,400 mg/kg	34,000 mg/kg	180,000 mg/kg	EU[3]
Selenium	11.2 mg/kg	370 mg/kg	9,400 mg/kg	51,000 mg/kg	310,000 mg/kg
Vanadium	60.1 mg/kg	520 mg/kg	13,000 mg/kg	71,000 mg/kg	430,000 mg/kg
Zinc	422 mg/kg	22,000 mg/kg	560,000 mg/kg	EU[3]	EU[3]

Notes:

1 = To be determined on a site-specific basis evaluating lack of feasibility to implement a 1E-06 risk-based criterion.

2 = Calculated using Integrated-Exposure Uptake Biokinetic Model (IEUBK) Method.

3 = Value exceeds unity (Risk-Based Concentration is greater than 1E+06 parts per million).

pCi/g = picocuries per gram

mg/kg = milligrams per kilogram

EU = Exceeds Unity

2.1.2.2 Remedial Action Goals for Groundwater

According to the RAP, cleanup levels for groundwater COCs were based on 40 CFR 192.32(a)(2). In 2001, the RAP was updated and 12 contaminants were removed from the list of groundwater COCs. CDPHE updated the RAP again in 2005, reducing the list of groundwater COCs further to include cadmium, fluoride, nickel, selenium, uranium (natural), vanadium, zinc, Ra-226 and gross alpha. As shown in Exhibit 2-2, current groundwater protection standards for cadmium and selenium have become more stringent since the 2005 RAP Amendment. However, the more stringent standards do not affect current protectiveness. Groundwater is not currently in use at the Site. The groundwater discharges to the San Miguel River (EPA 2015).

In 2003, CDPHE approved a groundwater alternate concentration limits (ACLs) application for 11 contaminants at the Site and EPA supported the decision for the use of State ACLs for this Site. The State ACLs were based on protection of surface water quality in the San Miguel River and are also shown in Exhibit 2-2.

Monitoring of groundwater, to confirm that State ACLs are protective of human health and the environment, is ongoing (Umetco 2017).

Exhibit 2-2 Summary of Cleanup Goals, Amended RAP Cleanup Goals, and State ACLs for Groundwater COCs

Contaminant of Concern	1987 RAP Cleanup Goal (mg/L)	2005 Amended RAP Cleanup Goal (mg/L)	2003 State Alternate Concentration Limit (mg/L)
Aluminum	None	None	7.9
Ammonium	None	None	6,900
Antimony	Background	None	None
Arsenic	0.05	None	None
Barium	1.0	None	None
Beryllium	Background	None	None
Cadmium	0.01	0.05	0.26
Chromium	0.05	None	None
Cyanide	Background	None	None
Fluoride	Background	4.0	None
Iron	None	None	130
Lead	0.05	None	None
Manganese	None	None	130
Mercury	0.002	None	None
Molybdenum	0.05 (during period of RAP activities), 0.01, SDWA MCL, or Background, whichever is higher (after conclusion of RAP activities)	See Notes	None
Natural Uranium	0.03 (during period of RAP activities), 0.015, SDWA MCL, or Background, whichever is higher (after conclusion of RAP activities)	0.044	5.5
Nickel	Background	Background	21
Nitrate + Nitrite (as N)	None	None	1,360
Selenium	0.01	0.05	0.5
Silver	0.05	None	None
Sulfate	None	None	32,600
Thallium	Background	None	None
Thorium-230	None	None	8,200 pCi/L
Vanadium	Background	Background	None
Zinc	Background	5.0	None
Radium-226 + Radium-228	Background	5 pCi/L	None
Gross Alpha	Background	15 pCi/L	None

Note:

Background methodology for dissolved constituents pursuant to Addendum A of the RAP, and as amended. Exhibit referenced and modified from the five-year review report (EPA 2015). Values for molybdenum and natural uranium were revised to reflect the most recent version of 5 Colorado Code of Regulations 1002-41. The molybdenum standard in 2012 was changed to 0.21 mg/L.

pCi/L = picocuries per liter
mg/L = milligrams per liter
RAP = Remedial Action Plan
SDWA = Safe Drinking Water Act
MCL = maximum concentration limit

2.2 Summary of Remedial Action Implementation

Remedial activities for the various areas of the Site are described in detail in the RI report (CDM Smith 2017). Under the CD, Umetco was required to complete the following general remedial activities as specified in the RAP, as amended.

- Determine the extent of dispersed contamination and clean up areas found to be contaminated to applicable criteria for approximately 400 acres.
- Relocate more than 3 million cubic yards of mill wastes and contaminated materials to secure repositories on Club Mesa.
- Construct waste and tailing repository covers, liquid evaporation and retention ponds, and permanent runoff control structures, utilizing more than 1.7 million cubic yards of earthen materials.
- Construct five double-lined ponds (totaling 40 acres) for the evaporation of hillside seepage, tailing pile seepage, and extracted groundwater.
- Construct and utilize a new repository in the "B-Plant" area capable of disposing in excess of 1.8 million cubic yards of evaporative pond demolition debris and radioactive waste.
- Demolish and remove about 50 major mill facility structures and buildings, including the process systems and circuits, and remove over 260 buildings in the former Town of Uravan.
- Collect over 70 million gallons of hillside and tailing seepage, containing approximately 6,000 tons of contaminated inorganic compounds. Hillside and tailing seepage that was collected was transferred to Club Ranch Ponds for management by evaporation.
- Extract approximately 245 million gallons of contaminated liquids from the groundwater with the removal of approximately 14,500 tons of contaminated inorganic compounds. Contaminated groundwater that was collected was transferred to Club Ranch Ponds for management by evaporation.
- Remove contaminated materials from the Old and New Town Dumps with placement into the Club Mesa Tailing repository.

A summary of remedial activities is provided in the section below for the solids areas (including town subareas) and liquids remedial activities described in the RAP.

2.2.1 Remediation of Contaminated Solids

Management of solids generally consisted of excavation of contaminated material, placement of material in onsite repositories, and site restoration. A brief summary of remedial activities for each area identified in the RAP is provided below:

- Atkinson Creek Crystal Disposal Area. Approximately 113,000 cubic yards of contaminated soil and raffinate crystals were removed. The site was graded with 1 ft of clean fill and revegetated.

- Club Ranch Ponds Area. Reclamation of the ponds occurred in three phases. Phases 1 and 2 included construction of new lined evaporation ponds for transfer of material from unlined ponds and for collection/evaporation of collected groundwater. Phase 3 consisted of removal of the ponds, disposal of contaminated media, and site restoration.
- River Ponds Area. Approximately 332,500 cubic yards of contaminated material was excavated from the floodplain to below historic flow elevation. Restoration consisted of placing riprap to enhance siltation.
- Tailings Piles. Remediation activities for Tailings Piles 1 and 2, Tailings Pile 3, and the B-Plant Repository that included dewatering, construction of drainage features, and capping.
- Club Mesa Area. Over 550,000 cubic yards of raffinate crystals, contaminated soil, and neutralized sludge were removed and placed in onsite repositories.
- Mill Areas. Remediation of the A-Plant and B-Plant areas was conducted in stages and included decommissioning of mill structures, removal of contaminated materials, and site restoration.
- Town Area. Over 236,000 cubic yards of contaminated materials were removed from the Town Area and placed in onsite repositories. The Town Area was then reclaimed and revegetated.
- Town Dump. Over 264,000 cubic yards of contaminated material were removed from the town dump and placed in the B-Plant repository. The area was then reclaimed and revegetated.
- Windblown Area. Exposure in most windblown areas was attributed to naturally occurring radioactive material. Residual impacts were noted for Area E and Area J. Tailings slimes were removed from Area J.
- Mill Hillside. Approximately 23,000 cubic yards of contaminated materials were removed from the mill hillside and placed in onsite repositories. Terraces were established to reduce erosion and enhance the hillside seepage collection system.
- County Road Y-11. Approximately 8,600 cubic yards of contaminated materials were removed from select portions of the roadway in 2006. Risk assessment was performed for deeper contamination along the roadway.
- County Road EE-22. Approximately 6,230 cubic yards of contaminated material was removed from the right-of-way and the roadway was restored. Paving of the roadway was recommended.
- Water Storage Ponds. Approximately 17,500 cubic yards of contaminated soil were removed and placed in onsite repositories. The area was then reclaimed and revegetated.
- Atkinson Creek Drainage Way. Radionuclide and metal concentrations in soil samples were found to be below background levels. No remediation was performed.

- Hieroglyphic Canyon Drainage Way. Discrete deposits of contaminated material were removed from the drainage way and placed in onsite repositories. No further action was proposed.
- Northeast Side of County Highway 141. Removals were conducted to the northeast of the right-of-way in 2000 and within the right-of-way during 2006. A portion of the right-of-way has been deleted from the Superfund site.
- Nature Conservancy Visitor's Site. Approximately 4,800 cubic yards of contaminated soil were removed and placed in the B-Plant repository. The site was reclaimed and revegetated. This cleanup was not proposed in the RAP.
- Other Town Areas. Based on contaminant levels reported to be below background levels, no remedial activities were performed at the Corrals, E Block, F Block, Gym Area, Ball Park, or Homer Woods.
- Burbank Quarry. The lower portion of the quarry was used as a repository for onsite materials. The upper portion of the quarry was used as a Title 1 Repository by the DOE for disposal of waste from the nearby Naturita processing site. The repository areas were capped and drainage materials were installed.
- Borrow Areas on Club Mesa. The borrow areas were not contaminated and were used as backfill sources during remediation activities.

2.2.2 Remediation of Contaminated Liquid

The RAP described liquid remedial activities associated with hillside seepage and tailings liquids, ponded liquids and surface runoff, and groundwater. These remedial activities are described in detail in the RI report (CDM Smith 2017). A summary of remedial activities is provided below.

2.2.2.1 Hillside Seepage and Tailings Liquids

Seepage had been occurring intermittently along approximately 4,600 linear ft of the Club Mesa rim. Seepage occurred near the contact between the Summerville and Salt Wash Formations and exits the valley walls of Hieroglyphic Canyon and the San Miguel River above the A-Plant Area. The seepage was composed of geochemically modified tailings solutions from the Club Mesa Tailings Piles and the Club Mesa Spray Area (E2 2010).

Umetco improved the Hillside Seepage Collection System in 1998. Seepage collection was completed by 2003, and the system was decommissioned. Decommissioning included sealing the toe drain system and placement of rock rubble to prevent erosion (EPA 2015).

2.2.2.2 Ponded Liquids and Surface Runoff

Contaminated liquids were contained in various ponds around the mill and within the mill circuit. By May 31, 1988, all collected fluids from mill circuit, hillside seepage and toe berm collection systems, and the surface runoff collection systems were being pumped into the new lined evaporation pond, CRP-7 (CDPHE 2015a).

On Apri1 30, 2003, Umetco notified CDPHE that the remediation of all waste material was complete and the placement of the reclamation covers on the Tailings Piles was complete. All the runoff control ponds were removed during the second quarter of 2003 (CDPHE 2015a).

2.2.2.3 Groundwater

Umetco installed the groundwater extraction system in 1991. Umetco upgraded it in 1996 and 1998. Groundwater pumping began in 1991. In 1997, the groundwater cleanup effort was evaluated and an optimized system developed to extract contaminated liquids from low-permeability zones in the Kayenta-Wingate Aquifer. The change in groundwater withdrawal successfully reduced contaminant concentrations (EPA 2015).

The groundwater extraction and CRP System has removed about 15,000 tons of contaminants from the groundwater flow regime. This action has helped reduce contaminant loading to the San Miguel River system. Throughout the groundwater remedial activities, Umetco modified the groundwater monitoring procedures with CDPHE approval to ensure optimum performance of the extraction program and to monitor compliance with groundwater protection standards (EPA 2015).

The Kayenta-Wingate Aquifer reached steady state conditions by 2002. The groundwater performance evaluations showed that future groundwater extraction would not significantly enhance aquifer restoration. In 2003, CDPHE approved a groundwater ACL application. State ACLs were proposed for 11 groundwater constituents at the Site. The State ACLs were developed using a point of exposure in the San Miguel River. The State ACL application implemented a monitoring program that consisted of quarterly monitoring with annual performance evaluations for a period of three years. After three years of monitoring and annual evaluations, the program showed that there were no contaminants in the Kayenta-Wingate Aquifer above the State ACLs. The State ACL monitoring program was terminated. Currently, as required by the State ACL application, groundwater is monitored in accordance with the anticipated DOE long-term monitoring for the Site (EPA 2015).

It is assumed that DOE will implement long-term monitoring of groundwater when it assumes ownership of the Site. The monitoring will ensure that the groundwater plume under the CRPs Area continues to naturally attenuate in accordance with the groundwater mixing model and that the State ACLs are not exceeded. DOE will assess the effectiveness of groundwater remediation in the future (EPA 2015).

2.3 Summary of Residual Contamination

Based on the remedial activities completed at the site and the use of Site-Specific soil cleanup objectives and State ACLs, residual contamination remains on Site. A summary of the Site solids and liquids containing residual contamination is presented below.

2.3.1 Summary of Residual Contamination in Solids

Residual impacts were primarily assessed through confirmation surveys at the various areas and subareas. The RI (CDM Smith 2017) describes in detail the residual impacts in soil (i.e., solids per RAP) with respect to concentrations of COCs compared to the goals described in Section 2.1.2.1. Exhibit 2-3 and Exhibit 2-4 shows a summary of contaminant exceedances by remediation area.

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Exhibit 2-3 Summary of Soil Cleanup Objectives, Average Residual Contaminant Values, and Exceedances in Soil

Description	One Meter Gamma Exposure Rate, Average µR/hr	Surface Soil Radium 226 Concentration, Average pCi/g	Radium 226 pCi/g	Thorium 230 pCi/g	Natural Uranium mg/kg	Arsenic mg/kg	Cadmium mg/kg	Lead mg/kg	Molybdenum mg/kg	Nickel mg/kg	Selenium mg/kg	Vanadium mg/kg	Zinc mg/kg
Soil Cleanup Objectives													
Category 1 Maximum Concentration	20	7.1	7.1 [2] 17.1 [3]	7.1 [2] 17.1 [3]	8.4	21.4	2	164	2.3	25.1	11.2	60.1	422
Category 2 Maximum Concentration	N/A N/A	N/A N/A	7.1 [2] 17.1 [3]	14 [2] 43 [3]	220	21.4	75	400	370	1400	370	520	22000
Check of Category 2 Screening Levels Metals - EPA Regional Screening Levels (May 2016) for Residential Soil [11], Radionuclides - EPA residential PRGs based on 1E-06 cancer risk [12].	N/A	N/A	0.012	0.054	230	0.68 [13]	71	400	390	1500	390	390 (Vanadium and compounds), 460 (vanadium pentoxide)	23000
Category 3 Recreational Visitor Maximum Concentration	N/A N/A	N/A N/A	58	58	5.60E+03	*site specific*	1.90E+03	--- [4]	9.40E+03	3.40E+04	9.40E+03	1.30E+04	5.60E+05
Average Residual Concentration by Remediation Area10													
Atkinson Creek Crystal Disposal Area [5], surface	13.6	3.4	1.4	3.8	3.2	3.5	0.5	6.8	2.9	4.2	0.2	15.5	21.3
Club Ranch Ponds, surface subsurface	19.3 N/A	4.4 N/A	2.94 1.25	9.83 8.3	6.45 4.14	7.79 7.51	1.1 1.09	41.85 37.45	2 2.04	6.88 10.79	0.51 0.53	58.29 39.75	88.63 89.08
River Ponds [6]	N/A	N/A	As allowed by RAP Section 4.3.2.(3), no soil sampling required as area excavated below water table										
Club Mesa Spray Area	N/A	7.1	As allowed by RAP Section 4.5.2.(3), no soil sampling required as area excavated to bedrock										
A-Plant, surface subsurface	15.8 N/A	4.2 N/A	2.5 3.1	2.7 4.7	6.9 12.2	2.4 2.9	0.3 0.3	7 9	0.7 1	5 5	0.2 0.2	63.8 72.3	21 26
A-Plant North, [6] surface subsurface	19.5 N/A	3.7 N/A	2.54 2.88	5.36 5.27	12.35 11.68	6.54 6.19	0.50 0.50	11.15 10.18	1.00 1.00	6.71 6.86	0.76 0.84	48.77 40.87	30.00 25.43
B-Plant, [7] surface subsurface	28.8 N/A	13.4 N/A	8.6 8.3	13.5 9.6	22.1 9.5	7.7 33.3	0.6 0.2	8.6 12.3	1.4 5.7	3.6 18	0.7 1.2	86.3 79.8	17.4 29
Historic Structures Area	16.0	3.2	No soil samples were collected in this area, however direct measurements have shown that it meets RAP criteria.										
Windblown Area, Area E, [8] surface	16.1	N/A	6.9	13.8	25.4	4.5	0.5	14	ND	5.3	0.5	111.7	46.3
Mill Hillside, [8] surface subsurface	35.1 N/A	22.0 N/A	17.1 10.5	22.6 12.7	60.6 33.3	7.2 6.3	0.5 0.3	12.8 8.8	1.4 1.1	20.3 10	1.8 1.3	194.3 124	39.5 31
County Road Y-11	N/A	4.5	No soil samples were collected in this area										
County Road EE-22 [9], surface subsurface	18.2 N/A	4.9 N/A	29.6 29.2	39.3 39.6	58.4 59.2	8.2 9.2	0.5 0.7	22.1 49	1.5 1.3	5 6	3 2	259 320	43 39.8
Water Storage Ponds, surface subsurface	15.7 N/A	3.0 N/A	2.3 1.8	2.8 1.7	6.7 5	6.5 6.3	ND ND	8.8 7.7	1.1 1.1	4.9 5	ND ND	35 29	26 27
Town Area, surface subsurface	16.9 N/A	4.3 N/A	2.9 2.9	4.9 4.7	10.2 8.7	7.4 7.6	0.6 0.6	38 41	1.6 1.6	8 6	1.2 1	45 40	129 118

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Exhibit 2-3 Summary of Soil Cleanup Objectives, Average Residual Contaminant Values, and Exceedances in Soil (continued)

Description	One Meter Gamma Exposure Rate, Average µR/hr	Surface Soil Radium 226 Concentration, Average pCi/g	Radium 226 pCi/g	Thorium 230 pCi/g	Natural Uranium mg/kg	Arsenic mg/kg	Cadmium mg/kg	Lead mg/kg	Molybdenum mg/kg	Nickel mg/kg	Selenium mg/kg	Vanadium mg/kg	Zinc mg/kg
Average Residual Concentration by Remediation Area10													
Atkinson Creek Streambed	N/A	N/A	1.9	2.5	2.8	7	1	6.1	2	3.9	0.8	18.3	33.4
Hieroglyphic Canyon Streambed	25.5^	13.8	No confirmation investigation necessary as remedial activities performed as prescribed in *Materials Identification and Removal Plan*										
Northeast Highway 141 including Right of Way, surface	16.9	8.0	4.4	6	8.1	5.8	0.36	19.8	0.89	4.5	0.41	28.2	45.5
subsurface	N/A	N/A	2.8	4	5.3	6	0.3	15.3	0.92	5.2	0.24	23.1	44.7
CDOT Highway 141, subsurface	17.9	4.1	3.1	4.1	8.5	8.8	0.7	16.7	1.3	5.5	0.2	40	55.7
Town Dump, surface	13.8	2.5	1.4	3.2	6.1	5.1	ND	9.7	1.6	6.5	ND	32	29
subsurface	N/A	N/A	1.8	2.6	5.8	5.5	ND	11	1.8	6.7	ND	32	31

Key:

Category 1 Exceedance Category 2 Exceedance

Notes:

1. The information summarized in this table is from the Compliance Reports provided by CDPHE.
2. Surface cleanup criteria i.e., 0 to 15 centimeters
3. Subsurface cleanup criteria i.e., > 15 centimeters
4. See Table 2-3 in Site-Specific Soil Cleanup Objectives Rationale Document for Uravan Project, Colorado, dated June 1999.
5. The sampling results have been calculated from information given in Potential Health Significance of Residual Levels of Metals in Soils at the Atkinson Creek Crystal Disposal Area, Uravan, Colorado, Revision 1, dated April 12, 1994 to be consistent with the results provided in other reclamation area confirmation reports.
6. Alternate Soils Standards have been approved for the River Ponds, A-Plant North, the Mill Hillside, and County Road Y-11.
7. The B-Plant area will be transferred to the Department of Energy for long-term stewardship and will effectively restrict future use of the land and minimize future exposure.
8. Soils samples were only collected in Area E. Since sampling for windblown, only surface soil samples were collected. Laboratory analyses indicate that soils are NORM rather than windblown licensed materials.
9. Soil samples collected on September 15 – 17, 1998, as part of characterization investigation. Additional sampling not conducted after remedial activities as roadway was immediately backfilled with clean materials so that road traffic could be maintained in accordance with Montrose County requirements. CDPHE inspected excavated area and confirmed that all tailings material were removed.
10. Confirmatory Soil samples were collected on a 10 x 10-meter grid basis. Surface Soil= 0-15 cm, Subsurface Soil= 15-30 cm
11. Regional Screening Levels (RSLs) are based on EPA 2014 exposure assumption recommendations which vary from those used in the 1999 RSL table; in addition, toxicity values and/or relative bioavailability default values have been updated since 1999. Exposure pathways include: ingestion, dermal contact, and inhalation of particulates.
12. The PRG table values were released in 2014 and do not reflect December 2016 changes to PRG equations. Residential exposure pathways include: external exposure, ingestion, inhalation, and ingestion of fruits and vegetables. EPA 40 CFR 192: The concentration of Ra-226 in land averaged over 100 m2 shall not exceed the background level by more the 5 pCi/g averaged over the first 15 cm of soil below the surface, and 15 pCi/g averaged over 15 cm thick layers of soil more than 15 cm below the surface.
13. Because the RSL for arsenic is below background; the background value is considered the appropriate value for IC determination.

* = Distance along streambed centerline.

^= The RAP Sections 4.7.2.4.1, 4.7.2.5.2 and 4.7.2.5.3 requires cleanup of Windblown Area, Atkinson Creek, and Hieroglyphic Canyon that are "concentrated, contaminated deposits" with exposure rates greater than 30 µR/hr. These results are from the characterization surveys as either no remediation or only limited prescriptive remediation was performed and as such no confirmation investigation was completed as noted in the Compliance Reports

N/A =Not Applicable/ Not Available mg/kg= milligrams per kilogram ND= Not Detected

NORM= Naturally-Occurring Radioactive Materials pCi/g = picocuries per gram

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Exhibit 2-4 Summary of Discrete Residual Contaminant Exceedances in Soil

Remediation Area	Restored Surface	COCs that exceed 1999 Site Specific Soil Cleanup Objectives Rationale Document Criteria		
		Category 1 RAP Criterion[1]	Category 2 Residential Land Use	Category 3 Dose/Risk Based[2]
Atkinson Creek Crystal Disposal Area[3]	Soil cover	Ra-226, Th-230, As, Mo, V	Ra-226, As	None[2]
Club Ranch Ponds[3]	Soil and rock cover	Ra-226, Th-230, As, Cd, Mo, U, V	Ra-226, Th-230, As	None[2]
Club Mesa Area	Soil and rock cover	Ra-226, Th-230, U	Ra-226	None
A-Plant[6]	Rock mulch and rubble cover	Ra-226, Th-230, Mo, U, V	Ra-226, Th-230	None
A-Plant North	Rock mulch and rubble cover	Ra-226, Th-230, U, V	Ra-226, Th-230	None
B-Plant	Rock mulch and rubble cover	Ra-226, Th-230, As, Mo, U, V	Ra-226, Th-230, As	None[2]
Town Area[3]	Graded and revegetated	Ra-226, Th-230, As, Cd Mo, Pb, U, V, Zn	Ra-226, Th-230, As, Pb	None[2]
Town Dump	Graded and revegetated	Th-230, Mo, U, V	Th-230	None
Windblown Area E	N/A	Ra-226, Th-230, U, V	Ra-226, Th-230	None
Mill Hillside	Rock cover	Ra-226, Mo, U, V	Ra-226, U, V	None
County Road Y-11	Backfilled and road surface cover	Ra-226	Ra-226	None
Water Storage Ponds	Soil Cover	Ra-226, Th-230, Mo, U, V	Ra-226, Th-230	None
Northeast Side Highway 141	Soil and rock cover	Ra-226, Th-230, U, V	Ra-226	None
CDOT Highway 141 Mileposts 75-76[4]	Soil cover	Ra-226, Th-230, Mo, U, V	Ra-226	None
Nature Conservancy Visitor's Site	Soil cover (with cobbles)	Ra-226, Th-230, U	Ra-226, Th-230	None

Notes:

1. RAP Table 4.1.2.1 Criterion 2 (Umetco 2005).
2. Category 3 standards for arsenic are area-specific and were not established for the area.
3. In March 2017, CDPHE consulted with NRC regarding 242 grids (10 meters by 10 meters) of elevated radium concentrations, which could affect the results presented. These grids have radium concentrations between 7.1 and 58 pCi/g, but still meet the Category 3 standard of the 1999 soil methodology document (Umetco 1999a). These areas include Atkinson Creek Disposal Area, Part of Club Ranch Ponds, A-Plant North outside of the original alternative soil standard area, County Road EE-22, and the Town Area. NRC requested an alternative soil standards application to be submitted to NRC for five areas containing these grids. CDPHE and Umetco are currently preparing an alternative soil standards application for submittal to NRC for approval.
4. Deleted from the NPL on September 4, 2007.

COC = contaminants of concern
RAP = Remedial Action Plan
Ra-226 = Radium-226
Th-230 = Thorium-230
As = Arsenic
Cd = Cadmium
Mo = Molybdenum
V = Vanadium
U = Uranium
Pb = Lead
Zn = Zinc
N/A = Not Applicable/ Not Available
CDOT = Colorado Department of Transportation
NRC = U.S. Nuclear Regulatory Commission
CDPHE = Colorado Department of Public Health and Environment
pCi/g = picocuries per gram

2.3.2 Summary of Residual Contamination in Liquids

2.3.2.1 Groundwater

As previously stated, the groundwater evaluation required by the State ACL application expired in 2006, but has been continued in anticipation of the DOE maintaining this evaluation under the LTS Program. Groundwater monitoring conducted in the Club Ranch Ponds area continues to demonstrate that State ACLs for constituents of concern were met during post-operational monitoring established in the State ACL application (Umetco 2017).

Groundwater monitoring currently consists of annual sampling of three wells at the Site (CRP-19A, CRP-25, and background well CRP-1). The most recent available data for these wells (September 2016) are presented in Exhibit 2-5.

Exhibit 2-5 2016 Groundwater Monitoring Results

Constituent	Unit	State ACL	Well CRP 1	Well CRP 19A	Well CRP 25	Mean Concentration
Aluminum	mg/L	7.9	<0.03	<0.06	<0.3	<0.18
Ammonium	mg/L	6,900	<0.05	36	640	338
Cadmium	mg/L	0.26	<0.0001	0.0249	0.01	0.02
Iron	mg/L	130	<0.02	<0.04	<0.2	0.12
Manganese	mg/L	130	<0.005	3.59	5.74	4.66
Natural Uranium	mg/L	5.5	0.0002	0.086	0.156	0.12
Nickel	mg/L	21	<0.008	<0.02	0.19	0.10
Nitrate + Nitrite (as N)	mg/L	1,360	0.16	20.3	22.5	21.4
Selenium	mg/L	0.5	0.0007	0.0066	0.209	0.11
Sulfate	mg/L	32,600	36.5	1,860	9,380	5,620
Thorium-230	pCi/L	8,200	0.01	0.02	-0.02	0

pCi/L = picocuries per liter
mg/L = milligrams per liter

The mean concentration of State ACL constituents is currently compared to the individual ACLs. If a State ACL exceedance is noted, Uravan Groundwater Monitoring Procedure E-11 requires corrective action including additional sampling of wells CRP-19B, CRP-19C, and CRP-21. Groundwater monitoring conducted in the Club Ranch Ponds area continues to demonstrate that ACLs for constituents of concern were met during post-operational monitoring established in the State ACL application.

2.3.2.2 Surface Water

Analytical data from the San Miguel River were evaluated in the State ACL application for historic trends of heavy metals, radionuclides, and inorganic constituents (CDPHE 2003). Data collected from 1987 through 2001 included total dissolved solids (TDS), total suspended solids, aluminum, arsenic, ammonia-N, cadmium, copper, iron, lead, manganese, mercury, nickel, nitrate+nitrite-N, pH, Ra-226, selenium, silver, sulfate, Th-230, uranium, and zinc. Two major conclusions were drawn from the historic trends (CDPHE 2003).

First, uranium milling operations were impacting the San Miguel River during the late 1980s. For example, standards in the river may have been exceeded for aluminum, cadmium, copper, iron,

lead, mercury, selenium, silver, and un-ionized ammonia in 1988 and 1989 at some of the river stations. As remedial activities progressed, exceedances of the San Miguel River water quality standards decreased. Remedial activities at the Site resulted in a direct improvement in San Miguel River water quality through: (1) removal of tailings material from the floodplain of the San Miguel River; (2) construction of new, lined evaporation ponds; (3) removal of contaminated solids and liquids from the unlined Club Ranch Ponds; and through (4) extraction and containment of contaminated groundwater from beneath the Club Ranch Ponds.

Second, there have been no significant or consistent exceedances of surface water quality standards in the San Miguel River at the Site since 1993. Water quality in the river for the past 5 years is nearly identical at all six sampling stations. Aluminum, arsenic, cadmium, copper, iron, lead, manganese, nickel, nitrate+nitrite-N, Ra-226, selenium, silver, Th-230, uranium, and zinc are not elevated above background conditions or surface water quality standards. A few isolated exceedances occur that are data outliers as reflected in the ambient upstream conditions. The concentrations of sulfate and TDS are not significantly different when upstream and downstream locations are compared. Therefore, the high TDS liquids contained in the groundwater do not discharge to the San Miguel River in quantities that produce significant increases in contaminant levels at stations downstream of the Club Ranch Ponds during normal river flows (Umetco 2003).

The post-operational surface water monitoring set forth in the CDPHE-approved Application for ACLs was completed in 2006. However, monitoring will continue in anticipation of the DOE continuance of surface water monitoring under the LTS Program.

2.4 Summary of Current or Potential Contaminant Exposures

The following section provides a summary of current and potential exposure scenarios for solids and liquids at the Site.

2.4.1 Solids

CERCLA does not require remediation of contamination associated with a release below background concentrations. Background concentrations for radionuclides and metals were evaluated and established to compare against receptor exposures to contaminants associated with the release, taking into account various land uses at the Site. This activity resulted in the development of soil cleanup objective categories as discussed in Section 2.1.2.1.

For natural uranium and all metals except arsenic, soil cleanup objectives presented as Category 2 soil cleanup objectives were calculated using the methods and assumptions specified in CDPHE (1997) guidance for residential land use scenarios. These objectives were derived using conservative default exposure parameters for soil ingestion, dermal contact, and inhalation pathways, assuming child receptors, combined with the toxicity factors recommended in EPA's Integrated Risk Information System (EPA 1999a) and/or Health Effects Assessment Summary Tables (EPA 1997). As demonstrated in Table 2-2 of the Umetco 1999 Site-Specific Soil Cleanup Objectives Rationale document (Umetco 1999), these values are lower (more conservative) than those shown in EPA Region III's Risk-Based Concentration (RBC) Table (EPA 1999b) due to the inclusion of the dermal pathway. The objectives do not account for soil to groundwater or surface water transfers (e.g., leaching or erosion/runoff) (Umetco 1999).

Various exposure scenarios, combinations of receptors, and exposure pathways were considered for the Site and presented as Category 3 soil cleanup objectives. For example, in accordance with NRC (NRC 1998) guidelines, ranching, mining, light industry, and residential (e.g., farmer or home-based business) scenarios were initially considered. However, not all scenarios and associated pathways were modeled because it was assumed that future residential use of Umetco property at the Site will be prevented through ICs. The rationales for selection or exclusion of various pathway scenarios for these soil cleanup objectives (refer to Section 2.1.2.1) are presented in Exhibit 2-6 (based on Table 2-4 of the Umetco 1999 Site-Specific Soil Cleanup Objectives Rationale document). Dose-based and risk-based soil cleanup objectives were developed for the following three exposure scenarios (Umetco 1999):

1. Recreational hikers. Children were considered in the evaluation of this scenario because they represent the most conservative receptor group.
2. Monitoring workers who are involved in maintaining the Site or in a monitoring activity are used to represent any onsite work.
3. Ranching is assumed to be grazing of beef cattle and ingestion of meat.

The risk analysis considered the following exposure pathways, which vary by receptor type (Umetco 1999):

1. Inhalation
2. Soil ingestion
3. External gamma radiation
4. Dermal contact (toxicity endpoints only, i.e., metals and natural uranium)
5. Consumption of meat from cattle grazing

Exhibit 2-6 Potential Exposure Scenarios Considered in the Soil Cleanup Objectives Rationale Document

Exposure Route	Scenario Evaluated?	Rationale for Selection or Exclusion
Recreational Receptor Scenario	Yes	The Site is located in a scenic area in the region of the canyonlands of the Colorado Plateau. Therefore, access to this area for hiking or camping purposes may occur in the future.
Monitoring Worker Scenario	Yes	Some Site areas may require long-term monitoring and/or maintenance.
Ranching Scenario: Meat Ingestion Pathway	Yes	Land surrounding the Site has been (and continues to be) used as rangeland for grazing of beef cattle. Therefore, meat (beef) ingestion and concomitant soil direct contact exposures (soil ingestion, dermal contact, inhalation, external gamma radiation) were evaluated. This pathway analysis likely will be required for any lands transferred to the BLM.
Dairy (Milk Ingestion) Scenario: Ingestion of milk from livestock grazing on land and consuming forage	No	No dairies are located in the vicinity of the Site nor are they likely to be established in the future. Even if some dairy cows were to graze in contaminated areas, the milk probably would be sent for processing and not consumed at the Site.
Hunting Scenario: Ingestion of meat from wild game grazing on Site land	No	Although hunting could occur on a seasonal basis, exposures and risks would be less than those associated with the rancher (livestock grazing) pathway scenario described above.
Residential Scenarios (e.g., residential farming or residential home-based business)	No	Residential land uses are addressed by the Category 1 (RAP Criteria) and Category 2 (risk-based residential use) soil cleanup goals.
Agricultural Scenario: Consumption of Crops and/or Vegetables (Food Production)	No	Plant uptake and subsequent crop or vegetable ingestion will not be evaluated given the planned residential land use restrictions identified above.
Mining Scenario	No	The uranium deposits on Club Mesa have been depleted, and no other mineral deposits of economic value are known to exist within the future DOE land transfer boundary. Therefore, although mining still occurs in the lands surrounding the Site, a future mining scenario is not applicable to the Site.
Construction, Commercial, or Industrial Use Scenarios	No	Construction, commercial, or industrial uses would be permitted by attaining Category 1 and 2 soil cleanup goals. Any potential future construction associated with Highway 141, County Road EE-22, or County Road Y-11 will be addressed on a site-specific basis.
Exposure pathways associated with soil to groundwater transfers, including leaching of soil contaminants to groundwater and subsequent groundwater ingestion and/or other domestic uses	No	As indicated above, future residential use of Umetco property at the Site is assumed to be prevented through ICs. Such controls would preclude domestic uses of groundwater.
Exposure pathways associated with soil to surface water transfers (e.g., migration of soil contaminants via runoff, erosion, and/or deposition), including direct ingestion of surface water, dermal contact with surface water, and/or ingestion of fish from the San Miguel River	No	The San Miguel River exhibits no measurable impacts from the Site based on surface water samples collected to date. Water in the San Miguel River meets safe drinking water standards for constituents of concern for soil cleanup. Under the hypothetical assumption that constituent levels in the river were attributable only to site soils (e.g., no migration from upgradient sources, no deposition, etc.), the current water quality in the river represents a worst-case snapshot (relative to potential future impacts), as site-wide soil contaminant levels at the Site will decrease as a result of the ongoing remedial activities.

2.4.2 Liquids

According to the groundwater exposure assessment presented in the Application for ACL (CDPHE 2003), four registered groundwater wells are present within 2 miles of the Club Ranch Ponds. These wells are owned by Umetco and historically provided water for the former Town of Uravan and mill. All of these wells are upgradient of the ponds and will be plugged prior to final closure of the Site. Five additional domestic or industrial wells are present within a radius of 5 miles from the site (DOE 1998).

There are currently no exposures of wildlife, crops, or vegetation to contaminated groundwater. There are no physical structures on site or exposure of physical structures to groundwater that would result in physical damage. Water from the Site discharges into the San Miguel River and is diluted such that it does not result in unacceptable risks to aquatic receptors.

Section 3

Rationale for Evaluation of Limited Action Remedial Alternatives

Given that several Site areas have solids and liquids containing residual contamination after implementation of the RAP, this section presents a summary of risk management considerations and conclusions affecting development and analysis of limited action remedial alternatives to ensure adequate protection of human health and the environment (short- and long-term) at the Site.

3.1 Summary of Risk Management Considerations Following RAP Implementation

EPA has developed a memorandum titled *Review of Umetco Risk Assessment, Alternative Soils Standards, and Residual Contamination* (see Appendix D) that evaluated residual risks associated with various remediation areas at the Site remaining after RAP implementation. The purpose of the evaluation was to determine the contemporary validity of the radiation and chemical risk assessments conducted as part of the response action; to determine whether the actions taken by Umetco are sufficiently protective of human health and the environment using current CERCLA risk assessment methodologies; and to make recommendations on which remediation areas with residual contamination may require additional remedial components to be sufficiently protective of human health and the environment. The following sections describe the assumptions, review, and evaluation process that was performed by EPA to evaluate residual risk as the Site based on remaining contamination (EPA 2017).

3.1.1 Review of Umetco Risk Assessment, Alternative Soils Standards, and Residual Contamination

As part of the RAP developed pursuant to the CD with CDPHE, Umetco developed a detailed risk assessment methodology in 1999 (Umetco 1999) which was used to establish soil cleanup objectives for the Site. As described in Section 2.1.2.1, this methodology established four different soil cleanup categories based upon the risk and dose assessments for area-specific land use scenarios and set concentration limits for each constituent of concern for each category. These four categories serve as the basis for evaluating the protectiveness of the remedy and determining the need for ICs (EPA 2017).

Shortly after the risk assessment methodology was developed for the Site in 1999, EPA promulgated guidance for environmental exposures to low-level radioactivity and published conservative radiological risk coefficients for many of the radionuclides of concern at the Site (EPA 1999c). While EPA's Preliminary Remediation Goals (PRG) Calculator for Radionuclides is now used in CERCLA Radiological Risk Assessment, 40 CFR 192.12 is still a pertinent regulation for Ra-226 for the cleanup of UMTCRA sites. The Category 2 risk-based soil cleanup objectives identified by Umetco and approved by CDPHE under the RAP for Ra-226 activity concentrations

(7.1 pCi/g from 0-15 cm soil depth and 17.1 pCi/g at soil depths greater than 15 cm) are in line with the requirements of 40 CFR 192.12. The Category 2 risk-based soil cleanup objectives developed for Th-230 activity concentrations (14 pCi/g from 0-15 cm soil depth and 17.1 pCi/g at soil depths greater than 15 cm) account for radioactive ingrowth of Ra-226 over a 1,000-year time horizon and are consistent with other radiological remedial actions performed by EPA in Region 8, which were also considered protective of human health and the environment (EPA 2017).

With respect to arsenic concentrations at the site, the natural background concentrations prevalent throughout the Site (21.4 mg/kg) are much higher than those found in the current EPA Region III RBC Table (0.68 mg/kg). As such, the background Category 1 concentration for arsenic is set as the default Category 2 concentration. For the site-specific residual uranium contamination, the principal health effect associated with uranium ingestion in a residential exposure scenario is chemical toxicity, not radioactive carcinogenic toxicity. Therefore, the Category 2 concentration is set at 220 mg/kg, which is below the EPA Region III RBC Table value of 230 mg/kg for residential soils. These risk-based objectives for uranium and all metals in Category 2 are lower (more conservative) than those shown in the EPA Region III RBC Table due to the inclusion of the dermal exposure pathway (EPA 2017).

3.1.2 Review of Anticipated Future Land Use and Potential Contaminant Exposure Pathways

There are currently no residential exposure pathways associated with the Site. The former Town of Uravan has been removed as part of the remedial action and the nearest resident is several miles from any of the remediation areas (EPA 2017).

As acknowledged by EPA in the risk assessment, given the size of some of these remediation areas and the variability in the residual contamination present therein, estimating residential risk using simple averaging is not appropriate and better spatial resolution of contamination down to typical residential parcel size of 0.5 acres is needed. A detailed risk assessment with smaller parcel sizes may be warranted if residential use is considered in the future for any of the areas (EPA 2017).

There are 12 remediation areas classified as UMTRCA Title II areas that will become the long-term responsibility of the DOE LM program, in whole or in part. In these remediation areas, DOE will be implementing controls to protect radiation workers, whose exposures will be governed by OSHA and the NRC under a general license. For this reason, only occupational exposure scenarios in these remediation areas was evaluated in the risk assessment (EPA 2017).

The BLM, Montrose County, and/or CDOT may take possession of the remaining areas, including the Windblown Areas, the Water Storage Ponds, the Town Area, Northeast Highway 141, the CDOT Highway 141 Right of Way, Hieroglyphic Canyon and Atkinson Creek Streambeds. The CDOT already has possession of the portion of the Site on Colorado Highway 141, which was deleted from the NPL (EPA 2015). For those remaining areas on the NPL and not included in the DOE LM program, recreational and rancher exposure scenarios were evaluated in the risk assessment using average residual contamination concentrations to determine exposure risks. For Hieroglyphic Canyon and Atkinson Creek Streambeds, residential exposure scenarios were

also evaluated for reference. While development for residential use is highly unlikely in any of these areas, the land ownership isn't yet in place. Also, in many areas, only partial data exist, so a complete risk assessment was not possible, but an estimate was made (EPA 2017).

3.1.3 Review of Remedial Action and Residual Contamination Category 1 and 2 Exceedances

During the remedial activities, most of the COCs were removed from nearly all the remediation areas to below the Category 1 soil cleanup objectives, which would permit unlimited use and unrestricted exposure (UU/UE) designation for those parcels. However, there were also several remediation areas with at least one COC above the Category 1 soil cleanup objectives, meaning that background equivalent concentrations had not been achieved for that contaminant. Some remediation areas, including B-Plant, Mill Hillside, and County Road E-22 had exceedances of Category 2 soil cleanup objectives for Arsenic, Ra-226, and/or Th-230, meaning that residential land use exposures would exceed acceptable risks. Since all of the remediation areas with Category 2 exceedances will be transferred to DOE LM, residential exposures would not be anticipated. Residual contamination soil concentrations and activity concentrations by remediation area can be found in Exhibit 2-3 (EPA 2017).

The only remediation areas that clearly met the 1999 Soil Cleanup Objectives for Category 1 were the Town Dump, which will remain under DOE LM control due the potential for groundwater contamination, and the Water Storage Ponds, which will likely be transferred either to BLM or Montrose County. Of the other remediation areas that will be transferred outside of DOE LM control anticipated to be going to BLM, Montrose County, and/or the State of Colorado, there were typically minor exceedances of Uranium or Vanadium. The radiological risk and dose calculations and the chemical risk assessment associated with these exceedances are discussed below (EPA 2017).

3.1.4 Findings from the Risks Assessment Associated Residual Contamination from Soil

A summary of the risks associated with residual contamination from soils based on confirmatory sample results are summarized below. The risk assessment memorandum prepared by EPA is provided in Appendix G of the RI Report (CDM Smith 2017) and Appendix D of this report.

3.1.4.1 Significant Radionuclide and Gamma Exposure Rate - Risk Calculations for the CSM

The risk assessment calculated the radionuclide carcinogenicity risk for residual radioactive contamination present in the various remediation areas at the Site using two difference methods. The first method applied the Conceptual Site Model (CSM) and risk assessment approach (Umetco 1999a). The second method used the EPA PRG Calculator and select exposure time and duration values from the CSM. The radionuclide carcinogenicity risks were calculated for worker, rancher, recreational user, and, where potential exists for land usage or zoning changes, resident exposure scenarios. The protective risk range that is acceptable for any CERCLA exposure scenario is 1E-04 to 1E-06 excess cancers, with the point of departure at the lower end of the risk range.

For the first method using the CSM and risk assessment approach, the evaluation findings included:

- Rancher exposure scenarios are below 1E-06 excess cancer risk for areas outside the future DOE transfer boundary.
- Excess cancer risk for recreational exposure scenarios are within the 1E-05 to 1E-06 risk range outside the future DOE transfer boundary.
- Occupational exposures are expected to fall in within the 1E-05 to 1E-06 excess cancer risk range outside the future DOE transfer boundary.
- Residential exposures were evaluated only for the Atkinson Creek Crystal Disposal Area and the Hieroglyphic Canyon Streambed. In these instances, the risk ranged from 3.39E-05 at Atkinson Creek to 1.30E-04 at Hieroglyphic Canyon.

For the second method using the EPA PRG Calculator and select exposure time and duration values from the CSM, the evaluation findings included:

- Rancher exposures and recreational exposures, which include a fractional contaminated beef consumption risk factor, are all less than 8.63E-06 for excess cancer risk.
- Occupational exposures are expected to be less than 1E-06 excess cancer risk at all the remediation areas expected to transfer to DOE LM.
- Residential exposures were evaluated only for the Atkinson Creek Crystal Disposal Area and the Hieroglyphic Canyon Streambed. In these instances, the excess cancer risk ranged from 2.03E-05 at Atkinson Creek to 9.06E-05 at Hieroglyphic Canyon (EPA 2017).

3.1.4.2 Significant Radionuclide and Gamma Exposure Rate - Dose Calculations for CSM - Dose Calculations for the CSM

Potential radiation dose calculations were performed using maximum grid and average residual contamination values for Ra-226 in each remediation area, with dose conversion factors and the CSM values to calculate doses for the various exposure scenarios (Umetco 1999a). ICs would restrict any potential residential development of the remediation areas, especially Hieroglyphic Canyon and Atkinson Creek Crystal Disposal Area, the calculations of potential doses indicate that recreational, rancher, and occupational exposure scenarios are sufficiently protective. The dose calculation evaluation findings included:

- Effective dose equivalents for occupational exposures to residual Ra-226 contamination on all the remediation areas expected to transfer to DOE LM is expected to fall within the range of 7 mrem/year to 1,816 mrem/year.
- Dose for recreational and rancher exposures, ranged from 0 to 87 mrem/year.
- Doses associated with residential exposures were evaluated only for the Atkinson Creek Crystal Disposal Area and the Hieroglyphic Canyon Streambed. In these instances, the effective dose equivalent ranged from 129 to 2,245 mrem/year at Atkinson Creek and 377 to 404 mrem/year at Hieroglyphic Canyon (EPA 2017).

3.1.4.3 Chemical Exposure Risks

To evaluate the non-carcinogenic residual risk, the HI for the various routes of exposure in the CSM for each remediation area. Hazard indices were calculated using the EPA RSL Calculator and the residual soil concentrations for the metal COCs. The evaluation findings included:

- Occupational exposures to residual metals contamination on all the remediation areas expected to transfer to DOE LM are below 0.00606 for expected adult exposure scenarios.
- Recreational exposures, for child and adult, ranged from 0.00197 to 0.185.
- Residential exposures, for child and adult, were evaluated for the Atkinson Creek Crystal Disposal Area and the Hieroglyphic Canyon Streambed, as well as all the areas where ranching is anticipated to occur.
    - In all these instances, the adult non-carcinogenic HI for metals exposure ranged from 0.0247 to 0.435.
    - For the child non-carcinogenic HI for metals exposure, the HI ranged from 0.0262 to 4.63. The HI for child residential metals exposure exceeded 1 on the Windblown Area (1.92) and County Road EE-22 (4.63) (EPA 2017).

3.1.4.4 Summary of Risk Assessment Findings

Based on the review of risk associated with residual contamination present at portions of the Site, additional remedial components such as ICs may be required for protectiveness. IC considerations based on review of risk are summarized in Section 5.1.3.1.

3.1.5 Risk Considerations Associated with Residual Liquid Contamination

As described in Section 2.3.2.2, the post-operational surface water monitoring set forth in the State ACLs was completed in 2006 and will continue in anticipation of the DOE continuance of surface water monitoring under the LTS Program. Groundwater could still pose unacceptable exposure risks from ingestion as drinking water in certain portions of the Site and additional remedial components may be needed to ensure protectiveness in conjunction with the State ACL.

3.2 Conclusions Affecting Development and Analysis of Limited Action Remedial Alternatives

The remedial activities as implemented have resulted in significant risk reduction to humans from exposure to contaminated solid and liquid media, but has not fully addressed all potential future uses of the Site that could result in unacceptable exposures to residual contamination in soils and groundwater. Based on the conclusions presented in the following subsections, this FFS evaluates limited action alternatives, which include ICs and long-term monitoring and maintenance to achieve the RAOs presented in Section 4.

3.2.1 Conclusions Regarding Management of Contamination in Soil

Sections XXIX and XXX of the CD provide a determination that the remedial activities provided for in the RAP and CD is the "appropriate extent of remedy" as defined and required by 40 CFR §§300.68(i)(1) and 300.71(a)(2)(ii)(C). Based on this determination, the remedial action, if

implemented in accordance with the RAP, would be protective of human health and the environment. The determination in the CD was predicated on the presumption that ICs and monitoring would be instituted to protect humans from exposures to residual contamination following the remedial action; this is confirmed based on results from the risk assessment described in Section 3.1. The remedial action was implemented as described in Section 2, with the exception of ICs and monitoring.

Given the determination in the CD and the risk considerations presented above, this FFS will evaluate limited action alternatives, which include ICs and long-term monitoring and maintenance as defined in Section 5, for residual contamination in soil.

3.2.2 Conclusions Regarding Management of Contamination in Groundwater

As previously indicated, and as part of the application, Umetco stated that ICs would ensure that ground water would not be used in any manner resulting in human health risks, ICs would prevent future exposure of wildlife, crops, and vegetation to groundwater contamination.

Given the risk considerations presented above, this FFS will evaluate limited action alternatives, which include ICs and long-term monitoring as defined in Section 5, for residual contamination in groundwater.

Section 4
Remedial Action Objectives

Section 300.430(e) of the NCP requires the remedial alternative development process be initiated by developing RAOs specifying contaminants and media of concern, potential exposure pathways, and remedial action goals. The purpose of the remedy selection process is to select remedies that are protective of human health and the environment, maintain protection over time, and minimize untreated waste.

This section presents the ARARs, PRAOs, and the soil cleanup objectives that are tentatively identified for the Site, based on current and reasonably anticipated future land uses. The purpose of establishing PRAOs is to mitigate unacceptable risks to human health and the environment posed by any remaining contaminated solid or liquid media at the Site.

While PRGs are typically identified in an FS report, remedial activities have already been completed for this Site and no additional physical remediation is planned. Therefore, for the purposes of this report, PRGs are referred to as soil cleanup objectives and groundwater standards, as presented in Section 2.

Final ARARs, RAOs, and remedial action goals in the form of cleanup levels will be developed as appropriate from evaluations presented within this FFS and set forth in the ROD selection of the CERCLA remedy.

4.1 Current and Reasonably Anticipated Future Land Uses

The current and reasonably anticipated future land uses for the Site are an important consideration for the development of PRAOs and remedial criteria, such as soil cleanup objectives, to ensure remedial alternatives are protective of human health and the environment. The final condition of the Site after remediation must be considered in evaluating future land uses or activities and the related protection to human health and the environment that is provided.

As described in Section 1.3.1, current land use is predominately grazing of cattle. Cattle, belonging to Weimer Ranches of Nucla, Colorado, were reported grazing within the survey area during the spring and fall months. There are no gardens or fruit trees at the Site. In the area surrounding the site, recreational activities may include, but are not limited to, hunting, fishing, camping, and rafting (Umetco 2013).

Umetco proposes to transfer ownership of land to various public entities, including DOE, Montrose County, and BLM. Figure 1-3, revised May 12, 2015, is the land status map that indicates the proposed land transfer boundaries. Within these transfer boundaries, various county and state roads have easements to facilitate long-term O&M.

Although future ownership has not yet been finalized, the reasonably anticipated future land use that will occur at specific properties is dependent on factors, such as ownership and location, but

uses are generally expected to be of a similar nature throughout the Site. For instance, the following expectations are assumed for this FFS:

- No residential land uses at the Site; therefore, no exposure to contaminated media is expected except for periodic recreational users (if permitted), trespassers, or construction workers. There is an office building on the site where meetings may occur, but it is not anticipated that this would become a residence. This building is anticipated to be transferred to Montrose County. Additionally, construction workers may be required to repair fences and signs (e.g., surveillance and monitoring workers), or install solar panels on the mesa, as an example.
- Only ecological exposures would occur through agricultural and wildlife grazing.

Future land uses or activities that would compromise the ability of the measures implemented under a CERCLA remedial action to be protective would be considered unacceptable.

4.2 Applicable or Relevant and Appropriate Requirements

Identification and evaluation of ARARs are integral components of the FS process to determine whether remedial alternatives can protect human health and the environment. The following information in this subsection was developed from EPA's *Introduction to Applicable or Relevant and Appropriate Requirements* (EPA 1998) which gives an overview of why ARARs must be identified and evaluated as part of the CERCLA process.

CERCLA and the NCP establish a standardized process through which EPA must respond to spills and clean up the nation's most dangerous hazardous waste sites. The CERCLA response process, while it sets acceptable risk-based goals for cleanups, does not impose specific restrictions on the various activities (such as treatment, storage, and disposal of wastes; construction and use of remediation equipment; and release of contaminants into air, soil, and water) that may occur during a response. EPA instead relies on other eligible federal and state environmental laws and regulations to govern response activities through the ARARs selection process.

A site-specific risk assessment is the foundation on which the selection of a CERCLA remedy is based. ARARs fill in the substantive gaps in CERCLA's risk-based response framework, ensuring protection of human health and the environment.

4.2.1 ARAR Identification Process

ARARs are designated as either "applicable" or "relevant and appropriate," according to EPA guidance, and may stem either from federal or state law. Determining exactly which laws and regulations will affect a CERCLA response is somewhat different than determining the effect of laws and regulations on activities that take place outside the boundaries of a site remediated under CERCLA. For onsite activities, CERCLA requires compliance with both applicable requirements (i.e., those that would apply to a given circumstance at any site or facility) and those that EPA deems to be relevant and appropriate (even though they do not apply directly), based on the unique conditions at a site.

ARARs must be identified on a site-specific basis and involve a two-part analysis. A determination must first be made on whether a given requirement is applicable. If it is not applicable, then a

second determination must be made on whether it is both relevant and appropriate. When the analysis determines that a requirement is both relevant and appropriate, such a requirement must be complied with to the same degree as if it were applicable (EPA 1988a). Compliance with ARARs is a threshold criterion that any selected remedy must meet unless a legal waiver, as provided by CERCLA Section 121(d)(4), is invoked (discussed in Section 4.2.3).

4.2.1.1 Applicable Requirements

Section 300.5 of the NCP defines "applicable requirements" as cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state environmental laws that specifically address a hazardous substance, pollutant, contaminant, removal action, location, or other circumstances at a CERCLA site.

4.2.1.2 Relevant and Appropriate Requirements

Relevant and appropriate requirements specifically refer to cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under federal or state environmental or facility siting laws. These requirements are not directly applicable to hazardous substances, pollutants, contaminants, remedial actions, locations, or other circumstances at a CERCLA site but address problems or situations sufficiently similar (relevant) to those encountered at the CERCLA site such that their use is well suited to the particular site.

4.2.1.3 Consideration of State Requirements as ARARs

State requirements are potential ARARs for CERCLA response actions if they meet the following eligibility criteria:

- State law or regulation
- Environmental or facility siting law or regulation
- Promulgated (of general applicability and legally enforceable)
- Substantive (not procedural or administrative)
- More stringent than federal requirements
- Identified in a timely manner
- Consistently applied

Many state requirements listed as ARARs are promulgated with identical or nearly identical requirements to federal law pursuant to delegated environmental programs administered by federal agencies and the state. The preamble to the NCP provides that such a situation results in citation to the state provision and treatment of the provision as a federal requirement.

4.2.1.4 Information to be Considered

In addition to ARARs, the NCP states that where ARARs do not exist, agency advisories, criteria, or guidance are to be considered useful "in helping to determine what is protective at a site or how

to carry out certain actions or requirements" (55 Federal Register 8745). These sources of information are referred to as information to be considered (TBC).

The NCP preamble states, however, that provisions in the TBC category "should not be required as cleanup standards because they are, by definition, generally neither promulgated nor enforceable, so they do not have the same status under CERCLA as do ARARs." Although not enforceable requirements, these documents are important sources of information that EPA and the state may consider during selection of the remedy, especially regarding the evaluation of public health and environmental risks, or which will be referred to, as appropriate, in selecting and developing cleanup actions (40 CFR § 300.400(g)(3), 40 CFR § 300.415(i)).

4.2.1.5 Other Regulatory Requirements Not Considered ARARs

There are other laws and regulations that do not constitute ARARs for the Site because they are not specifically related to environmental cleanup or facility siting, or because they address activities occurring off site where only applicable standards must be met. One example would be the U.S. Department of Transportation regulations for transport of hazardous and nonhazardous materials or wastes; another would be Occupational Safety and Health Administration general construction safety regulations.

4.2.2 Categories of ARARs

Environmental laws and regulations generally fit into three categories:

- Those that pertain to the management of certain chemicals
- Those that restrict activities at a given location
- Those that control specific actions

Thus, there are three primary types of ARARs: chemical-, location-, and action-specific. An ARAR can be one or a combination of all three types of ARARs.

Chemical-specific requirements address chemical or physical characteristics of compounds or substances on sites. These values establish acceptable amounts or concentrations of contaminants that may be found in, or discharged to, the ambient environment.

Location-specific requirements are restrictions placed on the concentrations of hazardous substances or the conduct of cleanup activities because they are in specific locations. Location-specific ARARs relate to the geographical or physical positions of sites rather than the nature of contaminants at sites.

Action-specific requirements are usually technology-based or activity-based requirements or limitations on actions taken with respect to hazardous substances, pollutants, or contaminants. A given cleanup activity will trigger an action-specific requirement. Such requirements do not themselves determine the cleanup alternative but define how chosen cleanup methods should be performed.

4.2.3 Waivers of Specific ARARs

CERCLA Section 121(d)(4) authorizes that any ARAR may be waived per one of the following six conditions if the protection of human health and the environment is ensured:

- It is part of a total remedial action that will attain such level or standard of control when completed (i.e., interim action waiver).
- Compliance with the ARAR at a given site will result in greater risk to human health and the environment than alternative options that do not comply with the ARAR.
- Compliance with such a requirement is technically impracticable from an engineering perspective.
- The remedial action will attain a standard or performance equivalent to that required by the ARARs through use of another method or approach.
- The ARAR in question is a state standard, and the state has not consistently applied (or demonstrated the intention to consistently apply) the ARAR in similar circumstances at other sites.
- In meeting the ARAR, the selected remedial action will not ensure a balance between the need for protection of public health and welfare and the environment at the site and the availability of Superfund monies to respond to other facilities.

4.2.4 CERCLA Permit Exemption

CERCLA Section 121(e)(1), 42 United States Code (U.S.C.) § 9621(e)(1), states, "No Federal, State, or local permit shall be required for the portion of any removal or remedial action conducted entirely onsite, where such remedial action is selected and carried out in compliance with this section." The onsite activities must, however, comply with substantive permit requirements. The term "onsite" is defined in the NCP as "*the areal extent of contamination and all suitable areas in very close proximity to the contamination necessary for implementation of the response action*" (40 CFR § 300.5).

For purposes of the FFS, it is assumed all areas that are within the Site would be considered onsite (for instance, a repository location within the Site). Other areas of the Site in very close proximity where contaminated media have come to be located are also considered onsite for purposes of the permit exemption. While no permits will be obtained for any response actions conducted onsite, EPA will evaluate the substantive requirements that would otherwise be included in any such permit and determine which substantive provisions must be complied with.

Offsite CERCLA actions would require compliance with both substantive and administrative components of applicable laws and regulations.

4.2.5 Identification of Potential ARARs for Limited Action Remedial Alternatives

Appendix A lists potential ARARs along with a brief description of ARARs for the implementation of remedial action at the Site as indicated in Section 3.2.1 and 3.2.2. The ARARs are organized by

whether they are federal or State of Colorado ARARs. The ARARs or group of related ARARs included in Appendix A are identified by a statutory or regulatory citation, followed by a brief explanation of the ARAR and how, and to what extent, the ARAR is expected to apply to potential activities to be conducted. The tables in Appendix A also identify whether the ARAR is chemical-, location-, and/or action-specific. The ARARs identified in this FFS are focused on the proposed alternatives, rather than on the remedial activities previously completed in accordance with the RAP.

The final ARARs will be determined in the ROD for the CERCLA remedy and selected as performance standards for remedial design and subsequent response action.

4.3 Preliminary Remedial Action Objectives

PRAOs are medium-specific and source-specific goals to be achieved through completion of a remedy that is protective of human health and the environment. These objectives typically are expressed in terms of the contaminant, the concentration of the contaminant, and the exposure routes and receptors.

Development of PRAOs is an important step in the FS process. PRAOs are typically the basis for determining whether protection of human health and the environment is achieved for a remedial alternative given current and reasonably anticipated future land uses. Based on the identified human health and ecological risks and ARARs presented in Appendix A, PRAOs are needed for residual contamination remaining in soil and groundwater.

The following PRAOs were identified for residual contamination in soil at the Site:

- Prevent the offsite relocation of soil by humans with concentrations of COCs greater than Category 1 criteria.
- Prevent unacceptable exposures to humans from soil with concentrations of COCs greater than Category 2 criteria under a residential use scenario.
- Prevent unacceptable exposures to humans from soil with concentrations of COCs greater than Category 3 criteria under recreational, worker, and ranching exposure scenarios.

The following PRAO was identified for residual contamination in groundwater at the Site:

- Prevent human exposure through ingestion of groundwater with concentrations of COCs that result in cancer risks exceeding 1E-06 or non-cancer risks greater than a hazard quotient of 1.

Section 5

Identification of Remedial Components for Limited Action Alternatives Development

This section identifies the remedial components that could address PRAOs and potential ARARs when combined as limited action remedial alternatives in Section 6. Based on the conclusions presented in Section 3.2, remedial components of the alternatives analyzed in this FFS are limited to ICs, monitoring, and maintenance.

It should be noted that these actions may be conducted under UMTRCA or Superfund, as appropriate, given the location within the Site and the activities being conducted.

5.1 Land Use Controls

LUCs may consist of non-engineered instruments, such as administrative and legal controls, or engineered and physical barriers, such as fences. LUCs help to minimize the potential for exposure to contamination and/or protect the integrity of a response action and are typically designed to work by limiting land and/or resource use or by providing information that helps modify or guide human behavior at a site.

For purposes of this report, the term LUC is specific to Federal Facilities, such as those being transferred to DOE, and, as such LUCs will not apply to the land anticipated to be transferred to others, such as Montrose County and BLM. To simplify this concept herein, the terms ICs and engineered controls will be used throughout.

5.1.1 Institutional Controls

In accordance with EPA guidance titled *A Guide to Planning, Implementing, Maintaining, and Enforcing Institutional Controls at Contaminated Sites* (EPA 2012), ICs are:

- Non-engineered instruments, such as administrative and/or legal controls, that minimize the potential for human exposure to contamination by limiting land or resource use
- Generally to be used in conjunction with, rather than in lieu of, engineering measures such as waste treatment or containment
- Generally "layered" (i.e., multiple ICs are used) or implemented in a series to provide overlapping assurances of protection from contamination

ICs typically are designed to work by limiting land and/or resource use or by providing information that helps modify or guide human behavior at a site. As response components, ICs typically are designed to achieve the substantive use restrictions identified in a response selection document to achieve the cleanup objectives; however, at the Site, these were not established in the CD/RAP (Umetco 2005). General objectives of ICs include:

- Restricting the excavation and handling of soils with contaminants that do not allow for UU/UE
- Restricting the installation of groundwater wells and groundwater use that could result in unacceptable exposures to contaminants
- Restricting inappropriate land use that could compromise the remedy and that could result in unacceptable exposures to contaminants
- Restricting access to the repositories that contain solid wastes and radioactive materials
- Prohibiting any action that may damage or interfere with the proper operation or maintenance of any engineered component of the remedy
- Ensuring long-term inspection and maintenance of the remedy components (See Section 5.2 for monitoring and maintenance)

5.1.1.1 Categories of Institutional Controls

The legal/administrative instruments for ICs are divided into four categories: proprietary controls, governmental controls, enforcement and permit tools with IC components, and information devices. These categories generally define how the ICs are meant to be effective, and within each category, there are a number of instruments that may be employed. Information regarding the types of ICs that may be used in each category is presented below.

Government Controls

Governmental controls impose restrictions on land or resource use using the authority of a government entity. Typical examples of governmental controls include zoning; building codes; state, tribal, or local groundwater use regulations; and commercial fishing bans and sports/recreational fishing limits posed by federal, state, and/or local resources and/or public health agencies. In many cases, federal landholding agencies, such as the U.S. Department of Defense, possess the authority to enforce ICs on their property. At active federal facilities, land or resource use restrictions may be addressed in base master plans, facility construction review processes, facility digging permit systems, and/or the facility well permitting systems.

Proprietary Controls

Proprietary controls refer to controls on land use that are considered private in nature because they tend to affect a single parcel of property and are established by private agreement between the property owner and a second party who, in turn, can enforce the controls. Common examples include easements that restrict use (also known as negative easements) and restrictive covenants. These types of controls can prohibit activities that may compromise the effectiveness of the response action or restrict activities or future resource use that may result in unacceptable risk to human health or the environment. State and tribal law typically authorize proprietary controls. In some states, the authority comes solely from common law. Other states, such as Colorado, have enacted statutes that directly authorize these types of controls for the purpose of preventing use in conflict with environmental contamination or remedies. These statutes tend to divide into ones modeled after the Uniform Environmental Covenants Act (UECA), and other non-UECA statutes. These UECA and non-UECA state statutes can provide advantages over traditional common law proprietary controls.

Enforcement and Permit Tools

Enforcement and permit tools with IC components are legal tools, such as administrative orders, permits, Federal Facility Agreements, and CDs, which limit certain site activities or require the performance of specific activities (e.g., monitoring and reporting on IC effectiveness). These legal tools may be issued unilaterally or negotiated.

Information Devices

Information devices provide information or notification often as recorded notice in property records or as advisories to local communities, tourists, recreational users, or other interested persons that residual contamination remains on site. As such, information devices generally do not provide enforceable restrictions. Typical information devices include state registries of contaminated sites, warning signs, notices in property titles, tracking systems, and advisories.

5.1.2 Engineered Controls

Engineered controls establish a means for restricting access to site areas. Engineered controls considered for remedial alternatives in this FFS would limit access to contaminated areas using restrictive physical barriers (e.g., fences, gates).

5.1.3 Site-Specific Determination of Institutional Controls

The evaluation of whether an IC is needed at a site is a site-specific determination. Whether a site area would meet the definition of UU/UE is one of the factors in deciding when an IC is appropriate. A UU/UE scenario generally represents the degree of cleanup at which all exposure pathways for COCs present an acceptable level of risk for all current and potential future land uses. If the remedy leaves residual contamination in place that prevents a UU/UE scenario, ICs should be considered to ensure that unacceptable risk from residual contamination does not occur.

Cleanup actions, such as capping waste in place, construction of containment facilities, monitored natural attenuation, and long-term pumping and treating of groundwater, may leave residual contamination on site, where restrictions or notices provided by ICs that supplement the engineered controls can help ensure adequate protection of human health and the environment.

At some areas of the Site, residual contamination exceeding the site-specific soil cleanup objectives (Umetco 1999) exists, which precludes a UU/UE scenario. In addition, construction of onsite repositories and establishment of alternative soil standard applications areas and State ACLs for groundwater inherently suggest consideration of ICs.

Reasonably anticipated future land uses of the Site should be considered. At sites where any media will not be cleaned up to a level that supports a UU/UE scenario, IC instruments (in addition to active response measures where needed) may be appropriate, considering financial concerns, legal implementation issues, jurisdictional questions, the impact of layering multiple ICs, and reliability and enforcement concerns. It also is important to recognize that, in addition to restricting certain land uses, certain types of ICs also can be used to restrict or modify specific activities at sites (e.g., fish consumption prohibitions). Similarly, engineered controls such as fencing can also be used to restrict or modify specific activities at sites when used in conjunction with ICs.

Additionally, a collaborative agreement between DOE and EPA would be a useful tool to clarify roles and responsibilities during five-year reviews and other site related activities.

5.1.3.1 Institutional Controls Considerations Based on Review of Risk

Exhibit 5-1 summarizes and outlines the rationale for ICs based on risk associated with residual contamination, as presented in the EPA memorandum titled *Review of Umetco Risk Assessment, Alternative Soils Standards, and Residual Contamination* (see Appendix D). The Town Area and Hieroglyphic Canyon Streambed, which are transferring to entities other than DOE LM, should have ICs put in place to prevent residential exposures due to Uranium soils concentrations and the potential for annual effective dose equivalent exceedances. Some form of IC should also be put in place to mitigate recreational exposures in the Windblown Area E, and the potential for annual effective dose equivalent exceedances. All other areas transferring to entities other than DOE LM do not require ICs for risk reduction (EPA 2017). One location, the Nature Conservancy Visitor's Site, was excluded from the risk assessment analysis. This area will need to be evaluated separate and has not been included in this FFS.

Additional sampling activities scheduled to be performed by Umetco, in addition, approval from NRC for additional alternative soil standard areas may alter the conclusions drawn from the risk assessment.

Exhibit 5-1. Summary of Remediation Area to Consider Institutional Controls (adopted from EPA 2017)

Remediation Area	Institutional Controls Required	Rationale
Atkinson Creek Crystal Disposal Area	Yes	DOE LM – Average Category 1 Exceedance (Molybdenum)
Club Ranch Ponds	Yes	DOE LM – Average Category 1 Exceedance (Thorium), Discrete Category 2 Exceedance (Thorium)
River Ponds	Yes	DOE LM – Alternative Soil Standards Area
Club Mesa Spray Area	Yes	DOE LM
A-Plant	Yes	DOE LM – Average Category 1 Exceedance (Uranium, Thorium), Discrete Category 2 Exceedance (Uranium, Thorium)
A-Plant North	Yes	DOE LM – Alternative Soil Standards
B-Plant	Yes	DOE LM – Exposure and Radium-226 Survey Exceedances, Average Category 1 Exceedance (Uranium, Thorium, Molybdenum, Vanadium), Discrete Category 2 Exceedance (Uranium, Thorium, Vanadium), and Average Category 2 Exceedance (Arsenic)
Historic Structures Area	No	Deleted from Superfund Site. UU/UE –HI< 1 and Excess Cancer Risk < 1E-06
Windblown	Yes	Partial DOE LM – Average Category 1 Exceedance (Uranium, Thorium, Vanadium)
Mill Hillside	Yes	DOE LM – Category 2 Exceedances, Alternative Soil Standards Area
County Road Y-11	Yes	DOE LM – Alternative Soil Standards Area
County Road EE-22	Yes	DOE LM – Average Category 1 Exceedance (Uranium, Thorium, Molybdenum, Vanadium), Average Category 2 Exceedance (Radium, Thorium)
Water Storage Ponds	No	UU/UE – Residential HI < 1 and Excess Cancer Risk < 1E-06
Town Area	Yes	Category 2 Exceedances (Uranium)
Atkinson Creek Streambed	No	UU/UE – Residential HI < 1 and Excess Cancer Risk < 1E-06
Hieroglyphic Canyon Streambed	Yes	No confirmatory sampling following hot-spot removal, Category 2 Exceedances (Uranium, Thorium, Vanadium)
Northeast CDOT Highway 141	No	Land use restrictions due to right-of-way
CDOT Highway 141 Mileposts 75-76	No	Deleted from Superfund Site
Town Dump	No	DOE LM – UU/UE – Residential HI < 1 and Excess Cancer Risk < 1E-06

DOE = U.S Department of Energy
LM = Legacy Management
UU/UE = Unlimited Use/Unrestricted Exposure
HI = Hazard Index

Governmental Controls

Portions of the Site may be transferred to other entities (currently anticipated to be DOE, Montrose County, and BLM) where workers or the public have potential access to areas containing residual contamination and therefore ICs should be considered. Title II uranium mill tailings sites must be transferred to DOE for LTS in accordance with the *Atomic Energy Act of 1954 (P.L. 83-703) – Section 83 (Ownership and Custody of Certain Byproduct Material and Disposal Sites)* and the *Uranium Mill Tailings Radiation Control Act (UMTRCA) (P.L. 95-604), Title II – Uranium Mill Tailings Licensing and Regulation, Section 202, Custody of Disposal Site.*

Proprietary Controls

Colorado law on ICs provides that proprietary controls, such as environmental covenants (EC) (covenants) or notices of environmental use restriction (restrictive notices[RN]), are required for "environmental remediation projects" where a remedial decision made after July 1, 2001 results in "residual contamination at levels that have been determined to be safe for one or more specific uses, but not all uses" or that incorporates an "engineered feature or structure that requires monitoring, maintenance, or operation, or that will not function as intended if it is disturbed" (CDPHE 2015c).

Long-term custody of property inside the future DOE transfer boundary at the Site would be transferred to DOE in accordance with UMTRCA Title II after NRC has approved the Completion Review Report (CRR). The State, under UMTCRA, would be required to terminate Umetco's Radioactive Materials License. Umetco would transfer property title within the land transfer boundary to DOE, along with a long-term care fee for LTS.

Proprietary controls either the Colorado law or another mechanism would be needed to ensure exposure to residual contaminated solids and liquids that remain in place is prevented both inside and outside of the future DOE transfer, as appropriate, conducted under UMTRCA or Superfund.

Information Devices

If ECs or RNs are adopted, these proprietary controls would be recorded and maintained in the State of Colorado Registry of Contaminated Sites. In addition, the DOE Long-Term Surveillance Plan (LTSP) likely will include warning signs for DOE- or county-maintained areas, especially for repository areas. These can be considered for other sites under an EC or RN as appropriate.

Engineered Controls

Engineered controls (i.e., fencing and gates) are in place at the Site at current repositories but may be required at additional locations to supplement existing engineered controls as part of actions taken by DOE within the transfer boundary.

5.2 Monitoring and Maintenance

Long-term monitoring and maintenance will be considered at the Site to supplement long-term effectiveness and permanence of the physical remedy installed under the RAP. Generally, monitoring and maintenance requirements would be documented in the LTSP, and may include the following:

Visual inspections

Visual inspections are conducted to provide information about a site's status and visually confirm and document the conditions of the remedy, the Site, and the surrounding area. Regular inspections of the Site have been ongoing since the implementation of the RAP.

Periodic Environmental Monitoring

Periodic environmental monitoring of repository conditions and contaminant levels in groundwater and/or soil. Routine groundwater monitoring has been conducted at the Site following the implementation of the RAP. Periodic monitoring may also include surface water sampling of the San Miguel River.

Site Maintenance

Site maintenance activities include but are not limited to repairing any engineered controls, maintaining signage, removing vegetation present on soil covers, and replacing markers.

5.2.1 Site-Specific Determination of Monitoring and Maintenance

Although long-term monitoring and maintenance could be completed throughout the Site, differing approaches would be taken for properties within and outside of the DOE transfer boundary. Monitoring and maintenance of contaminated solids and liquids is anticipated to be conducted at the Site where a UU/UE scenario is not achieved.

Within the DOE Transfer Boundary

Land transfer to DOE is a statutory requirement for uranium mill tailings sites. A general license will be issued for the custody of and long-term care, including monitoring, maintenance, and emergency measures necessary to protect the public health and safety and other actions necessary to comply with the standards for uranium mill tailings sites closed under Title II of the UMTRCA of 1978, as amended (10 CFR 40.28). The purpose of a general license is to ensure that uranium mill tailings disposal sites will be cared for in such a manner as to protect the public health, safety, and the environment after closure. The general license becomes effective when NRC terminates, or concurs in an agreement state's termination of, the current specific license and a site LTSP meeting the requirements of 10 CFR 40.28 has been accepted by the NRC. There is no termination of this general license.

The final disposition of tailings, residual radioactive material, or wastes at milling sites should be such that ongoing active maintenance is not necessary to preserve isolation. At a minimum, annual site inspections must be conducted by the government agency responsible for long-term care of the disposal site to confirm its integrity and to determine the need, if any, for maintenance and/or monitoring (10 CFR 40.28). The following activities are anticipated for inspection, maintenance, and environmental monitoring under the LTSP:

- **Annual Site Inspection:** An annual site inspection should include but is not limited to confirming the integrity of restrictive physical barrier features, signage, run-on/runoff controls, and repository covers, as well as determining the need for maintenance, additional inspections, or monitoring. Additionally, a survey to determine the amount of settling within the repository may be completed during the annual site inspection, as determined by NRC and DOE.

- **Annual Site Inspection Report:** An annual site inspection report should include results of the annual site inspection and be provided to the public and appropriate agencies.
- **Follow-up Inspection or Reports:** Requirements for follow-up inspections or reports are determined in response to any significantly new or changed conditions at the site.
- **Site Maintenance:** The site maintenance will include but is not limited to repairing any restrictive physical barriers, maintaining signage, removing vegetation present on repository covers, noxious weed control, and replacing markers.
- **Emergency Measures:** The emergency measures include the response actions in the unlikely event of a potential disaster, such as a breach in cover materials.
- **Environmental Monitoring:** Requirements for environmental monitoring may include but are not limited to groundwater monitoring, surface water monitoring of the San Miguel River, and cell performance monitoring within the repositories.

Within or Outside the DOE Transfer Boundary

It is anticipated that an Material Management Plan (MMP) will be developed and will require radiological monitoring during future excavation projects. Pursuant to an MMP, radiological monitoring of the excavated soils would be required.

Section 6
Development of Alternatives

In this section, remedial action alternatives (herein referred to as remedial alternatives) were assembled by combining the remedial components for limited action discussed in Section 5.

6.1 Assumptions Affecting Development of Remedial Alternatives

Primary assumptions affect the development of remedial alternatives evaluated in this FFS (other than a "no further action alternative"). These assumptions are driven by requirements of the PRAOs and ARARs identified in Section 4 and Site conditions to be considered in the selection of the remedial components for limited action described in Section 5. These assumptions were taken into consideration when developing the remedial alternatives for this FFS and include the items listed in Exhibit 6-1.

Exhibit 6-1 Primary Assumptions Affecting Development of Remedial Alternatives

Description	Primary Assumptions
Role of Consent Decree and RAP in Completing Physical Remedy	As described in Section 1, the remedial action completed pursuant to the RAP in the Consent Decree addressed the majority of the required cleanup at the Site for contaminated solids and liquids at the Site. The remedial action as implemented has resulted in significant risk reduction to humans from exposure to contaminated solid and liquid media, but has not fully addressed all potential future uses of the Site that could result in unacceptable exposures to residual contamination in soils and groundwater. It is anticipated that the CD/RAP will be terminated after the NRC approves the CRR, so it will not govern future activities to ensure overall protection of human health and the environment. Based on the exposure pathways to contamination presented in Section 2.4 and the conclusions made in Section 3.2, this FFS evaluates limited action alternatives that is focused on ICs, engineered controls, and long-term inspection, maintenance, and environmental monitoring to achieve the remedial action objectives and overall protection of human health and the environment.
Current and Reasonably Likely Future Land Use	Some land within the Site is used for cattle grazing and recreational activities (e.g., boat travel) while other portions of the land within the Site have restricted access (e.g. repositories). The existing office building is currently being used for non-residential purposes These land uses are unlikely to change in the future. Residential use would be prohibited unless additional physical cleanup was performed to meet residential cleanup levels.
Current and Reasonably Likely Future Groundwater Use	The application of site-specific groundwater ACLs was approved by CDPHE. While the site-specific groundwater ACLs have not been exceeded since they were approved in 2003, enforceable measures should be implemented that will preclude human exposure to the contaminated groundwater. Since current zoning could allow for residential development, prohibitions are needed to ensure that water from the Salt Wash Member and the Kayenta-Wingate aquifer is not withdrawn for residential and/or agricultural uses without treatment specific to the COCs.

Exhibit 6-1 Primary Assumptions Affecting Development of Remedial Alternatives (continued)

Description	Primary Assumptions
Five-Year Reviews as an Essential Component of Remedial Alternatives	Five-year reviews are an essential component of remedial alternatives with contamination left on site above levels that allow for UU/UE as required by 40 CFR 300.430(f)(4)(ii). Since the contemplated remedial approaches discussed in Section 5 cannot achieve UU/UE conditions, all alternatives are assumed to include five-year reviews in perpetuity.
Effect of Umetco's Corporate Divestiture Policy on Properties ("Omnibus Agreements")	Umetco's Corporate Divestiture Policy would impose deed restrictions on Umetco properties being transferred. This may include properties both within and outside of the DOE Transfer Boundary and properties categorized as UU/UE. UU/UE properties with concentrations below Category 1 do not require ICs under CERCLA, and a deed restriction on UU/UE properties does not add to the protectiveness of the remedy. Even though this policy would provide a layer of protection, it is assumed that the monitoring and maintenance would not occur on a regular basis and that this deed restriction would simply require notification, if disturbance activities are planned.
50-year Period of Analysis	It is likely that all remedial alternatives would require an indefinite duration of O&M. However, evaluation of long durations of O&M is cumbersome and generally not necessary for comparative evaluation between alternatives because of the effects of cost discounting in later years under present value analysis. The period of analysis for the FFS is assumed to be 50 years because the increase of present value cost due to periodic expenditures for maintenance and monitoring after 50 years is minimal relative to the accuracy range of the estimates. Additional information about period of analysis is discussed in Section 7.1.7

Secondary factors and considerations also have been identified to aid development of remedial alternatives for cost evaluation purposes. Examples of secondary factors and considerations include but are not limited to specific monitoring and inspection requirements. These assumptions are provided in Appendix C.

6.2 Development and Description of Remedial Alternatives

Remedial alternatives were assembled by combining remedial components capable of addressing the residual contaminated media (i.e. solids and liquids) described in Section 3. Remedial components discussed in Section 5 were used to develop each limited action remedial alternative.

The limited action remedial alternatives assembled for evaluation include:

- Alternative 1: No Further Action
- Alternative 2: Institutional Controls, Monitoring and Maintenance

As required by the NCP, five-year site reviews would be performed to evaluate whether adequate protection of human health and the environment is provided because contaminated solids would remain within the repositories and under covers in other parts of the Site that do not allow for UU/UE land use scenarios, and contaminated liquids would exist in groundwater posing unacceptable risks for use as drinking water. As stated in Section 5.1.3, a collaborative agreement between DOE and EPA would be a useful tool to clarify roles and responsibilities during five-year reviews and other site related activities.

The following subsections provide generalized descriptions of the remedy components for remedial alternatives to be evaluated in Section 7.

6.2.1 Alternative 1: No Further Action

Alternative 1 is required by the NCP to provide an environmental baseline against which impacts of the remedial alternatives can be compared. Although ICs, monitoring, and maintenance will be performed by the Responsible Party, Federal and/or State agencies under other regulatory programs, no further action under CERCLA would be initiated at the Site to address remaining contaminated media or otherwise mitigate the associated unacceptable risks to human health or the environment.

Property Inside the Future DOE Transfer Boundary

Alternative 1 assumes that long-term custody of property inside the future DOE transfer boundary at the Site would be transferred to DOE in accordance with UMTRCA Title II after NRC has accepted the CRR. The State, under UMTCRA, would be required to terminate Umetco's Radioactive Materials License. Umetco would transfer property title within the land transfer boundary to DOE, along with a long-term care fee. The general license would take effect upon NRC acceptance of DOE's LTSP. The general license would require DOE to provide custody and long-term care as specified in the LTSP, including inspections, maintenance, environmental monitoring, and emergency measures necessary to ensure that the area in the future transfer boundary will be cared for in a manner that protects public health, safety, and the environment after closure. Engineered controls, such as new fencing, may be used by DOE to control access at the Site within the DOE transfer boundary, if supplemental access control is needed.

Inspection and maintenance would be performed as specified in the LTSP to confirm the integrity of visible features at the Site within the DOE transfer boundary and to confirm that other remedy components (e.g., repository cover, ICs, access controls) have not been compromised. Routine maintenance of the cover systems would include controlling growth of trees and shrubs on the repository covers and access roads. Additional maintenance would be required if erosion, sloughing, slumping, or surface deformation is observed on the repository surface or if settlement or seeps are observed along the perimeter. Fencing and signage within the future DOE transfer boundary would be repaired or replaced as necessary to maintain those access controls.

Environmental monitoring may also be specified in the LTSP to ensure compliance with groundwater and surface water standards, as well as to verify the continued health of the on-site vegetation and to assure that undesirable plant species do not proliferate at the Site.

Property Outside the Future DOE Transfer Boundary

Alternative 1 assumes that the Umetco Divestiture Policy would be applied to all property outside the future DOE transfer boundary. This corporate policy includes restrictions to prevent groundwater use and residential property, which Umetco has operated on, whether there is contamination present or not (i.e., UU/UE) and is typically documented through an Omnibus Agreement. These current corporate policy restrictions would be imposed upon former Umetco properties in perpetuity and would be enforceable through common law by Umetco and UCC, jointly and severally. No mechanisms would be in place to require any monitoring or maintenance in these areas.

6.2.2 Alternative 2: Institutional Controls, Monitoring and Maintenance

Compared to Alternative 1, Alternative 2 provides protection of human health and the environment through the implementation of additional ICs, monitoring, and maintenance at the Site under CERCLA. Similar to Alternative 1, Alternative 2 includes custody, and long-term care of uranium and thorium mill tailings sites closed (reclaimed) under Title II of UMTRCA of DOE-administered land and application of Umetco's Corporate Divesture Policy, as described in Alternative 1. Inspection, maintenance, and environmental monitoring within the future DOE transfer boundary would also be completed by DOE as specified in the LTSP, as described for Alternative 1. Regardless of authority, it is recognized that inspection, maintenance, and environmental monitoring is necessary for the long-term protectiveness and permanence of the remedy.

Alternative 2 includes implementation, monitoring and maintenance of additional ICs in the form of proprietary controls (e.g., ECs, RNs, etc.) throughout the Site where residual contamination is present, either within and/or outside the future DOE transfer boundary. The additional ICs under CERCLA would be used to inform the community of risks, and restrict access and use of contaminated media within the DOE transfer boundary and parcels not resulting in UU/UE land use scenarios outside of the future DOE transfer boundary but still within the Site. The proprietary controls would generally prohibit residential use, soil disturbance, and/or groundwater use.

It is anticipated that proprietary controls, such as EC or RNs, would be implemented at the Site. EC or RNs may include enforceable restrictions on land use and excavation, and may include notification and self-certification requirements. An EC or RN can also be supplemented by a MMP, which would provide detailed procedures for radiological monitoring that must be performed when excavation takes place in areas that contain residual radioactive material in excess of 5 pCi/g radium (plus background). Areas where proprietary controls are anticipated include the three rights of way, as well as any land currently anticipated to be managed by BLM, Montrose County or CDOT.

Section 7

Detailed Analysis of Remedial Alternatives

This section presents the detailed analysis of the following remedial alternatives:

- Alternative 1: No Further Action
- Alternative 2: Institutional Controls, Monitoring, and Maintenance

7.1 Definition of Criteria Used in the Detailed Analysis of Remedial Alternatives

7.1.1 Overall Protection of Human Health and the Environment

Each alternative is assessed to determine whether it can provide adequate protection of human health and the environment (short- and long-term) from unacceptable risks posed by hazardous substances, pollutants, or contaminants present at the Site. Evaluation of this criterion focuses on how site risks are eliminated, reduced, or controlled through treatment, engineered controls, or ICs, and whether an alternative poses any unacceptable cross-media impacts.

7.1.2 Compliance with ARARs

For this criterion, an evaluation for each alternative is performed to determine how ARARs, identified in Appendix A of this document, will be met.

If the assessment indicates an ARAR will not be met, then the basis for justifying one of the six ARAR waivers allowed under CERCLA is discussed. These ARAR waivers are detailed in Exhibit 7-1.

Criteria Used to Evaluate Remedial Alternatives

- Protection of Human Health and Environment
- Compliance with ARARs
- Long-Term Effectiveness and Permanence
- Reduction of Toxicity, Mobility, or Volume through Treatment
- Short-Term Effectiveness
- Implementability
- Cost
- State Acceptance
- Community Acceptance

Exhibit 7-1 ARAR Waivers

Waiver	Description
Interim measures	The remedial action selected is only part of a total remedial action that will attain such level or standard of control when completed. (CERCLA §121(d)(4)(A))
Greater risk to health and the environment	Compliance with such requirement at the facility will result in greater risk to human health and the environment than alternative options. (CERCLA §121(d)(4)(B))
Technical impracticability	Compliance with such requirement is technically impracticable from an engineering perspective. (CERCLA §121(d)(4)(C))
Equivalent standard of performance	The remedial action selected will attain a standard of performance that is equivalent to that required under the otherwise applicable standard, requirement, criteria, or limitation through use of another method or approach. (CERCLA §121(d)(4)(D))
Inconsistent application of state requirements	With respect to a state standard, requirement, criteria, or limitation, the state has not consistently applied (or demonstrated the intention to consistently apply) the standard, requirement, criteria, or limitation in similar circumstances at other remedial actions. (CERCLA §121(d)(4)(E))
Fund balancing	In the case of a remedial action to be undertaken solely under Section 104 using the fund, selection of a remedial action that attains such level or standard of control will not provide a balance between the need for protection of public health and welfare and the environment at the facility under consideration and the availability of amounts from the fund to respond to other sites that present or may present a threat to public health or welfare or the environment, taking into consideration the relative immediacy of such threats. (CERCLA §121(d)(4)(F))

7.1.3 Long-Term Effectiveness and Permanence

Long-term effectiveness and permanence evaluates the likelihood that the remedy will be successful and the permanence that it affords. Factors to be considered, as appropriate, include the following:

- Magnitude of residual risk remaining from untreated waste or treatment residuals remaining at the conclusion of the remedial activities. The characteristics of the residuals are considered to the degree that they remain hazardous, taking into account their toxicity, mobility, or volume and propensity to bioaccumulate.
- Adequacy and reliability of controls that are used to manage treatment residuals and untreated waste remaining at the Site. This factor includes an assessment of containment systems and ICs to determine if they are sufficient to ensure that any exposure to human and ecological receptors is within protective levels. This factor also addresses the long-term reliability of management controls for providing continued protection from residuals, the assessment of the potential need to replace technical components of the alternative, and the potential exposure pathways and risks posed should the remedial action need replacement.

7.1.4 Reduction of Toxicity, Mobility, or Volume through Treatment

Each alternative is assessed for the degree to which it employs technology to permanently and significantly reduce toxicity, mobility, or volume, including how treatment is used to address the

principal threats posed by contaminated media in the Site. Factors to be considered, as appropriate, include the following:

- The treatment processes the alternatives use and materials they will treat
- The amount of hazardous substances, pollutants, or contaminants that will be destroyed or treated, including how the principal threat(s) will be addressed
- The degree of expected reduction in toxicity, mobility, or volume of the waste due to treatment
- The degree to which the treatment is irreversible
- The type and quantity of residuals that will remain following treatment, considering the persistence, toxicity, mobility, and propensity to bioaccumulate such hazardous substances and their constituents
- Whether the alternative would satisfy the statutory preference for treatment as a principal element of the remedial action

7.1.5 Short-Term Effectiveness

This criterion reviews the effects of each alternative during the construction and implementation phase of the remedial action until remedial response objectives are met. The short-term impacts of each alternative are assessed, considering the following factors, as appropriate:

- Short-term risks that might be posed to the community during implementation of an alternative
- Potential impacts on workers during remedial action and the effectiveness and reliability of protective measures
- Potential adverse environmental impacts resulting from construction and implementation of an alternative and the reliability of the available mitigation measures during implementation in preventing or reducing the potential impacts
- Time until protection is achieved

7.1.6 Implementability

The technical and administrative feasibility of implementing an alternative and the availability of various services and materials required during its implementation are evaluated under this criterion. The ease or difficulty of implementing each alternative will be assessed by considering the following factors detailed in Exhibit 7-2.

Exhibit 7-2 Implementability Factors to be Considered during Alternative Evaluation

Waiver	Description
Technical feasibility	▪ Technical difficulties and unknowns associated with the construction and operation of a technology ▪ Reliability of the technology, focusing on technical problems that will lead to schedule delays ▪ Ease of undertaking additional remedial actions, including what, if any, future remedial actions would be needed and the difficulty to implement additional remedial actions ▪ Ability to monitor the effectiveness of the remedy, including an evaluation of risks of exposure should monitoring be insufficient to detect a system failure
Administrative feasibility	▪ Activities needed to coordinate with other offices and agencies and the ability and time required to obtain any necessary approvals and permits from other agencies (for offsite actions)
Availability of services and materials	▪ Availability of adequate offsite treatment, storage capacity, and disposal capacity and services ▪ Availability of necessary equipment and specialists and provisions to ensure any necessary additional resources ▪ Availability of services and materials plus the potential for obtaining competitive bids, which is particularly important for innovative technologies ▪ Availability of prospective technologies

7.1.7 Cost

Types of costs that are assessed for each alternative include the following:

- Capital costs
- Annual O&M costs (synonymously referred to in this FFS as post-construction costs)
- Periodic costs
- Present value of capital and annual O&M costs

Cost estimates are developed according to *A Guide to Developing and Documenting Cost Estimates during the Feasibility Study* (EPA 2000). Flexibility is incorporated into each alternative for the location of remedial facilities, the selection of cleanup levels, and the period in which remedial action will be completed. Assumptions of the project scope and duration are defined for each alternative to provide cost estimates for the various remedial alternatives. Important assumptions specific to each alternative are summarized in the description of the alternative. Additional assumptions are included in the detailed cost estimates in Appendix C.

The levels of detail employed in making these estimates are conceptual but are considered appropriate for making choices between alternatives; however, they are not meant to be design-level estimates used for budgeting purposes or Superfund settlements. The information provided

in the cost estimate is based on the best available information regarding the anticipated scope of the remedial alternatives. The costs are evaluated with respect to the following categories:

- Capital costs are expenditures that are required to construct a remedial action. They are exclusive of costs required to operate or maintain the action throughout its lifetime. Capital costs consist primarily of expenditures initially incurred to build or install the remedial action. Capital costs include all labor, equipment, and material costs (including contractor markups such as overhead and profit) associated with activities such as construction of the restrictive physical barriers and installation of signage. Capital costs may also include expenditures for professional/technical services that are necessary to support construction of the remedial action. Capital costs for ICs, such as the ECs or RNs, MMP, and Umetco Divestiture Policy, did not include remedial design or construction management markups because no design or construction elements are involved in these capital costs.

- Annual O&M costs are post-construction costs necessary to ensure or verify the continued effectiveness of a remedial action. These costs are estimated on an annual basis and include all labor, equipment, and material costs (including contractor markups such as overhead and profit). There are no annual O&M costs associated with the alternatives.

- Periodic costs are costs that occur only once every few years (e.g., five-year reviews, updating MMP and right-of-way work notifications) These costs may be either capital or O&M costs, but because of their periodic nature, it is more practical to consider them separately from other capital or O&M costs in the estimating process.

- The present value cost of each alternative provides the basis for the cost comparison. The present value cost represents the amount of money that, if invested in the initial year of the remedial action at a given rate, would provide the funds required to make future payments to cover all costs associated with the remedial action over its planned life. Future O&M and periodic costs are included and discounted (reduced) by the appropriate present value discount rate over the period of analysis selected for each alternative. Per guidance, inflation and depreciation are not considered in preparing the present value costs.

- As discussed in *A Guide to Developing and Documenting Cost Estimates during the Feasibility Study* (EPA 2000), the real discount (interest) rate used for present value analysis in the FFS depends on whether the Site is classified as a federal facility site. Federal facility sites are former or current installations operated or controlled by a federal government agency and identified by EPA's Federal Facilities Restoration and Reuse Office (FFRRO). The Site is not a federal facility identified within FFRRO's site inventory. In addition, the guidance specifically mentions that although a federal-led site cleaned up by EPA using the Superfund trust fund (i.e., fund-led sites) may be an analogous situation to a federal facility site being cleaned up using Superfund authority, there is always a chance that a RP could remediate the Site. Thus, per guidance a real discount rate of 7 percent should be used in calculating present value costs for all non-federal facility sites. A 7 percent real discount rate was used to develop present value costs for each retained alternative as presented in Appendix C.

- The alternatives retained for detailed analysis have a project duration longer than the period of evaluation, and thus have indefinite project durations and likely require perpetual maintenance. The assumed period of analysis used to develop estimates of present value costs for each alternative is 50 years. The guidance indicates site-specific justification should be provided when the project duration exceeds the selected period of present value analysis. Those justifications were provided in Exhibit 6-1 of Section 6.

- A "no-discounting" scenario is also included for the present value analysis of each alternative in Appendix C as recommended by the guidance for long-term projects (e.g., project duration exceeding 50 years). A non-discounted constant dollar cash flow over time demonstrates the impact of a discount rate on the total present value cost and the relative amounts of future annual expenditures. Non-discounted constant dollar costs are presented for comparison purposes only and should not be used in place of present value costs in the Superfund remedy selection process.

7.1.8 State (Support Agency) Acceptance

State (support agency) acceptance is a modifying criterion under the NCP. Assessment of the state acceptance will not be completed until comments on the PP are submitted to EPA. Thus, state acceptance is not considered in the detailed analysis of alternatives presented in the FFS.

7.1.9 Community Acceptance

Community acceptance is also a modifying criterion under the NCP. Assessment of community acceptance will include responses to questions any interested person in the community may have regarding any component of the remedial alternatives presented in the PP. This assessment will be completed after EPA receives public comments on the PP during the public commenting period. Thus, community acceptance is not considered in the detailed analysis of alternatives presented in the FFS.

7.1.10 Criteria Priorities

The nine NCP alternative evaluation criteria are separated into three groups to establish priority among these criteria during detailed evaluation of the remedial alternatives as detailed in Exhibit 7-3.

Exhibit 7-3 Criteria Priorities

Group	Criteria	Definition
Threshold criteria	▪ Overall protection of human health and the environment ▪ Compliance with ARARs	Must be satisfied by the remedial alternative being considered as the preferred remedy
Balancing criteria	▪ Long-term effectiveness and permanence ▪ Reduction of toxicity, mobility, or volume through treatment ▪ Short-term effectiveness ▪ Implementability ▪ Cost	Technical criteria evaluated among those alternatives satisfying the threshold criteria
Modifying criteria	▪ State acceptance ▪ Community acceptance	Not evaluated in this FFS; evaluated after comments received on the FS and PP

7.2 Detailed Analysis of Remedial Alternatives

This FFS evaluated the two remedial alternatives against the two threshold criteria and five balancing criteria as described in Section 7.1.

7.2.1 Summary of Detailed Analysis for Alternative 1: No Further Action

A summary of the remedial components of Alternative 1 is provided in Section 6.2.1; the following subsection provides a summary of the detailed analysis of Alternative 1.

Evaluation of threshold and primary balancing criteria for Alternative 1 is provided in Exhibit 7-4. The exhibit includes the qualitative ratings for each criterion and reference to the evaluation tables in Appendix B that provide justification for the rating. Evaluation of modifying criteria are not provided in the FFS for the reasons indicated in Sections 7.1.8 and 7.1.9.

Exhibit 7-4 Detailed Analysis Summary – Alternative 1

Evaluation Criterion Category	Evaluation Criterion	Qualitative Rating	Evaluation Table Reference (Appendix B)
Threshold Criteria	▪ Overall Protection of Human Health and the Environment	Inadequate	B-1
	▪ Compliance with ARARs	Compliant	B-2
Primary Balancing Criteria	▪ Long-Term Effectiveness and Permanence	Moderate	B-3
	▪ Reduction of Toxicity, Mobility, or Volume Through Treatment	None	B-4
	▪ Short-Term Effectiveness	Moderate to High	B-5
	▪ Implementability	High	B-6
	▪ Cost	Low	B-7

Notes:

1. Detailed cost spreadsheets (cost summaries, present value analyses, and cost worksheets) for each alternative are presented in Appendix C.

7.2.2 Summary of Detailed Analysis for Alternative 2: Institutional Controls, Monitoring, and Maintenance

A summary of the remedial components of Alternative 2 is provided in Section 6.2.2; the following subsection provides a summary of the detailed analysis of Alternative 2.

Evaluation of threshold and primary balancing criteria for Alternative 2 is provided in Exhibit 7-5. The exhibit includes the qualitative ratings for each criterion and reference to the evaluation tables in Appendix B that provide justification for the rating. Evaluation of modifying criteria are not provided in the FFS for the reasons indicated in Sections 7.1.8 and 7.1.9.

Exhibit 7-5 Detailed Analysis Summary – Alternative 2

Evaluation Criterion Category	Evaluation Criterion	Qualitative Rating	Evaluation Table Reference (Appendix B)
Threshold Criteria	▪ Overall Protection of Human Health and the Environment	Adequate	B-8
	▪ Compliance with ARARs	Compliant	B-9
Primary Balancing Criteria	▪ Long-Term Effectiveness and Permanence	Moderate to High	B-10
	▪ Reduction of Toxicity, Mobility, or Volume Through Treatment	None	B-11
	▪ Short-Term Effectiveness	Moderate to High	B-12
	▪ Implementability	Moderate	B-13
	▪ Cost	Low to Moderate	B-14

Notes:

1. Detailed cost spreadsheets (cost summaries, present value analyses, and cost worksheets) for each alternative are presented in Appendix C.

Section 8
Comparative Analysis of Alternatives

This FFS evaluated the two remedial alternatives addressing remaining contaminated media (i.e., soil and groundwater) against the two threshold criteria and five balancing criteria. The results of the detailed analysis for each remedial alternative are presented in Exhibit 8-1. A comparative analysis for these two remedial alternatives using the threshold and balancing criteria has been put into narrative form in the following subsections. Only significant comparative differences between alternatives are presented; the full set of rationale for the qualitative ratings determined as part of detailed analysis for the remedial alternatives is provided in Appendix B.

8.1 Overall Protection of Human Health and the Environment

As described in Section 3.2, Sections XXIX and XXX of the CD provide the determination that the remedial action would be protective of human health and the environment, if implemented in accordance with the RAP. The remedial activities were implemented as described in Section 2, with the exception of ICs, monitoring, and maintenance. The remedial activities resulted in significant risk reduction to humans from exposure to contaminated solid and liquid media; however, as implemented (without ICs, monitoring, and maintenance), the previous remedial activities did not fully address all residual contamination in soils and groundwater that could result in unacceptable exposures based on potential future uses of the Site.

Both Alternatives 1 and 2 provide protection for human receptors from radionuclides and inorganic contaminants for areas inside the future DOE boundary as described in the assumptions for alternative development presented in Exhibit 6-1. Continued monitoring and maintenance will be performed under the NRC General License and the LTSP to minimize current and potential future exposure risks within the DOE transfer boundary.

The absence of the layered ICs, monitoring, and maintenance for properties with contamination posing potential exposure risks outside of the DOE transfer boundary, but still inside the Site where residual contamination remains under Alternative 1, introduces some uncertainty that PRAOs would be fully addressed in the future. While Omnibus Agreements initiated under Umetco's Divestiture Policy would result in proprietary controls being established on these properties, regular inspections to confirm compliance would not necessarily be conducted in a timely manner, and enforcement is dependent on Umetco initiating civil proceedings in court. Thus, the ability of this type of IC to provide adequate protection to mitigate the potential exposure risks is uncertain, and could result in unacceptable non-carcinogenic risk to children from metals exposure in a potential future residential land use scenario outside the DOE transfer boundary. Thus, Alternative 1 does not adequately address PRAOs, and it is rated *Inadequate* in this category.

Alternative 2 would provide additional protection of human health and the environment from exposure to contaminants compared to Alternative 1 through implementation of ICs and long-term monitoring and maintenance for residual contamination within and outside the DOE

transfer boundary, in the form of enforceable proprietary controls, such as ECs and RNs, which may include MMPs and periodic monitoring to confirm compliance with the conditions set forth in the proprietary controls. Violations of these proprietary controls would be directly enforceable under existing laws and regulations. Periodic monitoring would be performed to determine whether remedy components (i.e., ICs) have been compromised in the future, or changes in land use have occurred that would require re-evaluation of IC instruments used. Thus, Alternative 2 provides adequate overall protection of human health and the environment by meeting PRAOs. This alternative is rated *Adequate* in this category.

8.2 Compliance with Applicable or Relevant and Appropriate Requirements

Both alternatives are rated as being *Compliant* with ARARs. Chemical- and location-specific ARARs were not identified in Appendix A for evaluation of remedial alternatives in this FFS. Two of the action-specific ARARs identified in Appendix A (the Uranium Mill Tailings Radiation Control Title II and Domestic Licensing of Source Material) are being addressed under separate ongoing legal and regulatory frameworks. The other action-specific ARAR which is not addressed under the other ongoing legal or regulatory processes is the Colorado Environmental Real Covenants Act.

Under Alternative 1, action-specific ARARs would not be triggered since no new remedial measures would be undertaken. Alternative 2 is expected to achieve compliance with ARARs, including the Colorado Environmental Real Covenants Act, since ICs in the form of ECs and RNs would be established, monitored, and maintained in accordance with this ARAR, as identified in Appendix A.

8.3 Long-Term Effectiveness and Permanence

For both alternatives, contaminated media (i.e., soil and groundwater) remain present at the Site, as discussed in Section 2.3. Contaminated soil at several properties exhibit concentrations that pose unacceptable non-carcinogenic risk to children from metals exposure in a potential future residential land use scenario (see Section 3.1). Alternatives 1 and 2 have the same untreated waste remaining after the conclusion of the remedial activities onsite in soil and groundwater; however, the two alternatives differ in types of controls that are being used to manage untreated waste remaining at the Site.

Activities performed under separate legal and regulatory frameworks are ongoing and provide some degree of long-term effectiveness and permanence of the previous remedial activities for both alternatives. Long-term monitoring and maintenance would be conducted under the NRC General License and the LTSP to minimize current and potential future exposure risks within the DOE transfer boundary. However, long-term effectiveness and permanence of covered areas is dependent on periodic inspection of the integrity of the covers and post-construction monitoring and maintenance performed in perpetuity under other regulatory programs. While Omnibus Agreements initiated under Umetco's Divestiture Policy would result in proprietary controls being established on properties outside the DOE transfer boundary, regular monitoring to confirm compliance would not necessarily be conducted in a timely manner, and enforcement is dependent on Umetco initiating civil proceedings in court.

No further remedial actions would be undertaken under Alternative 1. Given the reliability of the controls implemented under separate private, legal and regulatory frameworks is somewhat uncertain (particularly with respect to the Umetco Divestiture Policy), the alternative was rated as *Moderate* for long-term effectiveness and permanence.

Under Alternative 2, proprietary controls, such as ECs and RNs, implemented under state law would be applied and may be supplemented with MMPs, where appropriate. These proprietary controls provide layering with the land use restrictions established by the Umetco Divestiture Policy and could also provide an additional enforcement mechanism. Compared to Alternative 1, Alternative 2 provides additional long-term effectiveness and permanence through layering of ICs, monitoring, and maintenance. Thus, Alternative 2 is rated *Moderate to High* for long-term effectiveness and permanence.

8.4 Reduction of Toxicity, Mobility, or Volume through Treatment

The previous remedial activities resulted in significant risk reduction to humans from exposure to contaminated solid and liquid media, and treatment is not a component of Alternative 1 nor Alternative 2 since physical remediation measures have been previously completed. Thus, both alternatives do not provide a reduction of toxicity, mobility, or volume through treatment, and were given a rating of *None* for this category.

8.5 Short-Term Effectiveness

Containment measures already in-place at the Site and the exclusion of additional physical remedy components result in short-term protection of human health and environment for both alternatives. Although LTS activities are ongoing, unacceptable exposure risk to humans could occur as part of potential future land uses given that enforcement of Omnibus Agreements by Umetco is uncertain, and the LTS activities such as monitoring and maintenance conducted within the DOE land transfer boundary are being performed under separate legal and regulatory frameworks.

No further remedial action other than five-year site reviews would be undertaken to address contaminated media for Alternative 1, thus, minimal impacts to the community, workers, or environment are expected during implementation of the alternative. However, Alternative 1 was rated *Moderate to High* for short-term effectiveness due to the uncertainty of the time until protection is achieved, especially for properties outside the DOE land transfer boundary.

The proposed ICs for Alternative 2 could be implemented in less than 1 year but are potentially dependent on completion of the land transfer process. Although Alternative 2 involves additional work outside the DOE transfer boundary compared to Alternative 1, the additional properties would result in minimal additional impact to workers since the remedial activities associated with ICs are primarily administrative and inspections associated with the MMPs and five-year site reviews are expected to be periodic and non-intrusive within contaminated media. Therefore, both Alternatives 1 and 2 were given a rating of *Moderate to High* for short-term effectiveness.

8.6 Implementability

Except for five-year site reviews, no further remedial measures would be undertaken under Alternative 1. Five-year site reviews should be relatively straightforward and easily implementable, thus, Alternative 1 was given a rating of *High* for this category

Implementation of ICs, monitoring, and maintenance as part of Alternative 2 adds complexity compared to Alternative 1. Regulatory approvals for implementation of ICs, monitoring, and maintenance should be obtainable. However, some difficulties may be encountered with implementing ICs on various types of properties with differing ownership. Thus, Alternative 2 was given a rating of *Moderate to High* for this category.

8.7 Cost

Capital, annual, periodic, and present value costs for all alternatives were evaluated over a 50-year period after the base year (Years 0 through 50).

The present value cost for Alternative 1 was given a rating of *Low to Moderate*. The present value cost for this alternative is approximately $290,000. Excluding present value discounting, the capital, annual, and periodic costs for Alternative 1 are $31,000, $450,000, and $450,000, respectively.

The present value cost for Alternative 2 was given a rating of *Moderate*. The present value cost for this alternative is approximately $520,000. Excluding present value discounting, the capital, annual, and periodic costs for Alternative 1 are $227,000, $450,000, and $570,000, respectively.

Exhibit 8-1 Summary of Comparative Analysis for Remedial Alternatives

Remedial Alternative	Description	Threshold Criteria		Balancing Criteria					
		Overall Protection of Human Health and the Environment	Compliance with ARARs	Long Term Effectiveness and Permanence	Reduction of Toxicity, Mobility, or Volume through Treatment	Short Term Effectiveness	Implementability	Present Value Cost (Dollars)	
1	No Further Action	Inadequate	Compliant	Moderate	None	Moderate to High	High	Low to Moderate	$290,000
2	Institutional Controls, Monitoring, and Maintenance	Adequate	Compliant	Moderate to High	None	Moderate to High	Moderate to High	Moderate	$520,000

Notes:

1. Detailed cost spreadsheets (cost summaries, present value analyses, and cost worksheets) for each alternative are presented in Appendix C, and the legend for the qualitative rating of costs is below:

Low - $0 through $200,000

Low to Moderate - $200,000 through $400,000

Moderate - $400,000 through $600,000

Moderate to High - $600,000 through $800,000

High – Greater than $800,000

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Section 9
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Tables

Table 5-1. Identification of Potential Institutional Controls, Monitoring, and Maintenance

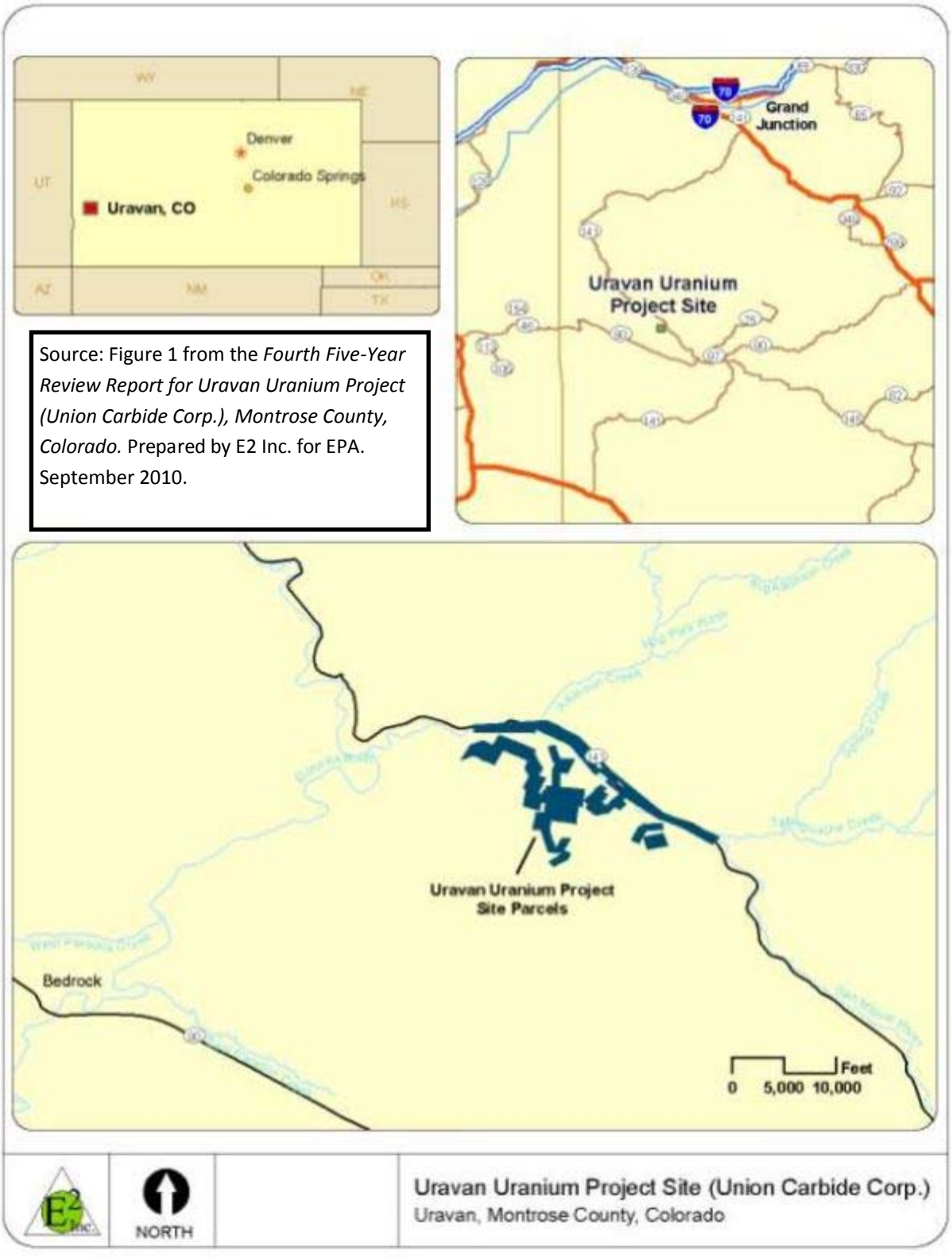
Objective	Institutional Control Types and Instruments	Remediation Areas	Anticipated Primary Implementing Entity	Retained for Consideration in Focused Feasibility Study Evaluation
Institutional Control Instruments - Proprietary Controls				
Prohibit groundwater extraction, excavation and removal of soil, permanent habitation.	**Environmental Covenants and Restrictive Notices.** The purpose of the Environmental Covenants and Restrictive Notices (EC/RN) is to restrict the future use of a property using an enforceable agreement for protecting human health or the environment in accordance with §§25-15-321(2) and 321.5(3) C.R.S. EC/RNs are legal mechanisms placed on properties to enforce limits on land and water use related to residual contamination. The difference between the environmental covenant and the use restriction is that the restrictive notice is explicitly defined in Colorado law (SB 145) as an exercise of the state's police power. However, the State of Colorado also views the environmental covenant as a police-power-based mechanism. EC/RNs would be established through meetings between the property owners, CDPHE, Colorado Department of Law, EPA, and other stakeholders. EC/RNs for the Site likely would include prohibitions of types of uses (e.g., no residential activities) or of activities (e.g., well drilling, removal or disturbance of soil, activities that may erode cover materials).	All Solids and Liquid Areas not UU/UE (Site Wide)	CDPHE	Retained.
	Umetco's Corporate Divestiture Policy. Umetco's Corporate Policy is to restrict groundwater use and residential development on any property which we have operated. Can include land that meets UU/UE criteria and outside of the DOE transfer boundary. However, no mechanisms would be in place to require any monitoring or maintenance in these areas.	All Solids and Liquid Areas not UU/UE (Site Wide)	Umetco	Retained.
Institutional Control Instruments - Government Controls				
Protect remedial features and require long-term inspection and maintenance	**NRC General License.** Uranium ore processing sites addressed by Title II of UMTRCA were active when the act was passed in 1978. These sites were commercially owned and regulated under an NRC license. For license termination, the owner conducts an NRC-approved reclamation of any onsite radioactive waste remaining from uranium ore processing operations. The site owner also ensures full funding for inspections and, if necessary, ongoing maintenance. DOE then accepts title to a site for long-term custody and care. DOE administers Title II sites under the provisions of a general NRC license granted under 10 CFR 40.28, "General License for Custody and Long-Term Care of Uranium or Thorium Byproduct Materials Disposal Sites." The license mandates creation of an LTSP for the site.	All Solids and Liquid Areas not UU/UE (Inside DOE Transfer Boundary)	DOE	Retained.
Prohibit permanent habitation.	**New Zoning District and/or Overlay.** The purpose of a new zoning district and/or overlay is to impose land use restrictions under the authority of an existing unit of government. Two Montrose County zoning districts currently exist at the Site: 1. General Agricultural "A": Provides for the conduct of agriculture related to ranching, farming, and forestry production; and maintaining and promoting agriculture as an essential and economic factor in the county. Multiple uses include but are not limited to agricultural, agribusiness, residential, mining operations, oil and gas, multifamily, day-care, utility transmission, county facilities, garages, and parking. 2. Public Lands "P-L": The Public Lands District shall include all land owned by the U.S. Government and State of Colorado, located in the unincorporated areas of Montrose County and not included in any other zone district except for all federally owned lands under the jurisdiction of the DOE. The Public Lands District has been created to accommodate and encourage the greatest possible range of uses within the district and to create and maintain conditions under which man and nature can exist in productive harmony, and fulfill the social, economic, and other requirements of present and future generations of Americans. Uses within the Public Lands District shall include, but are not limited to: natural resource development, recreation/tourism, transportation, agricultural, commercial, industrial, residential and business.	All Solids and Liquid Areas not UU/UE (Site Wide)	Montrose County	Not Retained.
Restrict excavation and removal of soil greater than 4 feet below ground surface (bgs).	**Montrose County Right-of-Way Work - Notification Requirements.** Right-of-way work requires notification of CDPHE and DOE for utility excavations greater than 4 feet or major modifications. All work would be performed in accordance with any proprietary controls and the LTSP.	Not UU/UE Inside Montrose County Right-of-Way Areas	DOE	Not Retained.
	San Miguel Power Association Right-of-Way Work - Notification Requirements. Right-of-way work requires notification of CDPHE and DOE for utility excavations greater than 4 feet or major modifications. All work would be performed in accordance with any proprietary controls and the LTSP.	Not UU/UE Inside San Miguel Power Association Right-of-Way Areas	DOE	Not Retained.
Restrict groundwater extraction and excavations that may expose groundwater.	**Colorado Department of Transportation (CDOT) Right-of-Way – Groundwater Extraction Restrictions.** Right-of-way work requires restrictions on groundwater extraction. All work would be performed in accordance with any proprietary controls and follow the material management plan.	Not UU/UE Inside CDOT Right-of-Way Areas	CDPHE	Not Retained.

Objective	Institutional Control Types and Instruments	Remediation Areas	Anticipated Primary Implementing Entity	Retained for Consideration in Focused Feasibility Study Evaluation
Require notification of State, DOE, and/or EPA concurrence.	**General Soil Disturbance Notification Requirements (or Permit).** The purpose of the general soil disturbance permit is to protect human health by ensuring adequate engineering controls are in place when excavating into residual contamination. In addition, the permit would require that contaminated materials/waste are properly handled, stored, and disposed of at an approved disposal facility. This would be a unique permit requirement to manage disturbance of general soil within the Site (separate from other existing city and county permits). The permit may provide requirements and options for acquiring clean fill and topsoil, donning personal protective equipment, providing qualified contractors, and requiring proper waste disposal requirements.	All Solids and Liquid Areas not UU/UE (Site Wide)	DOE	Not Retained.
Establish engineering controls to protect human health and the environment.	**Consent Decree/Remedial Action Plan.** The CD/RAP (State of Colorado 1986 and CDPHE 2005), as amended, acted as the functional equivalent of a remedial investigation/feasibility study and ROD for remedial action work completed in accordance with the CD/RAP. The CD was executed in 1986 between the State of Colorado and Umetco (i.e., the responsible party for Site work); the CD is included as part of the 2005 RAP. In accordance with the RAP, "long-term monitoring and maintenance after closure of the Uravan Facility shall be conducted pursuant to the Colorado Radioactive Materials License".	N/A	CDPHE	Not Retained.
Institutional Control Instruments - Information Devices				
Notify public of Site engineering control to limit exposure to residual contamination.	**Advisories/Hazard Notices** The purpose of the advisories/hazard notices is to provide resources and education to inform the community (including public utility) of the Site engineering controls in place (e.g., soil cap) to limit exposures and risk to residual contamination. Long-term site control information may be distributed to the nearby public through websites, community meetings, signage onsite, and/or provided to title companies to distribute to new homeowners. A fact sheet, updated periodically, may also include contact information of long-term program staff and revised points of contact.	All Solids and Liquid Areas not UU/UE (Site Wide)	DOE	Not Retained.
	State Registry of Contaminated Sites. The objective of recording sites with environmental covenants and use restrictions is to enhance institutional memory with the public as it relates to the use restrictions.	All Solids and Liquid Areas not UU/UE (Site Wide)	CDPHE	Retained if EC/RNs applied.
Restrict access to certain Site areas.	**Warning Signs:** The DOE LTSP likely will include warning signs for DOE or County maintained areas, especially for repository areas. These can be considered for other sites under an EC/RN as appropriate.	All Solids and Liquid Areas not UU/UE (Site Wide)	By Owner	Retained.
Engineered Controls				
Restrict access to certain Site areas.	**Restrictive Physical Barriers.** The DOE LTSP likely will include physical barriers such as fencing for DOE or County maintained areas. These barriers can be considered for other sites under an EC/RN as appropriate.	All Solids and Liquid Areas not UU/UE (Site Wide)	By Owner	Retained.
Monitoring and Maintenance				
Establish procedures for material handling and worker protection if approved work is required. Establish maintenance and enforcement procedures.	**Materials Management Plan.** A Materials Handling Plan would supplement EC/RN's. A Materials Handling Plan would provide detailed procedures for radiological monitoring that must be performed when excavation takes place in areas that contain residual radioactive material in excess of 5 pCi/g radium (plus background).	All Solids and Liquid Areas not UU/UE (Site Wide)	CDPHE	Retained.
	Long-Term Surveillance Plan. The purpose of an LTSP is to establish the long-term care program for a disposal site, including surveillance and monitoring requirements. The LTSP explains how DOE will fulfill the general license requirements in 10 CFR 40.27 or 10 CFR 40.28 as the long-term custodian of the Site. The LTSP should define the frequency of monitoring and the steps DOE will take to ensure that any required ICs remain effective (i.e., durable) such as a periodic documented awareness check with applicable property owners or verification of continued transparency within the public record. This includes monitoring of those institutional controls (ICs) related to (1) restricting unauthorized entry, (2) notices of contamination, and (3) enforceable restrictions that limit land uses and prevent access to contaminated soil or groundwater.	All Solids and Liquid Areas not UU/UE (Inside DOE Transfer Boundary)	DOE	Retained.
Notify state agency to confirm permit requirements are in place.	**Colorado 811 Program.** The purpose of the Colorado 811 program is to utilize an existing "call before you dig" notification system to inform property owners or workers of potential residual contamination. The Colorado 811 program could enhance the implementation of hazard notices and/or the soil disturbance permits.	All Solids and Liquid Areas not UU/UE (Site Wide)	CDPHE	Not Retained.

Key:

	Institutional Control Instruments Not Retained for Consideration in Focused Feasibility Study Evaluation

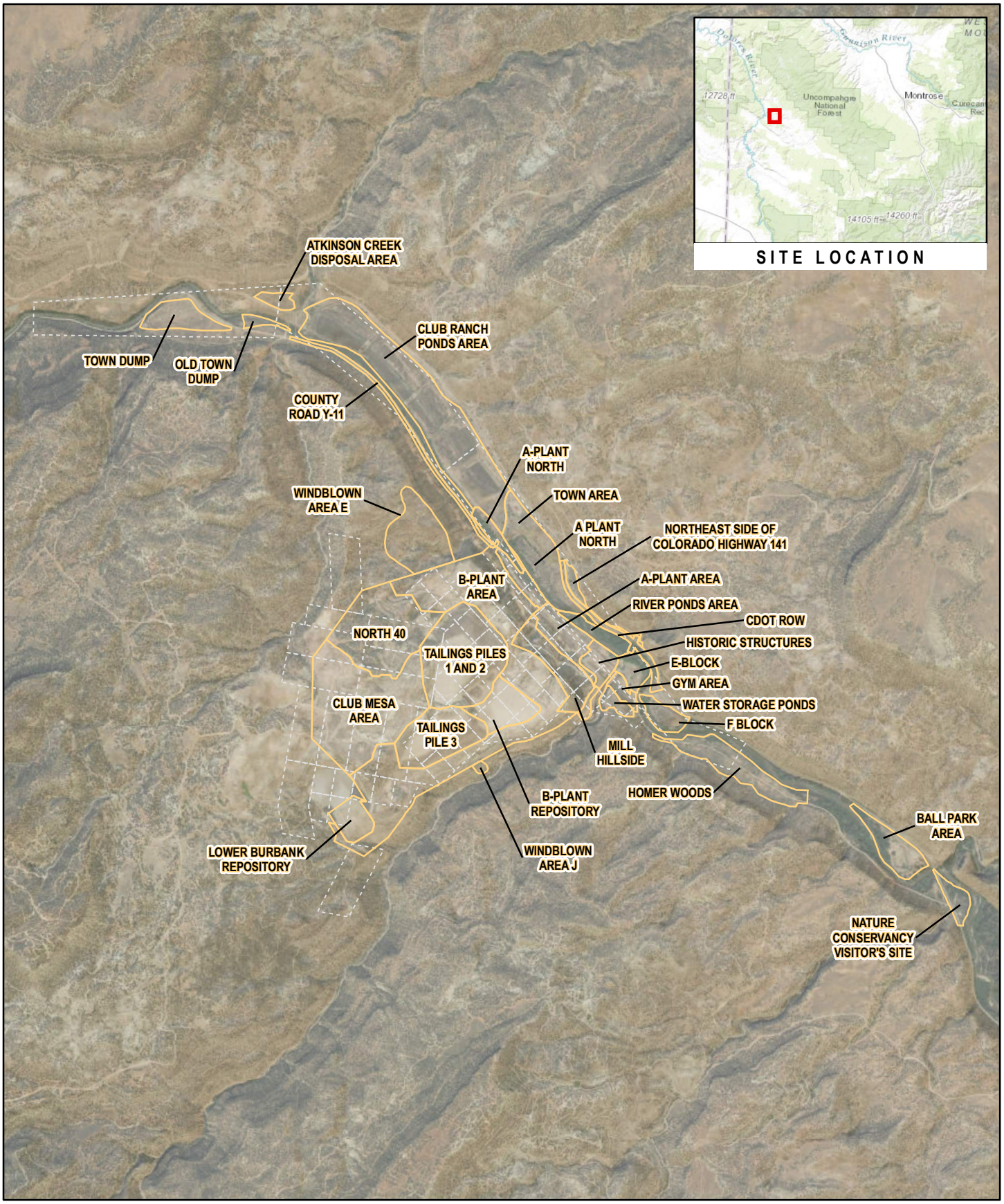
Figures



Source: Figure 1 from the *Fourth Five-Year Review Report for Uravan Uranium Project (Union Carbide Corp.), Montrose County, Colorado.* Prepared by E2 Inc. for EPA. September 2010.

Disclaimer: This map and any boundary lines within the map are approximate and subject to change. The map is not a survey. The map is for informational purposes only regarding EPA's response actions at the Site, and is not intended for any other purpose.

CDM Smith	***Uravan Uranium Project*** ***Uravan, Colorado***	**Figure 1-1** **Location Map**



N

0 0.25 0.5 1

1 inch = 0.5 miles Miles

Site Area Boundary

Claim Boundary

Service Layer Credits: Sources: Esri, HERE, DeLorme, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community; Sources: Esri, USGS, NOAA; Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Figure 1-2 **| Site Area Boundaries and Nomenclature**
Uravan Uranium Project, Uravan, Colorado

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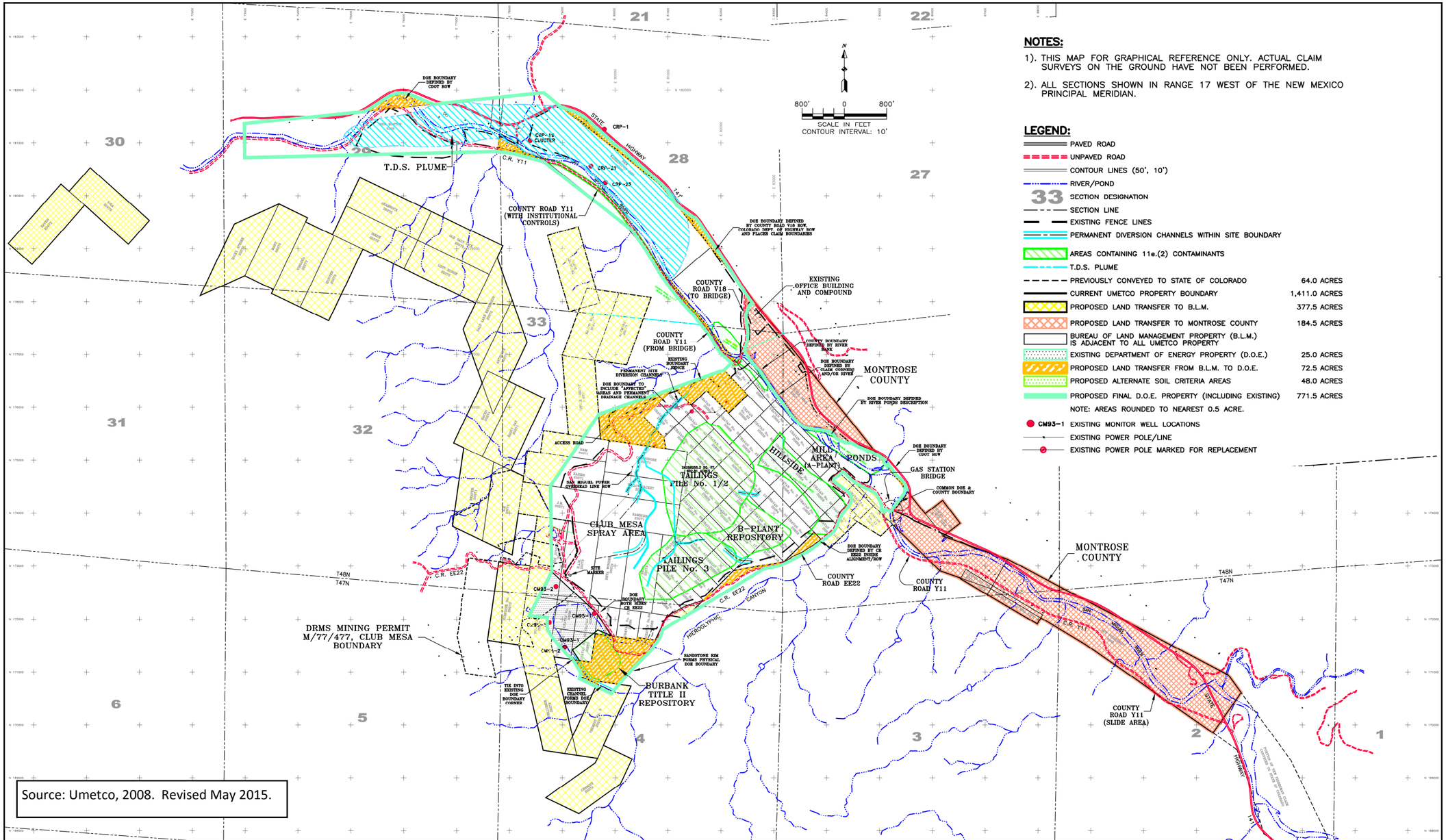
Document Path: T:\79171_Uravan\MXD\SiteOverview_v2.mxd Date Saved: 8/30/2017 Author: WAGNERA CDMSmith



Source: Umetco, 2008. Revised May 2015.

CDM Smith

Uravan Uranium Project

Uravan, Colorado

Figure 1-3

Proposed Land Transfer Boundaries

Appendix A

Summary of Federal and State Applicable or Relevant and Appropriate Requirements (ARARs) and To Be Considered (TBC)

Summary of Federal and State Applicable or Relevant and Appropriate Requirements (ARARs) and To Be Considered (TBC)
Uravan Uranium Project (Union Carbide Corp.) Site, Montrose County, Colorado

	Statute and Regulatory Citation	ARAR Determination	Description	Comment	Chemical	Location	Action
Potential Federal ARARs							
1	Uranium Mill Tailings Radiation Control Title II 42 U.S.C. §§ 2113	Potentially Applicable	The Uranium Mill Tailings Radiation Control Act (UMTRCA) of 1978 (Public Law 95-604) is a federal law that provides for the safe and environmentally sound disposal, long-term stabilization, and control of uranium mill tailings in a manner that minimizes or eliminates radiation health hazards to the public. Uranium ore–processing sites addressed by Title II of UMTRCA were active when the act was passed in 1978. These sites were commercially owned and regulated under an NRC or Agreement State license. For license termination, the owner conducts an NRC-approved reclamation of any onsite radioactive waste remaining from uranium ore–processing operations. The site owner also ensures full funding for inspections and, if necessary, ongoing maintenance. DOE then accepts title to a site for long-term custody and care. DOE administers Title II sites under the provisions of a general NRC license granted under 10 CFR 40.28.	It is anticipated that portion of the Site will be managed for long-term custody and care by DOE under a general NRC license.			✓
2	Domestic Licensing of Source Material 10 CFR 40.28 (*General License for Custody and Long-Term Care of Uranium or Thorium Byproduct Materials Disposal Sites*)	Potentially Applicable	For DOE to accept title to a site for long-term custody and care, DOE administers Title II sites under the provisions of a general NRC license granted under 10 CFR 40.28.	It is anticipated that portion of the Site will be managed for long-term custody and care by DOE under a general NRC license.			✓

	Statute and Regulatory Citation	ARAR Determination	Description	Comment	Chemical	Location	Action
Potential Colorado ARARs							
1	Colorado Environmental Real Covenants Act CRS § 25-15-317 to 327	Potentially Applicable	Requires environmental covenant whenever environmental remediation project results in less than unrestricted land use or uses an engineered structure or feature that requires monitoring, maintenance or operation to function or that will not function as intended if disturbed.	Substantive requirements will be considered during the development of ICs.			✓
2	Institutional Controls Implementation Guidance CDPHE HMWMD, January 2012	To Be Considered	A policy outlining the process of evaluating, creating, modifying, terminating, and implementing environmental covenants and restrictive notices ("ECs/RNs"), as well as the ordinance/intergovernmental agreement mechanism.	Substantive requirements will be considered during the development of ICs.			✓

Appendix B

Detailed Evaluation of Alternatives

Alternative 1
No Further Action

Table B-1. Evaluation Summary for Overall Protection of Human Health and the Environment – Alternative 1

Evaluation Factors for Overall Protection of Human Health and the Environment	Evaluation Summary
Adequate protection of human health and the environment (short- and long-term) from unacceptable risks posed by hazardous substances, pollutants, or contaminants present at the Site	▪ No further remedial measures would be undertaken to address contaminated media or control exposure to potential receptors. ▪ The remedial action completed pursuant to the RAP in the CD has resulted in significant risk reduction to humans from exposure to contaminated solid and liquid media. Monitoring of groundwater to confirm that State ACLs are protective of human health and the environment is ongoing, pursuant to UMTCRA. Based on the remedial action completed at the Site and the use of Site-specific soil cleanup objectives and State ACLs, residual contamination remains onsite. The previous remedial action implemented has not fully addressed all residual contamination in soils and groundwater that could result in unacceptable exposures, based on potential future uses of the Site. Contaminated media present at the Site would be left unaddressed, beyond containment measures put in place as part of the RAP/CD removal action (repository covers). The absence of layered ICs, monitoring, and maintenance for properties with contamination posing potential exposure risks introduces some uncertainty that PRAOs would be fully addressed in the future. ▪ Preliminary RAOs are currently addressed by the containment measures already in place within the DOE transfer boundary, and result in short-term protection of human health and environment. ICs, monitoring, and maintenance would be conducted under the NRC General License and the LTSP to minimize current and potential future exposure risks within the DOE transfer boundary. ▪ The absence of layered ICs, monitoring, and maintenance for areas outside of the DOE transfer boundary, but still inside the Site where residual contamination remains under Alternative 1, introduces some uncertainty that PRAOs would be fully addressed in the future. While Omnibus agreements initiated under Umetco's Divestiture Policy would result in proprietary controls being established for these properties, regular inspections to confirm compliance would not necessarily be conducted in a timely manner and enforcement is dependent on Umetco initiating civil proceedings in court. Thus, the ability of this type of IC to provide adequate protection to mitigate the potential exposure risks is uncertain, and could result in unacceptable non-carcinogenic risk to children from metals exposure in a potential future residential land use scenario. ▪ The lack of ICs, monitoring, and maintenance for this alternative would not prevent changes in land use or activities, which could lead to the following unacceptable risks associated with potential future land uses as described in Section 3: • Soil poses non-carcinogenic risk to children from metals exposure in a potential future residential land use scenario. • Groundwater could still pose unacceptable exposure risks from ingestion as drinking water in a potential future residential land use scenario.
Overall Protection of Human Health and the Environment Rating:	Inadequate

Table B-2. Evaluation Summary for Compliance with ARARs – Alternative 1

Evaluation Factors for Compliance with ARARs	Evaluation Summary
Compliance with chemical-specific applicable or ARARs	▪ Chemical-specific ARARs were not identified in Appendix A for evaluation of remedial alternatives in this FFS.
Compliance with location-specific ARARs	▪ Location-specific ARARs were not identified in Appendix A for evaluation of remedial alternatives in this FFS.
Compliance with action-specific ARARs	▪ Although action-specific ARARs were identified in Appendix A for evaluation of remedial alternatives in this FFS, they would not be triggered under this remedial alternative since no new remedial measures would be undertaken. ▪ Two of the action-specific ARARs identified in Appendix A (the Uranium Mill Tailings Radiation Control Title II and Domestic Licensing of Source Material) are being addressed under separate legal and regulatory frameworks.
Compliance with ARARs Rating:	Compliant

Table B-3. Evaluation Summary for Long-Term Effectiveness and Permanence – Alternative 1

Evaluation Factors for Long-Term Effectiveness and Permanence	Evaluation Summary
Magnitude of residual risk remaining from untreated waste or treatment residuals remaining at the conclusion of the remedial activities	▪ No further remedial measures would be undertaken to address contaminated media (i.e., soil and groundwater). ▪ Contaminated media (i.e., soil and groundwater) remain present at the Site, as discussed in Section 2.3. Contaminated soil at several properties exhibit concentrations that pose unacceptable non-carcinogenic risk to children from metals exposure in a potential future residential land use scenario (see Section 3.1). ▪ The repositories and covers over contaminated soils could be breached causing release and migration of contaminated media, thus, causing potential exposure risk to human receptors. ▪ Contaminated soil at portions of the Site would remain unaddressed, thus, posing potential future unacceptable risks to children in a potential future residential land use scenario. ▪ Contaminated groundwater at portions of the Site would remain unaddressed, thus, posing potential future unacceptable risks to humans if used as drinking water.
Adequacy and reliability of controls that are used to manage treatment residuals and untreated waste remaining at the Site	▪ Long-term effectiveness and permanence is not entirely ensured since contaminated media (i.e., soil and groundwater) remain present at the Site, as discussed in Section 2.3. Contaminated soil at several properties exhibit concentrations that pose unacceptable non-carcinogenic risk to children from metals exposure in a potential future residential land use scenario (see Section 3.1). ▪ Monitoring of groundwater to confirm that State ACLs are protective of human health and the environment is ongoing. Based on the remedial action completed at the Site and the use of Site-specific soil cleanup objectives and State ACLs, residual contamination remains onsite.

Table B-3. Evaluation Summary for Long-Term Effectiveness and Permanence – Alternative 1 (continued)

Evaluation Factors for Long-Term Effectiveness and Permanence	Evaluation Summary
Adequacy and reliability of controls that are used to manage treatment residuals and untreated waste remaining at the Site (continued)	▪ Contaminated media present at the Site would be left unaddressed, beyond containment measures put in place as part of the RAP/CD removal action (repository covers). ▪ Activities performed under separate legal and regulatory frameworks are ongoing and provide some degree of long-term effectiveness and permanence of the previous remedial action. Long-term monitoring and maintenance would be conducted under the NRC General License and the LTSP to minimize current and potential future exposure risks within the DOE transfer boundary. However, long-term effectiveness and permanence of covered areas is dependent on periodic inspection of the integrity of the covers and post construction monitoring and maintenance performed in perpetuity under other regulatory programs. ▪ While Omnibus agreements initiated under Umetco's Divestiture Policy would result in proprietary controls being established, regular inspections to confirm compliance would not necessarily be conducted in a timely manner and enforcement is dependent on Umetco initiating civil proceedings in court. Thus, the ability of this type of IC to provide adequate protection to mitigate the potential exposure risks is uncertain, and could result in unacceptable non-carcinogenic risk to children from metals exposure in a potential future residential land use scenario.
Long-Term Effectiveness and Permanence Rating:	Moderate

Table B-4. Evaluation Summary for Reduction of Toxicity, Mobility, or Volume through Treatment – Alternative 1

Evaluation Factors for Reduction of Toxicity, Mobility, or Volume through Treatment	Evaluation Summary
The treatment processes, the alternative uses, and materials they will treat	▪ This alternative would not treat contaminated media (i.e., soil and groundwater), thus, there would be no reduction of toxicity, mobility, or volume of contamination through treatment. ▪ The statutory preference for treatment as a principal element of the remedial action would not be met.
The amount of hazardous substances, pollutants, or contaminants that will be destroyed or treated, including how the principal threat(s) will be addressed	
The degree of expected reduction in toxicity, mobility, or volume of the waste due to treatment	
The degree to which the treatment is irreversible	
The type and quantity of residuals that will remain following treatment, considering the persistence, toxicity, mobility, and propensity to bioaccumulate such hazardous substances and their constituents	
Whether the alternative would satisfy the statutory preference for treatment as a principal element of the remedial action	
Reduction of Toxicity, Mobility, or Volume through Treatment Rating:	None

Table B-5. Short-Term Effectiveness Evaluation Summary – Alternative 1

Evaluation Factors for Short-Term Effectiveness	Evaluation Summary
Short-term risks that might be posed to the community during implementation of an alternative	▪ No further remedial action other than five-year site reviews would be undertaken. Thus, there would be no potential adverse community impacts resulting from implementation of the remedial alternative.
Potential impacts on workers during remedial action and the effectiveness and reliability of protective measures	▪ Workers performing site inspections would potentially be exposed to contaminated media (i.e., soil and groundwater) that pose unacceptable human health risks. ▪ Safety measures, such as monitoring, dust suppression, and use of personal protective equipment, would protect workers during site inspections. ▪ LTS activities, in accordance with the LTSP, such as monitoring and maintenance conducted within the DOE land transfer boundary, are being performed under separate legal and regulatory frameworks.
Potential adverse environmental impacts resulting from construction and implementation of an alternative and the reliability of the available mitigation measures during implementation in preventing or reducing the potential impacts	▪ No further remedial action other than five-year site reviews would be undertaken. Thus, there would be no potential adverse environmental impacts resulting from implementation of the remedial alternative. ▪ LTS activities, in accordance with the LTSP, such as monitoring and maintenance conducted within the DOE land transfer boundary, are being performed under separate legal and regulatory frameworks.
Time until protection is achieved	▪ No further remedial action other than five-year site reviews would be undertaken to address contaminated media. ▪ LTS activities, in accordance with the LTSP, such as monitoring and maintenance conducted within the DOE land transfer boundary, are being performed under separate legal and regulatory frameworks. ▪ Contaminated media existing outside of the DOE land transfer boundary would remain unaddressed, and unacceptable exposure risk to humans could occur as part of current and potential future land uses given that enforcement of Omnibus Agreements by Umetco is uncertain. ▪ Based on these factors, time until protection is achieved for this remedial alternative is unknown, especially for properties outside the DOE land transfer boundary.
Short-Term Effectiveness Rating:	Moderate to High

Table B-6. Implementability Evaluation Summary – Alternative 1

Evaluation Factors for Implementability		Evaluation Summary
Technical feasibility	Technical difficulties and unknowns associated with the construction and operation of a technology	▪ No further remedial action would be undertaken to address contaminated media, thus, none of these criteria are met. ▪ LTS activities, in accordance with the LTSP, such as monitoring and maintenance conducted within the DOE land transfer boundary, are being performed under separate legal and regulatory frameworks. ▪ Non-intrusive visual inspections, which are part of Alternative 1, would be performed and could be easily implemented with available labor, material, and technical resources. ▪
	Reliability of the technology, focusing on technical problems that will lead to schedule delays	
	Ease of undertaking additional remedial actions including what, if any, future remedial actions would be needed and the difficulty to implement additional remedial actions	
	Ability to monitor the effectiveness of the remedy, including an evaluation of risks of exposure should monitoring be insufficient to detect a system failure	
Administrative feasibility	Activities needed to coordinate with other offices and agencies	▪ Site inspections would be coordinated with multiple parties.
	The ability and time required to obtain any necessary approvals and permits from other agencies (for offsite actions)	▪ No offsite remedial activities would be conducted under this remedial alternative.
Availability of services and materials	Availability of adequate offsite treatment, storage capacity, and disposal capacity and services	▪ No further remedial action would be undertaken to address contaminated media; thus, this criterion is not applicable.
	Availability of necessary equipment and specialists and provisions to ensure any necessary additional resources	▪ No further remedial measures would be undertaken to address contaminated media. ▪ Technical equipment and specialists are available for conducting non-intrusive visual inspections.
	Availability of services and materials plus the potential for obtaining competitive bids, which is particularly important for innovative technologies	
	Availability of prospective technologies	
Implementability Rating:	High	

Table B-7. Cost Evaluation Summary – Alternative 1

Evaluation Factors for Cost	Approximate Cost (Dollars)
Total capital cost	$31,000
Total O&M cost	$450,000
Total periodic cost	$450,000
Total cost (excluding present value discounting)	$931,000
Total present value cost	$290,000
Cost Rating:	Low to Moderate

Note: Total costs are for the assumed period of evaluation (Years 0 through 50). Costs are rounded to the nearest $1,000.

Alternative 2
Institutional Controls, Monitoring, and Maintenance

Table B-8. Evaluation Summary for Overall Protection of Human Health and the Environment – Alternative 2

Evaluation Factors for Overall Protection of Human Health and the Environment	Evaluation Summary
Adequate protection of human health and the environment (short- and long-term) from unacceptable risks posed by hazardous substances, pollutants, or contaminants present at the Site	▪ The remedial action completed pursuant to the RAP in the CD has resulted in significant risk reduction to humans from exposure to contaminated solid and liquid media. Monitoring of groundwater to confirm that State ACLs are protective of human health and the environment is ongoing (Umetco 2016). Based on the remedial action completed at the Site and the use of Site-specific soil cleanup objectives and State ACLs, residual contamination remains onsite. However, the remedial action implemented did not fully address all potential future uses of the Site that could result in unacceptable exposures to residual contamination in soils and groundwater. ▪ Preliminary RAOs are currently addressed by the containment measures already in place and result in short term protection of human health and environment. Within the DOE transfer boundary, ICs, monitoring, and maintenance would be conducted under the NRC General License and the LTSP to minimize current and potential future exposure risks. ▪ This alternative would also provide protection of human health and the environment from exposure to contaminants through implementation of ICs (i.e., proprietary controls), long-term monitoring, and maintenance throughout the Site. ▪ Periodic monitoring would be performed to determine whether remedy components (ICs) have been compromised in the future, or changes in land use have occurred that would require re-evaluation of the IC instruments used.
Overall Protection of Human Health and the Environment Rating:	Adequate

Table B-9. Evaluation Summary for Compliance with ARARs – Alternative 2

Evaluation Factors for Compliance with ARARs	Evaluation Summary
Compliance with chemical-specific ARARs	▪ Chemical-specific ARARs were not identified in Appendix A for evaluation of remedial alternatives in this FFS.
Compliance with location-specific ARARs	▪ Location-specific ARARs were not identified in Appendix A for evaluation of remedial alternatives in this FFS.
Compliance with action-specific ARARs	▪ Two of the action-specific ARARs identified in Appendix A (the Uranium Mill Tailings Radiation Control Title II and Domestic Licensing of Source Material) are currently being addressed separate legal and regulatory frameworks. This remedial alternative would not preclude actions taken to address compliance with these potentially applicable laws and regulations. ▪ Colorado Environmental Real Covenants Act: Substantive requirements of this potentially applicable law identified in Appendix A would be addressed during design and implementation of ICs (i.e., proprietary controls) for this remedial alternative at portions of the Site.
Compliance with ARARs Rating:	Compliant

Table B-10. Evaluation Summary for Long-Term Effectiveness and Permanence – Alternative 2

Evaluation Factors for Long-Term Effectiveness and Permanence	Evaluation Summary
Magnitude of residual risk remaining from untreated waste or treatment residuals remaining at the conclusion of the remedial activities	▪ Contaminated media (i.e., soil and groundwater) remain present at the Site, as discussed in Section 2.3. Contaminated soil at several properties exhibit concentrations that pose unacceptable non-carcinogenic risk to children from metals exposure in a potential future residential land use scenario (see Section 3.1). ▪ The repositories and covers over contaminated soils could be breached, causing release and migration of contaminated media and thus causing potential exposure risk to human receptors. ▪ Contaminated groundwater beneath portions of the Site would remain unaddressed, thus, posing potential future unacceptable risks to humans if used as drinking water. ▪ Contaminated soil at portions of the Site would remain unaddressed, thus, posing potential future unacceptable risks to children in a potential future residential land use scenario. ▪ As part of this alternative, ICs, monitoring, and maintenance would be implemented to prevent changes in land use and restrict activities that could lead to unacceptable risks.
Adequacy and reliability of controls that are used to manage treatment residuals and untreated waste remaining at the Site	▪ Long-term effectiveness and permanence is not entirely ensured since contaminated media (i.e., soil and groundwater) remain present at the Site, as discussed in Section 2.3. Contaminated soil at several properties exhibit concentrations that pose unacceptable non-carcinogenic risk to children from metals exposure in a potential future residential land use scenario (see Section 3.1). ▪ Monitoring of groundwater to confirm that State ACLs are protective of human health and the environment is ongoing. Based on the remedial action completed at the Site and the use of Site-specific soil cleanup objectives and State ACLs, residual contamination remains onsite. ▪ ICs, monitoring, and maintenance would be conducted under the NRC General License and the LTSP to minimize current and potential future exposure risks within the DOE transfer boundary. Long-term effectiveness and permanence of covered areas is dependent on integrity of the covers, periodic inspection, and post-construction monitoring and maintenance performed in perpetuity. ▪ Under this alternative, proprietary controls, such as environmental covenants and restrictive notices, may be applied and may be supplemented with MMPs, where appropriate. These proprietary controls provide layering with the land use restrictions established by the Umetco Divestiture Policy, and could also be directly enforced under existing law and regulation. ▪ Periodic monitoring would be performed to evaluate long-term effectiveness and permanence of the remedy.
Long-Term Effectiveness and Permanence Rating:	Moderate to High

Table B-11. Evaluation Summary for Reduction of Toxicity, Mobility, or Volume through Treatment – Alternative 2

Evaluation Factors for Reduction of Toxicity, Mobility, or Volume through Treatment	Evaluation Summary
The treatment processes, the alternative uses, and materials they will treat	▪ This alternative would not treat contaminated media (i.e., soil and groundwater). Thus, there would be no reduction of toxicity, mobility, or volume of contamination through treatment. ▪ The statutory preference for treatment as a principal element of the remedial action would not be met.
The amount of hazardous substances, pollutants, or contaminants that will be destroyed or treated, including how the principal threat(s) will be addressed	
The degree of expected reduction in toxicity, mobility, or volume of the waste due to treatment	
The degree to which the treatment is irreversible	
The type and quantity of residuals that will remain following treatment, considering the persistence, toxicity, mobility, and propensity to bioaccumulate such hazardous substances and their constituents	
Whether the alternative would satisfy the statutory preference for treatment as a principal element of the remedial action	
Reduction of Toxicity, Mobility, or Volume through Treatment Rating:	None

Table B-12. Short-Term Effectiveness Evaluation Summary – Alternative 2

Evaluation Factors for Short-Term Effectiveness	Evaluation Summary
Short-term risks that might be posed to the community during implementation of an alternative	▪ There would be minimal impacts to the community because there are no residential receptors at the Site. ▪ There would be minimal risks as there would be no transport of contaminated media during remedial action.
Potential impacts on workers during remedial action and the effectiveness and reliability of protective measures	▪ If required, property boundary surveys required as part of implementation of ICs would expose workers to short-term risks. ▪ Workers performing site inspections would potentially be exposed to contaminated media (i.e., soil and groundwater) that pose unacceptable human health risks. ▪ Safety measures, such as dust suppression, use of personal protective equipment, and establishment of work zones, would protect workers during remedy implementation. ▪ LTS activities, in accordance with the LTSP, such as monitoring and maintenance conducted within the DOE land transfer boundary, are being performed under separate legal and regulatory frameworks.

Table B-12. Short-Term Effectiveness Evaluation Summary – Alternative 2 (continued)

Evaluation Factors for Short-Term Effectiveness	Evaluation Summary
Potential adverse environmental impacts resulting from construction and implementation of an alternative and the reliability of the available mitigation measures during implementation in preventing or reducing the potential impacts	▪ There would be minimal adverse impacts resulting from implementation of the alternative. Protective measures, such as adherence to standard operating procedures, would minimize environmental impacts during implementation of this alternative. ▪ LTS activities, in accordance with the LTSP, such as monitoring and maintenance conducted within the DOE land transfer boundary, are being performed under separate legal and regulatory frameworks. ▪ Additionally, protective measures, such as dust suppression, would be used for minimizing the environmental impact as necessary.
Time until protection is achieved	▪ Containment measures already in-place at the Site and the exclusion of additional physical remedy components result in current protection of human health and the environment. ▪ LTS activities, in accordance with the LTSP, such as monitoring and maintenance conducted within the DOE land transfer boundary, are being performed under separate legal and regulatory frameworks. ▪ The proposed ICs for all land use categories could be implemented in less than 1 year, but are potentially dependent on completion of the land transfer process.
Short-Term Effectiveness Rating:	Moderate to High

Table B-13. Implementability Evaluation Summary – Alternative 2

Evaluation Factors for Implementability		Evaluation Summary
Technical feasibility	Technical difficulties and unknowns associated with the construction and operation of a technology	▪ Maintenance of ICs may be more difficult owing to various types of properties with differing ownership and land use. Maintaining ICs would require agency coordination. ▪ LTS activities, in accordance with the LTSP, such as monitoring and maintenance conducted within the DOE land transfer boundary, are being performed under separate legal and regulatory frameworks. ▪ Maintenance, monitoring, and five-year site review reports would be easily implemented with available labor, material, and technical resources.
	Reliability of the technology, focusing on technical problems that will lead to schedule delays	▪ Maintenance, monitoring, and five-year site review reports would be easily implemented with available labor, material, and technical resources. ▪ Reliable operation of ICs may not be ensured since human receptors could ignore them.

Table B-13. Implementability Evaluation Summary – Alternative 2 (continued)

Evaluation Factors for Implementability		Evaluation Summary
Technical feasibility (continued)	Ease of undertaking additional remedial actions, including what, if any, future remedial actions would be needed and the difficulty to implement additional remedial actions	▪ Any additional remedial actions performed on or below the repositories could potentially affect the integrity of those containment elements. ▪ Additional remedial action may be more difficult to implement owing to various types of properties with differing ownership and land use.
	Ability to monitor the effectiveness of the remedy, including an evaluation of risks of exposure should monitoring be insufficient to detect a system failure	▪ Monitoring of ICs is dependent on periodic reviews of the ICs used (i.e., proprietary controls). Modifications of ICs may be difficult, especially because of various types of properties with differing ownership and land use. Maintaining ICs would require agency coordination. ▪ LTS activities, in accordance with the LTSP, such as monitoring and maintenance conducted within the DOE land transfer boundary, are being performed under separate legal and regulatory frameworks.
Administrative feasibility	Activities needed to coordinate with other offices and agencies	▪ Regulatory approvals for implementation of ICs, monitoring, and maintenance should be obtainable. However, some difficulties may be encountered with implementing ICs on various types of properties with differing ownership. ▪ Site inspections would be coordinated with multiple parties.
	The ability and time required to obtain any necessary approvals and permits from other agencies (for offsite actions)	▪ No offsite remedial activities would be conducted under this alternative.
Availability of services and materials	Availability of adequate offsite treatment, storage capacity, and disposal capacity and services	▪ No offsite remedial activities would be conducted under this alternative.
	Availability of necessary equipment and specialists and provisions to ensure any necessary additional resources	▪ Monitoring could be easily implemented with available labor, material, and technical resources. ▪ Technical specialists are available for conducting periodic inspections and implementation of ICs. ▪ No specialized equipment or technologies are needed to conduct periodic inspections.
	Availability of services and materials plus the potential for obtaining competitive bids, which is particularly important for innovative technologies	
	Availability of prospective technologies	
Implementability Rating:	Moderate	

Table B-14. Cost Evaluation Summary – Alternative 2

Evaluation Factors for Cost	Approximate Cost (Dollars)
Total capital cost	$227,000
Total O&M cost	$450,000
Total periodic cost	$570,000
Total cost (excluding present value discounting)	$1,247,000
Total present value cost	$520,000
Cost Rating:	Moderate

Note: Total costs are for the assumed period of evaluation (Years 0 through 50). Costs are rounded to the nearest $1,000.

Appendix C

Cost Estimate Backup

The cost spreadsheets included in this appendix were developed in accordance with EPA 540-R-00-002 (OSWER 9355.0-75) July 2000.

These costs should be used to compare alternative relative costs. Costs for project management, remedial design, and construction management were determined as percentages of capital cost per the guidance. Costs for these work items may not reflect costs for implementation. These costs are determined based on specific client requirements during implementation.

Detailed Costs for Alternatives

TABLE CS-ALT

ALTERNATIVE COST SUMMARY

Site: Uravan Uranium Project (Union Carbide Corp.)
Location: Uravan, Colorado
Phase: Focused Feasibility Study
Base Year: 2017

Alternative	Total Capital Cost	Total Annual O&M Cost	Total Periodic Cost	Total Non-Discounted Cost	Present Value Cost
1 No Further Action	$31,000	$450,000	$450,000	$931,000	$290,000
2 Institutional Controls, Maintenance, and Monitoring	$227,000	$450,000	$570,000	$1,247,000	$520,000

Notes:

1 - Capital costs, annual costs, and periodic costs are presented on Tables CS-1 through CS-2
2 - Estimated remedial timeframes and associated present value analysis for each remedial alternative are provided on Tables PV-1 through PV-2
3 - The non-discounted total cost demonstrates the impact of a discount rate on the total present value cost and the relative amount of future annual expenditures. Non-discounted costs are presented for comparison purposes only and should not be used in place of present value costs in the CERCLA remedy selection process.
4 - Costs presented for this alternative are expected to have an accuracy between -30% to +50% of actual costs, based on the scope presented. They are prepared solely to facilitate relative comparisons between alternatives for feasibility study level evaluation purposes.

Present Value and Cost Estimate Summary

Alternative 1
No Further Action

TABLE PV-1

PRESENT VALUE ANALYSIS

Alternative 1
No Further Action

Site: Uravan Uranium Project (Union Carbide Corp.)
Location: Uravan, Colorado
Phase: Focused Feasibility Study
Base Year: 2017

Year[1]	Capital Costs[2]	Annual O&M Costs	Periodic Costs (Five-Year Review)	Total Annual Expenditure[3]	Discount Factor (7.0%)	Present Value[4]
0	$31,000	$0	$0	$31,000	1.0000	$31,000
1	$0	$9,000	$0	$9,000	0.9346	$8,411
2	$0	$9,000	$45,000	$54,000	0.8734	$47,164
3	$0	$9,000	$0	$9,000	0.8163	$7,347
4	$0	$9,000	$0	$9,000	0.7629	$6,866
5	$0	$9,000	$0	$9,000	0.7130	$6,417
6	$0	$9,000	$0	$9,000	0.6663	$5,997
7	$0	$9,000	$45,000	$54,000	0.6227	$33,626
8	$0	$9,000	$0	$9,000	0.5820	$5,238
9	$0	$9,000	$0	$9,000	0.5439	$4,895
10	$0	$9,000	$0	$9,000	0.5083	$4,575
11	$0	$9,000	$0	$9,000	0.4751	$4,276
12	$0	$9,000	$45,000	$54,000	0.4440	$23,976
13	$0	$9,000	$0	$9,000	0.4150	$3,735
14	$0	$9,000	$0	$9,000	0.3878	$3,490
15	$0	$9,000	$0	$9,000	0.3624	$3,262
16	$0	$9,000	$0	$9,000	0.3387	$3,048
17	$0	$9,000	$45,000	$54,000	0.3166	$17,096
18	$0	$9,000	$0	$9,000	0.2959	$2,663
19	$0	$9,000	$0	$9,000	0.2765	$2,489
20	$0	$9,000	$0	$9,000	0.2584	$2,326
21	$0	$9,000	$0	$9,000	0.2415	$2,174
22	$0	$9,000	$45,000	$54,000	0.2257	$12,188
23	$0	$9,000	$0	$9,000	0.2109	$1,898
24	$0	$9,000	$0	$9,000	0.1971	$1,774
25	$0	$9,000	$0	$9,000	0.1842	$1,658
26	$0	$9,000	$0	$9,000	0.1722	$1,550
27	$0	$9,000	$45,000	$54,000	0.1609	$8,689
28	$0	$9,000	$0	$9,000	0.1504	$1,354
29	$0	$9,000	$0	$9,000	0.1406	$1,265
30	$0	$9,000	$0	$9,000	0.1314	$1,183
31	$0	$9,000	$0	$9,000	0.1228	$1,105
32	$0	$9,000	$45,000	$54,000	0.1147	$6,194
33	$0	$9,000	$0	$9,000	0.1072	$965
34	$0	$9,000	$0	$9,000	0.1002	$902
35	$0	$9,000	$0	$9,000	0.0937	$843
36	$0	$9,000	$0	$9,000	0.0875	$788
37	$0	$9,000	$45,000	$54,000	0.0818	$4,417
38	$0	$9,000	$0	$9,000	0.0765	$689
39	$0	$9,000	$0	$9,000	0.0715	$644
40	$0	$9,000	$0	$9,000	0.0668	$601
41	$0	$9,000	$0	$9,000	0.0624	$562
42	$0	$9,000	$45,000	$54,000	0.0583	$3,148
43	$0	$9,000	$0	$9,000	0.0545	$491
44	$0	$9,000	$0	$9,000	0.0509	$458
45	$0	$9,000	$0	$9,000	0.0476	$428
46	$0	$9,000	$0	$9,000	0.0445	$401
47	$0	$9,000	$45,000	$54,000	0.0416	$2,246
48	$0	$9,000	$0	$9,000	0.0389	$350
49	$0	$9,000	$0	$9,000	0.0363	$327
50	$0	$9,000	$0	$9,000	0.0339	$305
TOTALS:	$31,000	$450,000	$450,000	$931,000		$287,494
TOTAL PRESENT VALUE OF ALTERNATIVE 1 [5]						$290,000

Notes:

[1] Estimated remedial timeframes are discussed within the FS report.

[2] Capital costs, for purposes of this analysis, are assumed to be distributed as indicated on Table CS-1.

[3] Total annual expenditure is the total cost per year with no discounting.

[4] Present value is the total cost per year including a 7.0% discount factor for that year. See Table PV-ADRFT for details.

[5] Total present value is rounded to the nearest $10,000. Inflation and depreciation are excluded from the present value cost.

Costs presented for this alternative are expected to have an accuracy between -30% to +50% of actual costs, based on the scope presented. They are prepared solely to facilitate relative comparisons between alternatives for FS evaluation purposes.

TABLE CS-1

Alternative 1
No Further Action

COST ESTIMATE SUMMARY

Site: Uravan Uranium Project (Union Carbide Corp.)
Location: Uravan, Colorado
Phase: Focused Feasibility Study
Base Year: 2017
Date: October 2017

Description: Alternative 1 is required by the NCP to provide an environmental baseline against which impacts of the remedial alternatives can be compared. Although ICs, monitoring, and maintenance will be performed by the responsible party, federal, and/or state agencies under other regulatory programs as described in Section 6, 5-year site reviews would be initiated at the Site to address remaining contaminated media or otherwise mitigate the associated unacceptable risks to human health or the environment. Additionally, five-year reviews may be facilitated with a collaborative agreement between EPA and DOE inspections and other site related activities.

CAPITAL COSTS

DESCRIPTION	WORKSHEET	QTY	UNIT(S)	UNIT COST	TOTAL	NOTES
Development and Implementation of Collaborative Agreement	CW1-2	1	LS	$23,459	$23,459	
SUBTOTAL					$23,459	
Contingency (Scope and Bid)		20%			$4,692	10% Scope, 10% Bid (Low end of the recommended range in EPA 540-R-00-002).
TOTAL					$28,151	
Project Management		10%			$2,815	Percentage from Exhibit 5-8 in EPA 540-R-00-002 was used.
TOTAL					$30,966	
TOTAL CAPITAL COST					**$31,000**	Total capital cost is rounded to the nearest $1,000.

ANNUAL OPERATION AND MAINTENANCE COSTS (Years 1 through 50)

DESCRIPTION	WORKSHEET	QTY	UNIT(S)	UNIT COST	TOTAL	NOTES
Annual Site Inspection	CW1-3	1	YR	$6,183	$6,183	
SUBTOTAL					$6,183	
Contingency (Scope and Bid)		20%			$1,237	10% Scope, 10% Bid (Low end of the recommended range in EPA 540-R-00-002).
SUBTOTAL					$7,420	
Project Management		7%			$519	Middle value of the recommended range in EPA 540-R-00-002 was used.
Technical Support		15%			$1,113	Middle value of the recommended range in EPA 540-R-00-002 was used.
TOTAL					$9,052	
TOTAL ANNUAL O&M COST					**$9,000**	Total annual O&M cost is rounded to the nearest $1,000.

5-YEAR SITE REVIEW PERIODIC COSTS (Years 2, 7, 12, 17, 22, 27, 32, 37, 42, and 47)

DESCRIPTION	WORKSHEET	QTY	UNIT(S)	UNIT COST	TOTAL	NOTES
5-Year Site Review	CW1-1	1	LS	$30,676	$30,676	Last 5-year site review was conducted in 2015, so next is scheduled for 2019 which is Year 2 in the cost estimate (Base Year- Year 0 is 2017).
SUBTOTAL					$30,676	
Contingency (Scope and Bid)		20%			$6,135	10% Scope, 10% Bid (Low end of the recommended range in EPA 540-R-00-002).
SUBTOTAL					$36,811	
Project Management		7%			$2,577	Middle value of the recommended range in EPA 540-R-00-002 was used.
Technical Support		15%			$5,522	Middle value of the recommended range in EPA 540-R-00-002 was used.
TOTAL					$44,910	
TOTAL PERIODIC COST					**$45,000**	Total capital cost is rounded to the nearest $1,000.

Notes:

Percentages used for contingency and professional/technical services costs are based on guidance from Section 5.0 of "A Guide to Developing and Documenting Cost Estimates During the Feasibility Study", EPA 2000. purposes.

Abbreviations:

EA Each
LS Lump Sum
QTY Quantity
YR Year

Present Value and Cost Estimate Summary

Alternative 2
Institutional Controls, Maintenance, and Monitoring

TABLE PV-2

PRESENT VALUE ANALYSIS

Alternative 2
Institutional Controls, Maintenance, and Monitoring

Site: Uravan Uranium Project (Union Carbide Corp.)
Location: Uravan, Colorado
Phase: Focused Feasibility Study
Base Year: 2017

Year[1]	Capital Costs[2]	Annual O&M Costs	Periodic Costs (Reviewing / Updating Plans)	Periodic Costs (Five-Year Review)	Total Annual Expenditure[3]	Discount Factor (7.0%)	Present Value[4]
0	$227,000	$0	$0	$0	$227,000	1.0000	$227,000
1	$0	$9,000	$0	$0	$9,000	0.9346	$8,411
2	$0	$9,000	$12,000	$45,000	$66,000	0.8734	$57,644
3	$0	$9,000	$0	$0	$9,000	0.8163	$7,347
4	$0	$9,000	$0	$0	$9,000	0.7629	$6,866
5	$0	$9,000	$0	$0	$9,000	0.7130	$6,417
6	$0	$9,000	$0	$0	$9,000	0.6663	$5,997
7	$0	$9,000	$12,000	$45,000	$66,000	0.6227	$41,098
8	$0	$9,000	$0	$0	$9,000	0.5820	$5,238
9	$0	$9,000	$0	$0	$9,000	0.5439	$4,895
10	$0	$9,000	$0	$0	$9,000	0.5083	$4,575
11	$0	$9,000	$0	$0	$9,000	0.4751	$4,276
12	$0	$9,000	$12,000	$45,000	$66,000	0.4440	$29,304
13	$0	$9,000	$0	$0	$9,000	0.4150	$3,735
14	$0	$9,000	$0	$0	$9,000	0.3878	$3,490
15	$0	$9,000	$0	$0	$9,000	0.3624	$3,262
16	$0	$9,000	$0	$0	$9,000	0.3387	$3,048
17	$0	$9,000	$12,000	$45,000	$66,000	0.3166	$20,896
18	$0	$9,000	$0	$0	$9,000	0.2959	$2,663
19	$0	$9,000	$0	$0	$9,000	0.2765	$2,489
20	$0	$9,000	$0	$0	$9,000	0.2584	$2,326
21	$0	$9,000	$0	$0	$9,000	0.2415	$2,174
22	$0	$9,000	$12,000	$45,000	$66,000	0.2257	$14,896
23	$0	$9,000	$0	$0	$9,000	0.2109	$1,898
24	$0	$9,000	$0	$0	$9,000	0.1971	$1,774
25	$0	$9,000	$0	$0	$9,000	0.1842	$1,658
26	$0	$9,000	$0	$0	$9,000	0.1722	$1,550
27	$0	$9,000	$12,000	$45,000	$66,000	0.1609	$10,619
28	$0	$9,000	$0	$0	$9,000	0.1504	$1,354
29	$0	$9,000	$0	$0	$9,000	0.1406	$1,265
30	$0	$9,000	$0	$0	$9,000	0.1314	$1,183
31	$0	$9,000	$0	$0	$9,000	0.1228	$1,105
32	$0	$9,000	$12,000	$45,000	$66,000	0.1147	$7,570
33	$0	$9,000	$0	$0	$9,000	0.1072	$965
34	$0	$9,000	$0	$0	$9,000	0.1002	$902
35	$0	$9,000	$0	$0	$9,000	0.0937	$843
36	$0	$9,000	$0	$0	$9,000	0.0875	$788
37	$0	$9,000	$12,000	$45,000	$66,000	0.0818	$5,399
38	$0	$9,000	$0	$0	$9,000	0.0765	$689
39	$0	$9,000	$0	$0	$9,000	0.0715	$644
40	$0	$9,000	$0	$0	$9,000	0.0668	$601
41	$0	$9,000	$0	$0	$9,000	0.0624	$562
42	$0	$9,000	$12,000	$45,000	$66,000	0.0583	$3,848
43	$0	$9,000	$0	$0	$9,000	0.0545	$491
44	$0	$9,000	$0	$0	$9,000	0.0509	$458
45	$0	$9,000	$0	$0	$9,000	0.0476	$428
46	$0	$9,000	$0	$0	$9,000	0.0445	$401
47	$0	$9,000	$12,000	$45,000	$66,000	0.0416	$2,746
48	$0	$9,000	$0	$0	$9,000	0.0389	$350
49	$0	$9,000	$0	$0	$9,000	0.0363	$327
50	$0	$9,000	$0	$0	$9,000	0.0339	$305
TOTALS:	$227,000	$450,000	$120,000	$450,000	$1,247,000		$518,770
TOTAL PRESENT VALUE OF ALTERNATIVE 2 [5]							$520,000

Notes:

[1] Estimated remedial timeframes are discussed within the FS report.

[2] Capital costs, for purposes of this analysis, are assumed to be distributed as indicated on Table CS-2.

[3] Total annual expenditure is the total cost per year with no discounting.

[4] Present value is the total cost per year including a 7.0% discount factor for that year. See Table PV-ADRFT for details.

[5] Total present value is rounded to the nearest $10,000. Inflation and depreciation are excluded from the present value cost.

Costs presented for this alternative are expected to have an accuracy between -30% to +50% of actual costs, based on the scope presented.
They are prepared solely to facilitate relative comparisons between alternatives for FS evaluation purposes.

TABLE CS-2

Alternative 2
Institutional Controls, Maintenance, and Monitoring

COST ESTIMATE SUMMARY

Site: Uravan Uranium Project (Union Carbide Corp.)
Location: Uravan, Colorado
Phase: Focused Feasibility Study
Base Year: 2017
Date: October 2017

Description: Although ICs, monitoring, and maintenance will be performed by the responsible party, federal, and/or state agencies under other regulatory programs as described in Section 6, Alternative 2 provides protection of human health and the environment through the implementation of additional ICs, monitoring, and maintenance at the Site. Under Alternative 2, proprietary controls, such as environmental covenants and restrictive notices, implemented under State law would be applied as necessary and may be supplemented with MMPs and monitoring to confirm compliance with the conditions set forth in the proprietary controls. For purposes of estimating costs, it is anticipated that proprietary controls, such as EC/RNs with MMPs and monitoring, would be implemented at the Site. Additionally, five-year reviews may be facilitated with a collaborative agreement between EPA and DOE inspections and other site related activities.

CAPITAL COSTS FOR INSTITUTIONAL CONTROLS: (Assumed to be Incurred During Year 0)

DESCRIPTION	WORKSHEET	QTY	UNIT(S)	UNIT COST	TOTAL	NOTES
Environmental Covenants and Restrictive Notices	CW2-2	3	EA	$24,655	$73,964	
Materials Management Plans	CW2-3	3	EA	$25,802	$77,407	
Development and Implementation of Collaborative Agreement	CW2-5	1	LS	$23,459	$23,459	
SUBTOTAL					$174,830	
Contingency (Scope and Bid)		20%			$34,966	10% Scope, 10% Bid (Low end of the recommended range in EPA 540-R-00-002).
TOTAL					$209,796	
Project Management		8%			$16,784	Percentage from Exhibit 5-8 in EPA 540-R-00-002 was used.
TOTAL					$226,580	
TOTAL CAPITAL COST					**$227,000**	Total capital cost is rounded to the nearest $1,000.

ANNUAL OPERATION AND MAINTENANCE COSTS (Years 1 through 50)

DESCRIPTION	WORKSHEET	QTY	UNIT(S)	UNIT COST	TOTAL	NOTES
Annual Site Inspection	CW2-6	1	YR	$6,183	$6,183	
SUBTOTAL					$6,183	
Contingency (Scope and Bid)		20%			$1,237	10% Scope, 10% Bid (Low end of the recommended range in EPA 540-R-00-002).
SUBTOTAL					$7,420	
Project Management		7%			$519	Middle value of the recommended range in EPA 540-R-00-002 was used.
Technical Support		15%			$1,113	Middle value of the recommended range in EPA 540-R-00-002 was used.
TOTAL					$9,052	
TOTAL ANNUAL O&M COST					**$9,000**	Total annual O&M cost is rounded to the nearest $1,000.

PERIODIC COSTS (Years 2, 7, 12, 17, 22, 27, 32, 37, 42, and 47)

DESCRIPTION	WORKSHEET	QTY	UNIT(S)	UNIT COST	TOTAL	NOTES
Updating Materials Management Plans	CW2-4	3	EA	$2,731	$8,194	Frequency is assumed to be the same as 5-year site reviews.
SUBTOTAL					$8,194	
Contingency (Scope and Bid)		20%			$1,639	10% Scope, 10% Bid (Low end of the recommended range in EPA 540-R-00-002).
SUBTOTAL					$9,833	
Project Management		7%			$688	Middle value of the recommended range in EPA 540-R-00-002 was used.
Technical Support		15%			$1,475	Middle value of the recommended range in EPA 540-R-00-002 was used.
TOTAL					$11,996	
TOTAL PERIODIC COST					**$12,000**	Total periodic cost is rounded to the nearest $1,000.

TABLE CS-2

Alternative **2**
Institutional Controls, Maintenance, and Monitoring

COST ESTIMATE SUMMARY

Site: Uravan Uranium Project (Union Carbide Corp.)
Location: Uravan, Colorado
Phase: Focused Feasibility Study
Base Year: 2017
Date: October 2017

Description: Although ICs, monitoring, and maintenance will be performed by the responsible party, federal, and/or state agencies under other regulatory programs as described in Section 6, Alternative 2 provides protection of human health and the environment through the implementation of additional ICs, monitoring, and maintenance at the Site. Under Alternative 2, proprietary controls, such as environmental covenants and restrictive notices, implemented under State law would be applied as necessary and may be supplemented with MMPs and monitoring to confirm compliance with the conditions set forth in the proprietary controls. For purposes of estimating costs, it is anticipated that proprietary controls, such as EC/RNs with MMPs and monitoring, would be implemented at the Site. Additionally, five-year reviews may be facilitated with a collaborative agreement between EPA and DOE inspections and other site related activities.

5-YEAR SITE REVIEW PERIODIC COSTS (Years 2, 7, 12, 17, 22, 27, 32, 37, 42, and 47)

DESCRIPTION	WORKSHEET	QTY	UNIT(S)	UNIT COST	TOTAL	NOTES
5-Year Site Review	CW2-1	1	LS	$30,676	$30,676	Last 5-year site review was conducted in 2015, so next is scheduled for 2019 which is Year 2 in the cost estimate (Base Year- Year 0 is 2017).
SUBTOTAL					$30,676	
Contingency (Scope and Bid)		20%			$6,135	10% Scope, 10% Bid (Low end of the recommended range in EPA 540-R-00-002).
SUBTOTAL					$36,811	
Project Management		7%			$2,577	Middle value of the recommended range in EPA 540-R-00-002 was used.
Technical Support		15%			$5,522	Middle value of the recommended range in EPA 540-R-00-002 was used.
TOTAL					$44,910	
TOTAL PERIODIC COST					**$45,000**	Total periodic cost is rounded to the nearest $1,000.

Notes:

Percentages used for contingency and professional/technical services costs are based on guidance from Section 5.0 of "A Guide to Developing and Documenting Cost Estimates During the Feasibility Study", EPA 2000.
Costs presented for this alternative are expected to have an accuracy between -30% to +50% of actual costs, based on the scope presented. They are prepared solely to facilitate relative comparisons between alternatives for FS evaluation purposes.

Abbreviations:

EA Each
LS Lump Sum
QTY Quantity
YR Year

Cost Worksheets

Alternative 1
No Further Action

TABLE CW1-1

Alternative 1 **Cost Worksheet:** **CW1-1**
Periodic Cost Sub-Element
5-Year Site Review

COST WORKSHEET

Site: Uravan Uranium Project (Union Carbide Corp.)
Location: Uravan, Colorado
Phase: Focused Feasibility Study
Base Year: 2017

Prepared By: EW **Date:** 9/8/2017
Checked By: JN **Date:** 9/13/2017

Work Statement:
This sub-element involves the 5-year site review report. The following includes labor, material and shipping costs for 5-year site review reports.

Cost Analysis:
Cost for 5-Year Site Reviews (Lump Sum)

COST DATABASE CODE	DESCRIPTION	QTY	UNIT(S)	HPF	LABOR	ADJ LABOR	EQUIP	ADJ EQUIP	MATL	OTHER	UNMOD UC	UNMOD LIC	PC OH	PC PF	BUR LIC	COST SOURCE CITATION	COMMENTS
	Site Visit																
L2	Environmental Engineer	16	HR	1.00	$45.65	$45.65	$0.00	$0.00	$0.00	$0.00	$45.65	$730.40	100%	9%	$1,592	FLC FLC Datacenter	
M1	Pickup Truck Rental	2	DY	1.00	$0.00	$0.00	$0.00	$0.00	$0.00	$85.00	$85.00	$170.00	8%	9%	$200	V Vendor Quote	
M2	Per Diem	2	DY	1.00	$0.00	$0.00	$0.00	$0.00	$0.00	$94.00	$94.00	$188.00	0%	0%	$188	GSA www.gsa.gov	
	Report Generation																
L8	Project Manager	30	HR	1.00	$78.74	$78.74	$0.00	$0.00	$0.00	$0.00	$78.74	$2,362.20	100%	9%	$5,150	FLC FLC Datacenter	
L2	Environmental Engineer	80	HR	1.00	$45.65	$45.65	$0.00	$0.00	$0.00	$0.00	$45.65	$3,652.00	100%	9%	$7,961	FLC FLC Datacenter	
L4	Environmental Scientist	120	HR	1.00	$39.07	$39.07	$0.00	$0.00	$0.00	$0.00	$39.07	$4,688.40	100%	9%	$10,221	FLC FLC Datacenter	
L6	Drafter	20	HR	1.00	$27.79	$27.79	$0.00	$0.00	$0.00	$0.00	$27.79	$555.80	100%	9%	$1,212	FLC FLC Datacenter	
L9	Quality Control Engineer	10	HR	1.00	$53.48	$53.48	$0.00	$0.00	$0.00	$0.00	$53.48	$534.80	100%	9%	$1,166	FLC FLC Datacenter	
L1	Clerks, Typist, Bookkeeper & Receptionist	20	HR	1.00	$22.62	$22.62	$0.00	$0.00	$0.00	$0.00	$22.62	$452.40	100%	9%	$986	FLC FLC Datacenter	
M3A	Copy and Shipping Allowance - 5 Yr Review Report	1	LS	1.00	$0.00	$0.00	$0.00	$0.00	$0.00	$2,000.00	$2,000.00	$2,000.00	0%	0%	$2,000	A Allowance	
												TOTAL COST:			$30,676		

Notes:
HTRW productivity factor is from Exhibit B-3 or B-4 of "A Guide to Developing and Documenting Cost Estimates During the Feasibility Study", EPA 2000
The Cost Database Code is a reference code for linking with line item cost information with the cost source database and is not otherwise used within these cost worksheets.

Source of Cost Data:
NA Not Applicable - costs are from previous work or vendor quote
For citation references, the following sources apply:
MII (MII Assemblies), GSA (www.gsa.gov), FLC (FLC Datacenter), A (Allowance), V (Vendor Quote), CW (Means CostWorks 2017), P (Previous Work), CB (MII English Cost Book), and FRTR (www.frtr.gov)

Cost Adjustment Checklist:

FACTOR:	**NOTES:**
H&S Productivity (labor and equipment only)	MII assembly costs include HPF adjustments.
Escalation to Base Year	2017 cost sources are not escalated (EF=1.00). All other costs are escalated based on the USACE CWCCIS, EM 1110-2-1304, Sep 2016
Area Cost Factor	An AF of 0.96 is used for Colorado, except that an AF of 1.00 (national unmodified average) is used for MII assembly costs and local vendor quotes.
Subcontractor Overhead and Profit	It is assumed that Subcontractor O&P is either included in the PC O&P or has been factored into vendor quotes or previous work.
Prime Contractor Overhead and Profit	It is assumed that home office OH is 8% and profit is 9% for the Prime Contractor. Professional labor overhead is 100%. Allowances and items with mandated costs such as per diem do not have overhead and profit applied.

Abbreviations:

QTY	Quantity	ACR	Acres
EQUIP	Equipment	BCY	Bank Cubic Yard
MATL	Material	CLF	100 Linear Foot
HPF	HTRW Productivity Factor	DY	Days
ADJ LABOR	Adjusted Labor for HFP	EA	Each
ADJ EQUIP	Adjusted Equipment for HFP	LF	Linear Foot
UNMOD UC	Unmodified Unit Cost	HR	Hours
UNMOD LIC	Unmodified Line Item Cost	LB	Pounds
UNBUR LIC	Unburdened Line Item Cost	LCY	Loose Cubic Yard
PC OH	Prime Contractor Overhead	LS	Lump Sum
PC PF	Prime Contractor Profit	RL	Roll
BUR LIC	Burdened Line Item Cost	SY	Square Yard
		TN	Tons

TABLE CW1-2

Alternative 1 **Cost Worksheet:** **CW1-2**
Capital Cost Sub-Element
Development and Implementation of Collaborative Agreement

COST WORKSHEET

Site: Uravan Uranium Project (Union Carbide Corp.)
Location: Uravan, Colorado
Phase: Focused Feasibility Study
Base Year: 2017

Prepared By: JN **Date:** 10/8/2017
Checked By: EW **Date:** 10/9/2017

Work Statement:
This sub-element involves the development of collaborative agreement for the Uravan Superfund Site between DOE and EPA. The following cost includes labor, material and shipping required to develop and implement the collaborative agreement.

Cost Analysis:
Cost for Development and Implementation of Collaborative Agreement (Lump Sum)

COST DATABASE CODE	DESCRIPTION	QTY	UNIT(S)	HPF	LABOR	ADJ LABOR	EQUIP	ADJ EQUIP	MATL	OTHER	UNMOD UC	UNMOD LIC	PC OH	PC PF	BUR LIC	COST SOURCE CITATION	COMMENTS
L3	Environmental Lawyer	60	HR	1.00	$68.60	$68.60	$0.00	$0.00	$0.00	$0.00	$68.60	$4,116.00	100%	9%	$8,973	FLC FLC Datacenter	
L10	Paralegal	120	HR	1.00	$30.97	$30.97	$0.00	$0.00	$0.00	$0.00	$30.97	$3,716.40	100%	9%	$8,102	FLC FLC Datacenter	
L2	Environmental Engineer	20	HR	1.00	$45.65	$45.65	$0.00	$0.00	$0.00	$0.00	$45.65	$913.00	100%	9%	$1,990	FLC FLC Datacenter	
L1	Clerks, Typist, Bookkeeper & Receptionist	8	HR	1.00	$22.62	$22.62	$0.00	$0.00	$0.00	$0.00	$22.62	$180.96	100%	9%	$394	FLC FLC Datacenter	
M3D	Copy and Shipping Allowance - Collab. Agreement	1	LS	1.00	$0.00	$0.00	$0.00	$0.00	$0.00	$2,000.00	$2,000.00	$2,000.00	0%	0%	$2,000	A Allowance	
M7D	Filing and Recording Fees Allowance - Collab. Agreement	1	LS	1.00	$0.00	$0.00	$0.00	$0.00	$0.00	$2,000.00	$2,000.00	$2,000.00	0%	0%	$2,000	A Allowance	
												TOTAL COST:			$23,459		

	Representative Unit Quantity	Unit(s)	Unit Cost	Total Cost
COST WORKSHEET SUMMARY	1	LS	$23,459	$23,459

Notes:
HTRW productivity factor is from Exhibit B-3 or B-4 of "A Guide to Developing and Documenting Cost Estimates During the Feasibility Study", EPA 2000
The Cost Database Code is a reference code for linking with line item cost information with the cost source database and is not otherwise used within these cost worksheets.

Source of Cost Data:
NA Not Applicable - costs are from previous work or vendor quote
For citation references, the following sources apply:
MII (MII Assemblies), GSA (www.gsa.gov), FLC (FLC Datacenter), A (Allowance), V (Vendor Quote), CW (Means CostWorks 2017), P (Previous Work), CB (MII English Cost Book), and FRTR (www.frtr.gov)

Cost Adjustment Checklist: **NOTES:**

FACTOR:	Field work will be in Level "D" PPE.
H&S Productivity (labor and equipment only)	MII assembly costs include HPF adjustments.
Escalation to Base Year	2017 cost sources are not escalated (EF=1.00). All other costs are escalated based on the USACE CWCCIS, EM 1110-2-1304, Sep 2016
Area Cost Factor	An AF of 0.96 is used for Colorado, except that an AF of 1.00 (national unmodified average) is used for MII assembly costs and local vendor quotes.
Subcontractor Overhead and Profit	It is assumed that Subcontractor O&P is either included in the PC O&P or has been factored into vendor quotes or previous work.
Prime Contractor Overhead and Profit	It is assumed that home office OH is 8% and profit is 9% for the Prime Contractor. Professional labor overhead is 100%. Allowances and items with mandated costs such as per diem do not have overhead and profit applied.

Abbreviations:

QTY	Quantity	ACR	Acres
EQUIP	Equipment	BCY	Bank Cubic Yard
MATL	Material	CLF	100 Linear Foot
HPF	HTRW Productivity Factor	DY	Days
ADJ LABOR	Adjusted Labor for HFP	EA	Each
ADJ EQUIP	Adjusted Equipment for HFP	LF	Linear Foot
UNMOD UC	Unmodified Unit Cost	HR	Hours
UNMOD LIC	Unmodified Line Item Cost	LB	Pounds
UNBUR LIC	Unburdened Line Item Cost	LCY	Loose Cubic Yard
PC OH	Prime Contractor Overhead	LS	Lump Sum
PC PF	Prime Contractor Profit	RL	Roll
BUR LIC	Burdened Line Item Cost	SY	Square Yard
		TN	Tons

TABLE CW1-3

Alternative 1 **Cost Worksheet:** **CW1-3**
Annual O&M Cost Sub-Element
Annual Site Inspection

COST WORKSHEET

Site: Uravan Uranium Project (Union Carbide Corp.)
Location: Uravan, Colorado
Phase: Focused Feasibility Study
Base Year: 2017

Prepared By: JN **Date:** 10/8/2017
Checked By: EW **Date:** 10/9/2017

Work Statement:
This sub-element involves annual inspection of the Uravan Superfund Site. The following cost includes the labor, equipment, and per diem required for an annual site inspection.

Cost Analysis:
Cost for Annual Site Inspection (Lump Sum)

COST DATABASE CODE	DESCRIPTION	QTY	UNIT(S)	HPF	LABOR	ADJ LABOR	EQUIP	ADJ EQUIP	MATL	OTHER	UNMOD UC	UNMOD LIC	PC OH	PC PF	BUR LIC	COST SOURCE CITATION	COMMENTS
L8	Project Manager	16	HR	1.00	$78.74	$78.74	$0.00	$0.00	$0.00	$0.00	$78.74	$1,259.84	100%	9%	$2,746	FLC FLC Datacenter	
L2	Environmental Engineer	16	HR	1.00	$45.65	$45.65	$0.00	$0.00	$0.00	$0.00	$45.65	$730.40	100%	9%	$1,592	FLC FLC Datacenter	
L4	Environmental Scientist	16	HR	1.00	$39.07	$39.07	$0.00	$0.00	$0.00	$0.00	$39.07	$625.12	100%	9%	$1,363	FLC FLC Datacenter	
M2	Per Diem	3	DY	1.00	$0.00	$0.00	$0.00	$0.00	$0.00	$94.00	$94.00	$282.00	0%	0%	$282	GSA www.gsa.gov	
M1	Pickup Truck Rental	2	DY	1.00	$0.00	$0.00	$0.00	$0.00	$0.00	$85.00	$85.00	$170.00	8%	9%	$200	V Vendor Quote	Enterprise Car Rental, 2017
												TOTAL COST:			$6,183		

	Representative Unit Quantity	Unit(s)	Unit Cost	Total Cost
COST WORKSHEET SUMMARY	1	YR	$6,183	$6,183

Notes:
HTRW productivity factor is from Exhibit B-3 or B-4 of "A Guide to Developing and Documenting Cost Estimates During the Feasibility Study", EPA 2000
The Cost Database Code is a reference code for linking with line item cost information with the cost source database and is not otherwise used within these cost worksheets.

Source of Cost Data:
NA Not Applicable - costs are from previous work or vendor quote
For citation references, the following sources apply:
MII (MII Assemblies), GSA (www.gsa.gov), FLC (FLC Datacenter), A (Allowance), V (Vendor Quote), CW (Means CostWorks 2017), P (Previous Work), CB (MII English Cost Book), and FRTR (www.frtr.gov)

Cost Adjustment Checklist:

	NOTES:
FACTOR:	Field work will be in Level "D" PPE.
H&S Productivity (labor and equipment only)	MII assembly costs include HPF adjustments.
Escalation to Base Year	2017 cost sources are not escalated (EF=1.00). All other costs are escalated based on the USACE CWCCIS, EM 1110-2-1304, Sep 2016
Area Cost Factor	An AF of 0.96 is used for Colorado, except that an AF of 1.00 (national unmodified average) is used for MII assembly costs and local vendor quotes.
Subcontractor Overhead and Profit	It is assumed that Subcontractor O&P is either included in the PC O&P or has been factored into vendor quotes or previous work.
Prime Contractor Overhead and Profit	It is assumed that home office OH is 8% and profit is 9% for the Prime Contractor. Professional labor overhead is 100%. Allowances and items with mandated costs such as per diem do not have overhead and profit applied.

Abbreviations:

QTY	Quantity	ACR	Acres
EQUIP	Equipment	BCY	Bank Cubic Yard
MATL	Material	CLF	100 Linear Foot
HPF	HTRW Productivity Factor	DY	Days
ADJ LABOR	Adjusted Labor for HFP	EA	Each
ADJ EQUIP	Adjusted Equipment for HFP	LF	Linear Foot
UNMOD UC	Unmodified Unit Cost	HR	Hours
UNMOD LIC	Unmodified Line Item Cost	LB	Pounds
UNBUR LIC	Unburdened Line Item Cost	LCY	Loose Cubic Yard
PC OH	Prime Contractor Overhead	LS	Lump Sum
PC PF	Prime Contractor Profit	RL	Roll
BUR LIC	Burdened Line Item Cost	SY	Square Yard
		TN	Tons

Cost Worksheets

Alternative 2
Institutional Controls, Maintenance, and Monitoring

TABLE CW2-1

Alternative 2 **Cost Worksheet:** **CW2-1**
Periodic Cost Sub-Element
5-Year Site Review

COST WORKSHEET

Site: Uravan Uranium Project (Union Carbide Corp.)
Location: Uravan, Colorado
Phase: Focused Feasibility Study
Base Year: 2017

Prepared By: EW **Date:** 9/8/2017
Checked By: JN **Date:** 9/13/2017

Work Statement:
This sub-element involves the 5-year site review report. The following includes labor, material and shipping costs for 5-year site review reports.

Cost Analysis:
Cost for 5-Year Site Reviews (Lump Sum)

COST DATABASE CODE	DESCRIPTION	QTY	UNIT(S)	HPF	LABOR	ADJ LABOR	EQUIP	ADJ EQUIP	MATL	OTHER	UNMOD UC	UNMOD LIC	PC OH	PC PF	BUR LIC	COST SOURCE CITATION	COMMENTS
	Site Visit																
L2	Environmental Engineer	16	HR	1.00	$45.65	$45.65	$0.00	$0.00	$0.00	$0.00	$45.65	$730.40	100%	9%	$1,592	FLC FLC Datacenter	
M1	Pickup Truck Rental	2	DY	1.00	$0.00	$0.00	$0.00	$0.00	$0.00	$85.00	$85.00	$170.00	8%	9%	$200	V Vendor Quote	
M2	Per Diem	2	DY	1.00	$0.00	$0.00	$0.00	$0.00	$0.00	$94.00	$94.00	$188.00	0%	0%	$188	GSA www.gsa.gov	
	Report Generation																
L8	Project Manager	30	HR	1.00	$78.74	$78.74	$0.00	$0.00	$0.00	$0.00	$78.74	$2,362.20	100%	9%	$5,150	FLC FLC Datacenter	
L2	Environmental Engineer	80	HR	1.00	$45.65	$45.65	$0.00	$0.00	$0.00	$0.00	$45.65	$3,652.00	100%	9%	$7,961	FLC FLC Datacenter	
L4	Environmental Scientist	120	HR	1.00	$39.07	$39.07	$0.00	$0.00	$0.00	$0.00	$39.07	$4,688.40	100%	9%	$10,221	FLC FLC Datacenter	
L6	Drafter	20	HR	1.00	$27.79	$27.79	$0.00	$0.00	$0.00	$0.00	$27.79	$555.80	100%	9%	$1,212	FLC FLC Datacenter	
L9	Quality Control Engineer	10	HR	1.00	$53.48	$53.48	$0.00	$0.00	$0.00	$0.00	$53.48	$534.80	100%	9%	$1,166	FLC FLC Datacenter	
L1	Clerks, Typist, Bookkeeper & Receptionist	20	HR	1.00	$22.62	$22.62	$0.00	$0.00	$0.00	$0.00	$22.62	$452.40	100%	9%	$986	FLC FLC Datacenter	
M3A	Copy and Shipping Allowance - 5 Yr Review Report	1	LS	1.00	$0.00	$0.00	$0.00	$0.00	$0.00	$2,000.00	$2,000.00	$2,000.00	0%	0%	$2,000	A Allowance	
												TOTAL COST:			$30,676		

Notes:
HTRW productivity factor is from Exhibit B-3 or B-4 of "A Guide to Developing and Documenting Cost Estimates During the Feasibility Study", EPA 2000
The Cost Database Code is a reference code for linking with line item cost information with the cost source database and is not otherwise used within these cost worksheets.

Source of Cost Data:
NA Not Applicable - costs are from previous work or vendor quote
For citation references, the following sources apply:
MII (MII Assemblies), GSA (www.gsa.gov), FLC (FLC Datacenter), A (Allowance), V (Vendor Quote), CW (Means CostWorks 2017), P (Previous Work), CB (MII English Cost Book), and FRTR (www.frtr.gov)

Cost Adjustment Checklist:

FACTOR:	**NOTES:**
H&S Productivity (labor and equipment only)	MII assembly costs include HPF adjustments.
Escalation to Base Year	2017 cost sources are not escalated (EF=1.00). All other costs are escalated based on the USACE CWCCIS, EM 1110-2-1304, Sep 2016
Area Cost Factor	An AF of 0.96 is used for Colorado, except that an AF of 1.00 (national unmodified average) is used for MII assembly costs and local vendor quotes.
Subcontractor Overhead and Profit	It is assumed that Subcontractor O&P is either included in the PC O&P or has been factored into vendor quotes or previous work.
Prime Contractor Overhead and Profit	It is assumed that home office OH is 8% and profit is 9% for the Prime Contractor. Professional labor overhead is 100%. Allowances and items with mandated costs such as per diem do not have overhead and profit applied.

Abbreviations:

QTY	Quantity	ACR	Acres
EQUIP	Equipment	BCY	Bank Cubic Yard
MATL	Material	CLF	100 Linear Foot
HPF	HTRW Productivity Factor	DY	Days
ADJ LABOR	Adjusted Labor for HFP	EA	Each
ADJ EQUIP	Adjusted Equipment for HFP	LF	Linear Foot
UNMOD UC	Unmodified Unit Cost	HR	Hours
UNMOD LIC	Unmodified Line Item Cost	LB	Pounds
UNBUR LIC	Unburdened Line Item Cost	LCY	Loose Cubic Yard
PC OH	Prime Contractor Overhead	LS	Lump Sum
PC PF	Prime Contractor Profit	RL	Roll
BUR LIC	Burdened Line Item Cost	SY	Square Yard
		TN	Tons

TABLE CW2-2

Alternative 2 **Cost Worksheet:** **CW2-2**
Capital Cost Sub-Element
Environmental Covenants and Restrictive Notices

COST WORKSHEET

Site: Uravan Uranium Project (Union Carbide Corp.)
Location: Uravan, Colorado
Phase: Focused Feasibility Study
Base Year: 2017

Prepared By: EW **Date:** 9/8/2017
Checked By: JN **Date:** 9/13/2017

Work Statement:
This sub-element involves implementation of proprietary controls for the Uravan Superfund Site. The following cost includes environmental covenants and restrictive notices. The cost for the state registry of contaminated sites was assumed to be included in this sub-element.

Cost Analysis:
Cost for Environmental Covenants and Restrictive Notices (Each)

COST DATABASE CODE	DESCRIPTION	QTY	UNIT(S)	HPF	LABOR	ADJ LABOR	EQUIP	ADJ EQUIP	MATL	OTHER	UNMOD UC	UNMOD LIC	PC OH	PC PF	BUR LIC	COST SOURCE CITATION	COMMENTS
L2	Environmental Engineer	120	HR	1.00	$45.65	$45.65	$0.00	$0.00	$0.00	$0.00	$45.65	$5,478.00	100%	9%	$11,942	FLC FLC Datacenter	
L3	Environmental Lawyer	84	HR	1.00	$68.60	$68.60	$0.00	$0.00	$0.00	$0.00	$68.60	$5,762.40	100%	9%	$12,562	FLC FLC Datacenter	
L10	Paralegal	312	HR	1.00	$30.97	$30.97	$0.00	$0.00	$0.00	$0.00	$30.97	$9,662.64	100%	9%	$21,065	FLC FLC Datacenter	
L6	Drafter	24	HR	1.00	$27.79	$27.79	$0.00	$0.00	$0.00	$0.00	$27.79	$666.96	100%	9%	$1,454	FLC FLC Datacenter	
L1	Clerks, Typist, Bookkeeper & Receptionist	54	HR	1.00	$22.62	$22.62	$0.00	$0.00	$0.00	$0.00	$22.62	$1,221.48	100%	9%	$2,663	FLC FLC Datacenter	
M15	Boundary Survey	15	ACR	1.00	$1,125.00	$1,125.00	$39.50	$39.50	$74.50	$0.00	$1,239.00	$18,585.00	8%	9%	$21,878	CW CostWorks	Labor, equipment, and material costs determined from CostWorks 2017, 02 21 1313 0400.
M16	Title Search Allowance	6	EA	1.00	$0.00	$0.00	$0.00	$0.00	$200.00	$0.00	$200.00	$1,200.00	0%	0%	$1,200	A Allowance	
M3B	Copy and Shipping Allowance	3	EA	1.00	$0.00	$0.00	$0.00	$0.00	$0.00	$200.00	$200.00	$600.00	0%	0%	$600	A Allowance	
M7B	Filing and Recording Fees Allowance	3	EA	1.00	$0.00	$0.00	$0.00	$0.00	$0.00	$200.00	$200.00	$600.00	0%	0%	$600	A Allowance	
												TOTAL COST:			$73,964		

	Representative Unit Quantity	Unit(s)	Unit Cost	Total Cost
COST WORKSHEET SUMMARY	3	EA	$24,655	$73,964

Notes:
HTRW productivity factor is from Exhibit B-3 or B-4 of "A Guide to Developing and Documenting Cost Estimates During the Feasibility Study", EPA 2000
The Cost Database Code is a reference code for linking with line item cost information with the cost source database and is not otherwise used within these cost worksheets.

Source of Cost Data:
NA Not Applicable - costs are from previous work or vendor quote
For citation references, the following sources apply:
MII (MII Assemblies), GSA (www.gsa.gov), FLC (FLC Datacenter), A (Allowance), V (Vendor Quote), CW (Means CostWorks 2017), P (Previous Work), CB (MII English Cost Book), and FRTR (www.frtr.gov)

Cost Adjustment Checklist:

	NOTES:
FACTOR:	Field work will be in Level "D" PPE.
H&S Productivity (labor and equipment only)	MII assembly costs include HPF adjustments.
Escalation to Base Year	2017 cost sources are not escalated (EF=1.00). All other costs are escalated based on the USACE CWCCIS, EM 1110-2-1304, Sep 2016
Area Cost Factor	An AF of 0.96 is used for Colorado, except that an AF of 1.00 (national unmodified average) is used for MII assembly costs and local vendor quotes.
Subcontractor Overhead and Profit	It is assumed that Subcontractor O&P is either included in the PC O&P or has been factored into vendor quotes or previous work.
Prime Contractor Overhead and Profit	It is assumed that home office OH is 8% and profit is 9% for the Prime Contractor. Professional labor overhead is 100%. Allowances and items with mandated costs such as per diem do not have overhead and profit applied.

Abbreviations:

QTY	Quantity	ACR	Acres
EQUIP	Equipment	BCY	Bank Cubic Yard
MATL	Material	CLF	100 Linear Foot
HPF	HTRW Productivity Factor	DY	Days
ADJ LABOR	Adjusted Labor for HFP	EA	Each
ADJ EQUIP	Adjusted Equipment for HFP	LF	Linear Foot
UNMOD UC	Unmodified Unit Cost	HR	Hours
UNMOD LIC	Unmodified Line Item Cost	LB	Pounds
UNBUR LIC	Unburdened Line Item Cost	LCY	Loose Cubic Yard
PC OH	Prime Contractor Overhead	LS	Lump Sum
PC PF	Prime Contractor Profit	RL	Roll
BUR LIC	Burdened Line Item Cost	SY	Square Yard
		TN	Tons

TABLE CW2-3

Alternative 2 **Cost Worksheet: CW2-3**
Capital Cost Sub-Element
Materials Management Plans

COST WORKSHEET

Site: Uravan Uranium Project (Union Carbide Corp.)
Location: Uravan, Colorado
Phase: Focused Feasibility Study
Base Year: 2017

Prepared By: EW **Date:** 9/8/2017
Checked By: JN **Date:** 9/13/2017

Work Statement:
This sub-element involves the Materials Management Plans which apply to portions of the Uravan Superfund Site not covered under other legal and regulatory requirements and where a UU/UE scenario is not achieved. The following cost assumes a Materials Management Plan will be created for each environmental covenants and restrictive notices. Three locations are assumed to require environmental covenants and restrictive notices.

Cost Analysis:
Cost for Creating the Materials Management Plan (Each)

COST DATABASE CODE	DESCRIPTION	QTY	UNIT(S)	HPF	LABOR	ADJ LABOR	EQUIP	ADJ EQUIP	MATL	OTHER	UNMOD UC	UNMOD LIC	PC OH	PC PF	BUR LIC	COST SOURCE CITATION	COMMENTS
L3	Environmental Lawyer	480	HR	1.00	$68.60	$68.60	$0.00	$0.00	$0.00	$0.00	$68.60	$32,928.00	100%	9%	$71,783	FLC FLC Datacenter	
L10	Paralegal	48	HR	1.00	$30.97	$30.97	$0.00	$0.00	$0.00	$0.00	$30.97	$1,486.56	100%	9%	$3,241	FLC FLC Datacenter	
L1	Clerks, Typist, Bookkeeper & Receptionist	24	HR	1.00	$22.62	$22.62	$0.00	$0.00	$0.00	$0.00	$22.62	$542.88	100%	9%	$1,183	FLC FLC Datacenter	
M3B	Copy and Shipping Allowance	3	EA	1.00	$0.00	$0.00	$0.00	$0.00	$0.00	$200.00	$200.00	$600.00	0%	0%	$600	A Allowance	
M7B	Filing and Recording Fees Allowance	3	EA	1.00	$0.00	$0.00	$0.00	$0.00	$0.00	$200.00	$200.00	$600.00	0%	0%	$600	A Allowance	
												TOTAL COST:			$77,407		

	Representative Unit Quantity	Unit(s)	Unit Cost	Total Cost
COST WORKSHEET SUMMARY	3	EA	$25,802	$77,407

Notes:
HTRW productivity factor is from Exhibit B-3 or B-4 of "A Guide to Developing and Documenting Cost Estimates During the Feasibility Study", EPA 2000
The Cost Database Code is a reference code for linking with line item cost information with the cost source database and is not otherwise used within these cost worksheets.

Source of Cost Data:
NA Not Applicable - costs are from previous work or vendor quote
For citation references, the following sources apply:
MII (MII Assemblies), GSA (www.gsa.gov), FLC (FLC Datacenter), A (Allowance), V (Vendor Quote), CW (Means CostWorks 2017), P (Previous Work), CB (MII English Cost Book), and FRTR (www.frtr.gov)

Cost Adjustment Checklist: **NOTES:**

FACTOR:	Field work will be in Level "D" PPE.
H&S Productivity (labor and equipment only)	MII assembly costs include HPF adjustments.
Escalation to Base Year	2017 cost sources are not escalated (EF=1.00). All other costs are escalated based on the USACE CWCCIS, EM 1110-2-1304, Sep 2016
Area Cost Factor	An AF of 0.96 is used for Colorado, except that an AF of 1.00 (national unmodified average) is used for MII assembly costs and local vendor quotes.
Subcontractor Overhead and Profit	It is assumed that Subcontractor O&P is either included in the PC O&P or has been factored into vendor quotes or previous work.
Prime Contractor Overhead and Profit	It is assumed that home office OH is 8% and profit is 9% for the Prime Contractor. Professional labor overhead is 100%. Allowances and items with mandated costs such as per diem do not have overhead and profit applied.

Abbreviations:

QTY	Quantity	ACR	Acres
EQUIP	Equipment	BCY	Bank Cubic Yard
MATL	Material	CLF	100 Linear Foot
HPF	HTRW Productivity Factor	DY	Days
ADJ LABOR	Adjusted Labor for HFP	EA	Each
ADJ EQUIP	Adjusted Equipment for HFP	LF	Linear Foot
UNMOD UC	Unmodified Unit Cost	HR	Hours
UNMOD LIC	Unmodified Line Item Cost	LB	Pounds
UNBUR LIC	Unburdened Line Item Cost	LCY	Loose Cubic Yard
PC OH	Prime Contractor Overhead	LS	Lump Sum
PC PF	Prime Contractor Profit	RL	Roll
BUR LIC	Burdened Line Item Cost	SY	Square Yard
		TN	Tons

TABLE CW2-4

Alternative 2 **Cost Worksheet:** **CW2-4**
Periodic Cost Sub-Element
Updating Materials Management Plans

COST WORKSHEET

Site: Uravan Uranium Project (Union Carbide Corp.)
Location: Uravan, Colorado
Phase: Focused Feasibility Study
Base Year: 2017

Prepared By: EW **Date:** 9/8/2017
Checked By: JN **Date:** 9/13/2017

Work Statement:
This sub-element involves the Materials Management Plans which apply to portions of the Uravan Superfund Site. The following cost includes the labor hours required to update three Materials Management Plans.

Cost Analysis:
Cost for Updating the Materials Management Plans (Each)

COST DATABASE CODE	DESCRIPTION	QTY	UNIT(S)	HPF	LABOR	ADJ LABOR	EQUIP	ADJ EQUIP	MATL	OTHER	UNMOD UC	UNMOD LIC	PC OH	PC PF	BUR LIC	COST SOURCE CITATION	COMMENTS
L2	Environmental Engineer	60	HR	1.00	$45.65	$45.65	$0.00	$0.00	$0.00	$0.00	$45.65	$2,739.00	100%	9%	$5,971	FLC FLC Datacenter	
L6	Drafter	12	HR	1.00	$27.79	$27.79	$0.00	$0.00	$0.00	$0.00	$27.79	$333.48	100%	9%	$727	FLC FLC Datacenter	
L1	Clerks, Typist, Bookkeeper & Receptionist	6	HR	1.00	$22.62	$22.62	$0.00	$0.00	$0.00	$0.00	$22.62	$135.72	100%	9%	$296	FLC FLC Datacenter	
M3B	Copy and Shipping Allowance	3	EA	1.00	$0.00	$0.00	$0.00	$0.00	$0.00	$200.00	$200.00	$600.00	0%	0%	$600	A Allowance	
M7B	Filing and Recording Fees Allowance	3	EA	1.00	$0.00	$0.00	$0.00	$0.00	$0.00	$200.00	$200.00	$600.00	0%	0%	$600	A Allowance	
												TOTAL COST:			$8,194		

	Representative Unit Quantity	Unit(s)	Unit Cost	Total Cost
COST WORKSHEET SUMMARY	3	EA	$2,731	$8,194

Notes:
HTRW productivity factor is from Exhibit B-3 or B-4 of "A Guide to Developing and Documenting Cost Estimates During the Feasibility Study", EPA 2000
The Cost Database Code is a reference code for linking with line item cost information with the cost source database and is not otherwise used within these cost worksheets.

Source of Cost Data:
NA Not Applicable - costs are from previous work or vendor quote
For citation references, the following sources apply:
MII (MII Assemblies), GSA (www.gsa.gov), FLC (FLC Datacenter), A (Allowance), V (Vendor Quote), CW (Means CostWorks 2017), P (Previous Work), CB (MII English Cost Book), and FRTR (www.frtr.gov)

Cost Adjustment Checklist:

	NOTES:
FACTOR:	Field work will be in Level "D" PPE.
H&S Productivity (labor and equipment only)	MII assembly costs include HPF adjustments.
Escalation to Base Year	2017 cost sources are not escalated (EF=1.00). All other costs are escalated based on the USACE CWCCIS, EM 1110-2-1304, Sep 2016
Area Cost Factor	An AF of 0.96 is used for Colorado, except that an AF of 1.00 (national unmodified average) is used for MII assembly costs and local vendor quotes.
Subcontractor Overhead and Profit	It is assumed that Subcontractor O&P is either included in the PC O&P or has been factored into vendor quotes or previous work.
Prime Contractor Overhead and Profit	It is assumed that home office OH is 8% and profit is 9% for the Prime Contractor. Professional labor overhead is 100%. Allowances and items with mandated costs such as per diem do not have overhead and profit applied.

Abbreviations:

QTY	Quantity	ACR	Acres
EQUIP	Equipment	BCY	Bank Cubic Yard
MATL	Material	CLF	100 Linear Foot
HPF	HTRW Productivity Factor	DY	Days
ADJ LABOR	Adjusted Labor for HFP	EA	Each
ADJ EQUIP	Adjusted Equipment for HFP	LF	Linear Foot
UNMOD UC	Unmodified Unit Cost	HR	Hours
UNMOD LIC	Unmodified Line Item Cost	LB	Pounds
UNBUR LIC	Unburdened Line Item Cost	LCY	Loose Cubic Yard
PC OH	Prime Contractor Overhead	LS	Lump Sum
PC PF	Prime Contractor Profit	RL	Roll
BUR LIC	Burdened Line Item Cost	SY	Square Yard
		TN	Tons

TABLE CW2-5

Alternative 2 **Cost Worksheet:** **CW2-5**
Capital Cost Sub-Element
Development and Implementation of Collaborative Agreement

COST WORKSHEET

Site: Uravan Uranium Project (Union Carbide Corp.)
Location: Uravan, Colorado
Phase: Focused Feasibility Study
Base Year: 2017

Prepared By: JN **Date:** 10/8/2017
Checked By: EW **Date:** 10/9/2017

Work Statement:
This sub-element involves the development of collaborative agreement for the Uravan Superfund Site between DOE and EPA. The following cost includes labor, material and shipping required to develop and implement the collaborative agreement.

Cost Analysis:
Cost for Development and Implementation of Collaborative Agreement (Lump Sum)

COST DATABASE CODE	DESCRIPTION	QTY	UNIT(S)	HPF	LABOR	ADJ LABOR	EQUIP	ADJ EQUIP	MATL	OTHER	UNMOD UC	UNMOD LIC	PC OH	PC PF	BUR LIC	COST SOURCE CITATION	COMMENTS
L3	Environmental Lawyer	60	HR	1.00	$68.60	$68.60	$0.00	$0.00	$0.00	$0.00	$68.60	$4,116.00	100%	9%	$8,973	FLC FLC Datacenter	
L10	Paralegal	120	HR	1.00	$30.97	$30.97	$0.00	$0.00	$0.00	$0.00	$30.97	$3,716.40	100%	9%	$8,102	FLC FLC Datacenter	
L2	Environmental Engineer	20	HR	1.00	$45.65	$45.65	$0.00	$0.00	$0.00	$0.00	$45.65	$913.00	100%	9%	$1,990	FLC FLC Datacenter	
L1	Clerks, Typist, Bookkeeper & Receptionist	8	HR	1.00	$22.62	$22.62	$0.00	$0.00	$0.00	$0.00	$22.62	$180.96	100%	9%	$394	FLC FLC Datacenter	
M3D	Copy and Shipping Allowance - Collab. Agreement	1	LS	1.00	$0.00	$0.00	$0.00	$0.00	$0.00	$2,000.00	$2,000.00	$2,000.00	0%	0%	$2,000	A Allowance	
M7D	Filing and Recording Fees Allowance - Collab. Agreement	1	LS	1.00	$0.00	$0.00	$0.00	$0.00	$0.00	$2,000.00	$2,000.00	$2,000.00	0%	0%	$2,000	A Allowance	
												TOTAL COST:			$23,459		

	Representative Unit Quantity	Unit(s)	Unit Cost	Total Cost
COST WORKSHEET SUMMARY	1	LS	$23,459	$23,459

Notes:
HTRW productivity factor is from Exhibit B-3 or B-4 of "A Guide to Developing and Documenting Cost Estimates During the Feasibility Study", EPA 2000
The Cost Database Code is a reference code for linking with line item cost information with the cost source database and is not otherwise used within these cost worksheets.

Source of Cost Data:
NA Not Applicable - costs are from previous work or vendor quote
For citation references, the following sources apply:
MII (MII Assemblies), GSA (www.gsa.gov), FLC (FLC Datacenter), A (Allowance), V (Vendor Quote), CW (Means CostWorks 2017), P (Previous Work), CB (MII English Cost Book), and FRTR (www.frtr.gov)

Cost Adjustment Checklist: **NOTES:**

FACTOR:	Field work will be in Level "D" PPE.
H&S Productivity (labor and equipment only)	MII assembly costs include HPF adjustments.
Escalation to Base Year	2017 cost sources are not escalated (EF=1.00). All other costs are escalated based on the USACE CWCCIS, EM 1110-2-1304, Sep 2016
Area Cost Factor	An AF of 0.96 is used for Colorado, except that an AF of 1.00 (national unmodified average) is used for MII assembly costs and local vendor quotes.
Subcontractor Overhead and Profit	It is assumed that Subcontractor O&P is either included in the PC O&P or has been factored into vendor quotes or previous work.
Prime Contractor Overhead and Profit	It is assumed that home office OH is 8% and profit is 9% for the Prime Contractor. Professional labor overhead is 100%. Allowances and items with mandated costs such as per diem do not have overhead and profit applied.

Abbreviations:

QTY	Quantity	ACR	Acres
EQUIP	Equipment	BCY	Bank Cubic Yard
MATL	Material	CLF	100 Linear Foot
HPF	HTRW Productivity Factor	DY	Days
ADJ LABOR	Adjusted Labor for HFP	EA	Each
ADJ EQUIP	Adjusted Equipment for HFP	LF	Linear Foot
UNMOD UC	Unmodified Unit Cost	HR	Hours
UNMOD LIC	Unmodified Line Item Cost	LB	Pounds
UNBUR LIC	Unburdened Line Item Cost	LCY	Loose Cubic Yard
PC OH	Prime Contractor Overhead	LS	Lump Sum
PC PF	Prime Contractor Profit	RL	Roll
BUR LIC	Burdened Line Item Cost	SY	Square Yard
		TN	Tons

TABLE CW2-6

Alternative 2
Annual O&M Cost Sub-Element
Annual Site Inspection

Cost Worksheet: **CW2-6**

COST WORKSHEET

Site: Uravan Uranium Project (Union Carbide Corp.)
Location: Uravan, Colorado
Phase: Focused Feasibility Study
Base Year: 2017

Prepared By: JN **Date:** 10/8/2017
Checked By: EW **Date:** 10/9/2017

Work Statement:
This sub-element involves annual inspection of the Uravan Superfund Site. The following cost includes the labor, equipment, and per diem required for an annual site inspection.

Cost Analysis:
Cost for Annual Site Inspection (Lump Sum)

COST DATABASE CODE	DESCRIPTION	QTY	UNIT(S)	HPF	LABOR	ADJ LABOR	EQUIP	ADJ EQUIP	MATL	OTHER	UNMOD UC	UNMOD LIC	PC OH	PC PF	BUR LIC	COST SOURCE CITATION	COMMENTS
L8	Project Manager	16	HR	1.00	$78.74	$78.74	$0.00	$0.00	$0.00	$0.00	$78.74	$1,259.84	100%	9%	$2,746	FLC FLC Datacenter	
L2	Environmental Engineer	16	HR	1.00	$45.65	$45.65	$0.00	$0.00	$0.00	$0.00	$45.65	$730.40	100%	9%	$1,592	FLC FLC Datacenter	
L4	Environmental Scientist	16	HR	1.00	$39.07	$39.07	$0.00	$0.00	$0.00	$0.00	$39.07	$625.12	100%	9%	$1,363	FLC FLC Datacenter	
M2	Per Diem	3	DY	1.00	$0.00	$0.00	$0.00	$0.00	$0.00	$94.00	$94.00	$282.00	0%	0%	$282	GSA www.gsa.gov	
M1	Pickup Truck Rental	2	DY	1.00	$0.00	$0.00	$0.00	$0.00	$0.00	$85.00	$85.00	$170.00	8%	9%	$200	V Vendor Quote	Enterprise Car Rental, 2017
												TOTAL COST:			$6,183		

	Representative Unit Quantity	Unit(s)	Unit Cost	Total Cost
COST WORKSHEET SUMMARY	1	YR	$6,183	$6,183

Notes:
HTRW productivity factor is from Exhibit B-3 or B-4 of "A Guide to Developing and Documenting Cost Estimates During the Feasibility Study", EPA 2000
The Cost Database Code is a reference code for linking with line item cost information with the cost source database and is not otherwise used within these cost worksheets.

Source of Cost Data:
NA Not Applicable - costs are from previous work or vendor quote
For citation references, the following sources apply:
MII (MII Assemblies), GSA (www.gsa.gov), FLC (FLC Datacenter), A (Allowance), V (Vendor Quote), CW (Means CostWorks 2017), P (Previous Work), CB (MII English Cost Book), and FRTR (www.frtr.gov)

Cost Adjustment Checklist:

	NOTES:
FACTOR:	Field work will be in Level "D" PPE.
H&S Productivity (labor and equipment only)	MII assembly costs include HPF adjustments.
Escalation to Base Year	2017 cost sources are not escalated (EF=1.00). All other costs are escalated based on the USACE CWCCIS, EM 1110-2-1304, Sep 2016
Area Cost Factor	An AF of 0.96 is used for Colorado, except that an AF of 1.00 (national unmodified average) is used for MII assembly costs and local vendor quotes.
Subcontractor Overhead and Profit	It is assumed that Subcontractor O&P is either included in the PC O&P or has been factored into vendor quotes or previous work.
Prime Contractor Overhead and Profit	It is assumed that home office OH is 8% and profit is 9% for the Prime Contractor. Professional labor overhead is 100%. Allowances and items with mandated costs such as per diem do not have overhead and profit applied.

Abbreviations:

QTY	Quantity	ACR	Acres
EQUIP	Equipment	BCY	Bank Cubic Yard
MATL	Material	CLF	100 Linear Foot
HPF	HTRW Productivity Factor	DY	Days
ADJ LABOR	Adjusted Labor for HFP	EA	Each
ADJ EQUIP	Adjusted Equipment for HFP	LF	Linear Foot
UNMOD UC	Unmodified Unit Cost	HR	Hours
UNMOD LIC	Unmodified Line Item Cost	LB	Pounds
UNBUR LIC	Unburdened Line Item Cost	LCY	Loose Cubic Yard
PC OH	Prime Contractor Overhead	LS	Lump Sum
PC PF	Prime Contractor Profit	RL	Roll
BUR LIC	Burdened Line Item Cost	SY	Square Yard
		TN	Tons

Calculations

PROJECT:	Uravan Uranium Project	COMPUTED BY :	EW	CHECKED BY:	JN
JOB NO.:	79171.3383.354.PPZ.SSPLN	DATE :	9/8/2017	DATE CHECKED:	9/13/2017
CLIENT:	USEPA - Region 8			WRKSHT NO. :	QTO-01

Description: Quantity calculations for the Five Year Site Review. Applicable to Alternatives 1 & 2.

Site Visit

Environmental Lawyer, HR:	**16**
Pickup Truck Rental, HR:	**2**
Per Diem, HR:	**2**

Report Generation

Project Manager, HR:	**30**
Environmental Engineer, HR:	**80**
Environmental Scientist, HR:	**120**
Drafter, HR:	**20**
Quality Control Engineer, HR:	**10**
Clerk, Typist, Bookkeeper, & Receptionist, HR:	**20**
Copy and Shipping Allowance, LS:	**1**

PROJECT:	Uravan Uranium Project	COMPUTED BY :	EW	CHECKED BY:	JN
JOB NO.:	79171.3383.354.PPZ.SSPLN	DATE :	9/8/2017	DATE CHECKED:	9/13/2017
CLIENT:	USEPA - Region 8			WRKSHT NO. :	QTO-02

Description: Quantity calculations for Environmental Covenants and Restrictive Notices. Steps were determined from the Institutional Controls Implementation Guidance published by the Colorado Department of Public Health and Environment, January 2012. Applicable to only Alternative 2.

Number of Applications, EA:	**3**	

Step 1: Scoping Meeting

Environmental Engineer, HR:	4	
Environmental Lawyer, HR:	4	
Paralegal, HR:	4	

Step 2: Determine Consistency with Local Zoning Requirements

Environmental Lawyer, HR:	1	
Paralegal, HR:	4	

Step 3: Facility Obtains Current Title Information

Environmental Lawyer, HR:	1	
Paralegal, HR:	4	
Title Search, EA:	1	

Step 4: AGO/the Division Evaluates Use Restrictions

Environmental Engineer, HR:	8	
Environmental Lawyer, HR:	4	
Paralegal, HR:	16	

Step 5: Agreement of Draft EC/RN Language, Interest Holders Notified to Create EC/RN

Environmental Engineer, HR:	8	
Environmental Lawyer, HR:	12	
Paralegal, HR:	48	
Drafter, HR:	4	
Clerk, Typist, Bookkeeper, & Receptionist, HR:	8	

Step 6: Copies of Notice Sent to the Division

Clerk, Typist, Bookkeeper, & Receptionist, HR:	2	

Step 7: Division Reviews Any Comments

Environmental Engineer, HR:	8	
Environmental Lawyer, HR:	2	
Paralegal, HR:	8	

Step 8: Finalize Remedial Decision, EC/RN and any Subordination Agreements

Environmental Engineer, HR:	8	
Environmental Lawyer, HR:	2	
Paralegal, HR:	8	

Step 9: Prepare Survey

Amount to be Surveyed, AC:	5	*Assumed per application*
Environmental Engineer, HR:	4	
Drafter, HR:	4	

Step 10: Final Review and Execution of the Final EC/RN

Environmental Lawyer, HR:	1	
Paralegal, HR:	4	
Clerk, Typist, Bookkeeper, & Receptionist, HR:	4	

Step 11: AGO Record EC/RN and any Subordination Agreements

Paralegal, HR:	4	

PROJECT:	Uravan Uranium Project	COMPUTED BY :	EW	CHECKED BY:	JN
JOB NO.:	79171.3383.354.PPZ.SSPLN	DATE :	9/8/2017	DATE CHECKED:	9/13/2017
CLIENT:	USEPA - Region 8			WRKSHT NO. :	QTO-02

Description: Quantity calculations for Environmental Covenants and Restrictive Notices. Steps were determined from the Institutional Controls Implementation Guidance published by the Colorado Department of Public Health and Environment, January 2012. Applicable to only Alternative 2.

Step 12: Provide a Copy of the EC/RN to Affected Local Government and Place Electronic Copy on Registry

Clerk, Typist, Bookkeeper, & Receptionist, HR:	4

Step 13: Obtain Updated Title Commitment

Environmental Lawyer, HR:	1
Paralegal, HR:	4
Title Search, EA:	1

Total

	Per Property	Total
Amount to be Surveyed, AC:	5	**15**
Environmental Engineer, HR:	40	**120**
Environmental Lawyer, HR:	28	**84**
Paralegal, HR:	104	**312**
Drafter, HR:	8	**24**
Clerk, Typist, Bookkeeper, & Receptionist, HR:	18	**54**
Title Search Allowance, EA:	2	**6**
Copy and Shipping Allowance, EA:	1	**3**
Filing and Recording Fees Allowance, EA:	1	**3**

PROJECT:	Uravan Uranium Project	COMPUTED BY :	EW	CHECKED BY:	JN
JOB NO.:	79171.3383.354.PPZ.SSPLN	DATE :	9/8/2017	DATE CHECKED:	9/13/2017
CLIENT:	USEPA - Region 8			WRKSHT NO. :	QTO-03

Description: Quantity calculations for the Materials Management Plans. Applicable to only Alternative 2.

Materials Management Plans

Number of Applications, EA: **3** *Same as EC/RN Applications*

	Per Property	Total
Environmental Engineer, HR:	160	**480**
Drafter, HR:	16	**48**
Clerk, Typist, Bookkeeper, & Receptionist, HR:	8	**24**
Copy and Shipping Allowance, EA:	1	**3**
Filing and Recording Fees Allowance, EA:	1	**3**

Updating Materials Management Plans

	Per Property	Total
Environmental Engineer, HR:	20	**60**
Drafter, HR:	4	**12**
Clerk, Typist, Bookkeeper, & Receptionist, HR:	2	**6**
Copy and Shipping Allowance, EA:	1	**3**
Filing and Recording Fees Allowance, EA:	1	**3**

PROJECT:	Uravan Uranium Project	COMPUTED BY :	JN	CHECKED BY:	EW
JOB NO.:	79171.3383.354.PPZ.SSPLN	DATE :	10/8/2017	DATE CHECKED:	10/9/2017
CLIENT:	USEPA - Region 8			WRKSHT NO. :	QTO-04

Description: Quantity calculations for development and Implementation of Collaborative Agreement. Applicable to Alternatives 1 & 2.

Development and Implementation of Collaborative Agreement

Environmental Lawyer, HR:	60
Paralegal, HR:	120
Environmental Engineer, HR:	20
Clerks, Typist, Bookkeeper & Receptionist, HR:	8
Copy and Shipping Allowance, LS:	1
Filing and Recording Fees Allowance, LS:	1

PROJECT:	Uravan Uranium Project	COMPUTED BY :	JN	CHECKED BY:	EW
JOB NO.:	79171.3383.354.PPZ.SSPLN	DATE :	10/8/2017	DATE CHECKED:	10/9/2017
CLIENT:	USEPA - Region 8			WRKSHT NO. :	QTO-05

Description: Quantity calculations for annual site inspection. Applicable to Alternatives 1 & 2.

Annual Site Inspection

Assumed Inspection Duration, DY:	2
Assumed Daily Hours, HR/DY:	8

	EA	DY	HR
Project Manager:	1	2	16
Environmental Engineer:	1	2	16
Environmental Scientist:	1	2	16
Per Diem:	3	3	-
Truck Rental:	1	2	-

Cost Estimate Backup

TABLE PV-ADRFT

PRESENT VALUE ANALYSIS

Annual Discount Rate Factors Table

Site: Uravan Uranium Project (Union Carbide Corp.)
Location: Uravan, Colorado
Phase: Focused Feasibility Study
Base Year: 2017

Discount Rate (Percent): 7.0

Year	Discount Factor[1,2]	Year	Discount Factor[1,2]
0	1.0000	26	0.1722
1	0.9346	27	0.1609
2	0.8734	28	0.1504
3	0.8163	29	0.1406
4	0.7629	30	0.1314
5	0.7130	31	0.1228
6	0.6663	32	0.1147
7	0.6227	33	0.1072
8	0.5820	34	0.1002
9	0.5439	35	0.0937
10	0.5083	36	0.0875
11	0.4751	37	0.0818
12	0.4440	38	0.0765
13	0.4150	39	0.0715
14	0.3878	40	0.0668
15	0.3624	41	0.0624
16	0.3387	42	0.0583
17	0.3166	43	0.0545
18	0.2959	44	0.0509
19	0.2765	45	0.0476
20	0.2584	46	0.0445
21	0.2415	47	0.0416
22	0.2257	48	0.0389
23	0.2109	49	0.0363
24	0.1971	50	0.0339
25	0.1842		

Notes:

[1] Annual discount factors were calculated using the formulas and guidance presented in Section 4.0 of "A Guide to Developing and Documenting Cost Estimates During the Feasibility Study", EPA 2000.

[2] The real discount rate of 7.0% was obtained from "A Guide to Developing and Documenting Cost Estimates During the Feasibility Study", EPA 2000, Page 4-5.

COST INDICES FOR ESCALATION

Base Year for Work: **2017**

Year	Cost Index[1]
2000	497.07
2001	503.52
2002	517.46
2003	529.95
2004	571.29
2005	608.36
2006	641.91
2007	673.52
2008	716.54
2009	703.00
2010	724.17
2011	756.48
2012	773.75
2013	787.64
2014	804.05
2015	804.97
2016	810.92
2017	829.89
2018	846.36
2019	863.28
2020	880.55
2021	898.16
2022	916.12
2023	934.45
2024	953.13
2025	972.20

1 Yearly composite cost index (weighted average) from the U.S. Army Corps of Engineers Civil Works Construction Cost Index System (CWCCIS), EM 1110-2-1304, 31 March 2012. Revised as of 31 March 2017.

FLC Data Center

Base Year: 2017

COST CODES FOR LABOR AND UNIT COSTS

Cost Code	Description	Units	Unit Labor Cost	Unit Equipment Cost	Unit Material Cost	Unit Other Cost	Year of Cost Source	Escalation Factor	Area Factor	Adjusted Labor Cost	Adjusted Equipment Cost	Adjusted Material Cost	Adjusted Other Cost	PC OH	PC PF	Cost Source		Comments
																Source	Source ID	
L1	Clerks, Typist, Bookkeeper & Receptionist	HR	$22.62	$0.00	$0.00	$0.00	2017	1	1	$22.62	$0.00	$0.00	$0.00	100%	9%	FLC	FLC Datacenter	
L2	Environmental Engineer	HR	$45.65	$0.00	$0.00	$0.00	2017	1	1	$45.65	$0.00	$0.00	$0.00	100%	9%	FLC	FLC Datacenter	
L3	Environmental Lawyer	HR	$68.60	$0.00	$0.00	$0.00	2017	1	1	$68.60	$0.00	$0.00	$0.00	100%	9%	FLC	FLC Datacenter	
L4	Environmental Scientist	HR	$39.07	$0.00	$0.00	$0.00	2017	1	1	$39.07	$0.00	$0.00	$0.00	100%	9%	FLC	FLC Datacenter	
L5	Field Engineer	HR	$33.30	$0.00	$0.00	$0.00	2017	1	1	$33.30	$0.00	$0.00	$0.00	100%	9%	FLC	FLC Datacenter	
L6	Drafter	HR	$27.79	$0.00	$0.00	$0.00	2017	1	1	$27.79	$0.00	$0.00	$0.00	100%	9%	FLC	FLC Datacenter	
L7	Field Technician	HR	$24.38	$0.00	$0.00	$0.00	2017	1	1	$24.38	$0.00	$0.00	$0.00	100%	9%	FLC	FLC Datacenter	
L8	Project Manager	HR	$78.74	$0.00	$0.00	$0.00	2017	1	1	$78.74	$0.00	$0.00	$0.00	100%	9%	FLC	FLC Datacenter	
L9	Quality Control Engineer	HR	$53.48	$0.00	$0.00	$0.00	2017	1	1	$53.48	$0.00	$0.00	$0.00	100%	9%	FLC	FLC Datacenter	
L10	Paralegal	HR	$30.97	$0.00	$0.00	$0.00	2017	1	1	$30.97	$0.00	$0.00	$0.00	100%	9%	FLC	FLC Datacenter	
L11	Geologist	HR	$59.78	$0.00	$0.00	$0.00	2017	1	1	$59.78	$0.00	$0.00	$0.00	100%	9%	FLC	FLC Datacenter	
L12	Surveyor	HR	$25.26	$0.00	$0.00	$0.00	2017	1	2	$50.52	$0.00	$0.00	$0.00	100%	9%	FLC	FLC Datacenter	
L13	Surveyor, Chief	HR	$30.29	$0.00	$0.00	$0.00	2017	1	3	$90.87	$0.00	$0.00	$0.00	100%	9%	FLC	FLC Datacenter	

Base Year: 2017

COST CODES FOR MATERIAL AND UNIT COSTS

Cost Code	Description	Units	Unit Labor Cost	Unit Equipment Cost	Unit Material Cost	Unit Other Cost	Year of Cost Source	Escalation Factor	Area Factor	Adjusted Labor Cost	Adjusted Equipment Cost	Adjusted Material Cost	Adjusted Other Cost	PC OH	PC PF	Cost Source		Comments
																Source	Source ID	
M1	Pickup Truck Rental	DY	$0.00	$0.00	$0.00	$85.00	2017	1	1	$0.00	$0.00	$0.00	$85.00	8%	9%	V	Vendor Quote	Enterprise Car Rental, 2017
M2	Per Diem	DY	$0.00	$0.00	$0.00	$94.00	2017	1	1	$0.00	$0.00	$0.00	$94.00	0%	0%	GSA	www.gsa.gov	
M3A	Copy and Shipping Allowance - 5 Yr Review Report	LS	$0.00	$0.00	$0.00	$2,000	2017	1	1	$0.00	$0.00	$0.00	$2,000.00	0%	0%	A	Allowance	
M3B	Copy and Shipping Allowance	EA	$0.00	$0.00	$0.00	$200	2017	1	1	$0.00	$0.00	$0.00	$200.00	0%	0%	A	Allowance	
M3C	Copy and Shipping Allowance - EC/RN	LS	$0.00	$0.00	$0.00	$2,000	2017	1	1	$0.00	$0.00	$0.00	$2,000.00	0%	0%	A	Allowance	
M3D	Copy and Shipping Allowance - Collab. Agreement	LS	$0.00	$0.00	$0.00	$2,000	2017	1	1	$0.00	$0.00	$0.00	$2,000.00	0%	0%	A	Allowance	
M7A	Filing and Recording Fees Allowance - 5 Yr Review Report	LS	$0.00	$0.00	$0.00	$2,000	2017	1	1	$0.00	$0.00	$0.00	$2,000.00	0%	0%	A	Allowance	
M7B	Filing and Recording Fees Allowance	EA	$0.00	$0.00	$0.00	$200	2017	1	1	$0.00	$0.00	$0.00	$200.00	0%	0%	A	Allowance	
M7C	Filing and Recording Fees Allowance - EC/RN	LS	$0.00	$0.00	$0.00	$2,000	2017	1	1	$0.00	$0.00	$0.00	$2,000.00	0%	0%	A	Allowance	
M7D	Filing and Recording Fees Allowance - Collab. Agreement	LS	$0.00	$0.00	$0.00	$2,000	2017	1	1	$0.00	$0.00	$0.00	$2,000.00	0%	0%	A	Allowance	
M8	Signage (18" x 24")	LS	$0.00	$0.00	$89.60	$0	2017	1	1	$0.00	$0.00	$89.60	$0.00	0%	0%	V	Vendor Quote	
M9	Installation of Signage (18" x 24")	LS	$5.85	$3.23	$0.00	$0	2017	1	1	$5.85	$3.23	$0.00	$0.00	8%	9%	CW	CostWorks	Labor/equipment costs determined from CostWorks 2017, 10 14 5320 1500.
M10	Barbed Wire, Standard 5-Wire Fence, Includes Excavation and Posts	LF	$4.38	$0.72	$2.91	$0	2017	1	1	$4.38	$0.72	$2.91	$0.00	8%	9%	CW	CostWorks	Labor, equipment, and materials determined from CostWorks 2017, 32 31 2610 0500.
M11	Sign Maintenance Allowance	LS	$0.00	$0.00	$0.00	$500.00	2017	1	1	$0.00	$0.00	$0.00	$500.00	0%	0%	A	Allowance	
M12	Restrictive Physical Allowance	LS	$0.00	$0.00	$0.00	$500.00	2017	1	1	$0.00	$0.00	$0.00	$500.00	0%	0%	A	Allowance	
M13	Tarter Gate, Heavy Duty, 5' High x 10' Wide	EA	$0.00	$0.00	$148.97	$0.00	2017	1	1	$0.00	$0.00	$148.97	$0.00	0%	0%	V	Vendor Quote	
M14	Installation of Tarter Gate, Heavy Duty, 5' High x 10' Wide	EA	$271.00	$67.50	$0.00	$0.00	2017	1	2	$542.00	$135.00	$0.00	$0.00	8%	9%	CW	CostWorks	Labor/equipment determined from CostWorks 2017, 32 31 1320 5060.
M15	Boundary Survey	ACR	$1,125.00	$39.50	$74.50	$0	2017	1	1	$1,125.00	$39.50	$74.50	$0.00	8%	9%	CW	CostWorks	Labor, equipment, and material costs determined from CostWorks 2017, 02 21 1313 0400.
M16	Title Search Allowance	EA	$0.00	$0.00	$200.00	$0	2017	1	1	$0.00	$0.00	$200.00	$0.00	0%	0%	A	Allowance	

Attachment A

Methodology and Organization of Detailed Analysis Cost Estimates, Feasibility Study

Memorandum

To: *Frances Costanzi, Project Manager – U.S. Environmental Protection Agency (EPA) Region 8*

From: *Derek Wintle and Gary Hazen, CDM Federal Programs Corporation*

Date: *October 9, 2017*

Subject: *Methodology and Organization of Detailed Analysis Cost Estimates, Feasibility Study, Uravan Uranium Project (Union Carbide Corp.)*

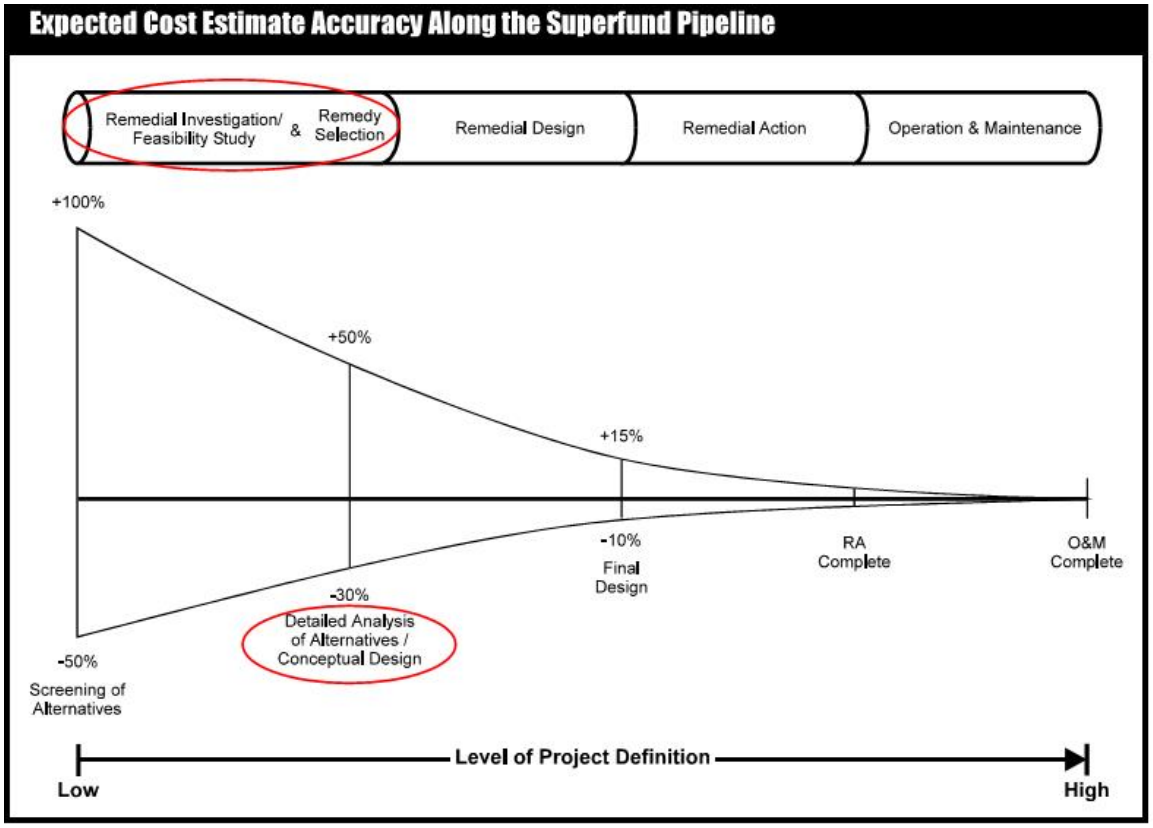
Introduction

CDM Federal Programs Corporation (CDM Smith) has been tasked to develop detailed analysis cost estimates for two alternatives (Alternatives 1 and 2) as part of the Focused Feasibility Study (FFS) for the Uravan Uranium Project (Union Carbide Corp.), herein referred to as "FFS cost estimates." The FFS cost estimates are based on the scope of the alternatives as presented in the FFS.

Purpose and Accuracy of FFS Detailed Analysis Cost Estimates

The FFS cost estimates are developed during the detailed analysis phase to compare alternatives and support remedy selection, not for establishing project budgets or negotiating Superfund enforcement settlements. At the FFS stage of the project, the "design" for the remedial action as represented by the remedial alternatives is still conceptual, not detailed, and the cost estimates are considered to be "order-of-magnitude." The information provided in the cost estimate is based on the best available information regarding the anticipated scope of the remedial alternatives. As described in *A Guide to Developing and Documenting Cost Estimates During the Feasibility Study* (EPA 2000), the detailed analysis cost estimate is expected to have an accuracy between -30% to +50% of actual cost, based on the scope presented in the FFS. **Exhibit 1** illustrates the relationship between level of alternative scope definition and related accuracy as a typical project progresses through the CERCLA process.

Exhibit 1. Expected Cost Estimate Accuracy Along the Superfund Pipeline (EPA 2000)



Generalized Scope of Remedial Alternatives

The FFS includes two alternatives, including the "No Further Action" alternative (Alternative 1).

Alternative 2 includes institutional controls (ICs) in the form of proprietary controls, such as environmental covenants and restrictive notices (ECs/RNs), supplemented with MMPs, implementation of collaborative agreement, and monitoring to confirm compliance with the conditions set forth in the proprietary controls. Major work activities and their associated alternative are listed as follows.

Major Work Activities Costed for Alternatives 1 and 2:

1. 5-year Site Reviews (Alternative 1 and 2)
2. Annual Site Inspections (Alternative 1 and 2)
3. Development and Implementation of Collaborative Agreement (Alternative 1 and 2)
4. Environmental Covenants and Restrictive Notices (Alternative 2 only)
5. Materials Management Plans (Alternative 2 only)
6. Updating Materials Management Plans (Alternative 2 only)

General Methodology and Relevant Cost Guidance

Cost estimates are developed according to *A Guide to Developing and Documenting Cost Estimates during the Feasibility Study* (EPA 2000). Flexibility is incorporated into each alternative for the location of remedial facilities, the selection of cleanup levels, and the period in which remedial action will be completed. Assumptions of the project scope and duration are defined for each alternative to provide cost estimates for the various remedial alternatives.

Types of costs that are assessed for each alternative include the following:

- Capital costs
- Annual operation and maintenance (O&M) costs
- Periodic costs
- Present value of capital, annual O&M, and periodic costs

The levels of detail employed in making these estimates are conceptual but are considered appropriate for making choices between alternatives. The information provided in the cost estimate is based on the best available information regarding the anticipated scope of the remedial alternatives.

The costs are evaluated with respect to the following categories:

- Capital costs are expenditures that are required to construct a remedial action. They are exclusive of costs required to operate or maintain the action throughout its lifetime. Capital costs consist primarily of expenditures initially incurred to build or install the remedial action. Capital costs include all labor, equipment, and material costs (including contractor markups, such as overhead and profit) associated with activities, such as implementation of ECs/RNs, materials management plans, and a collaborative agreement. Capital costs may also include expenditures for professional/technical services that are necessary to support construction of the remedial action.
- Annual O&M costs are post-construction costs necessary to ensure or verify the continued effectiveness of a remedial action. These costs are estimated on an annual basis and include labor, equipment, and material costs (including contractor markups, such as overhead and profit). Annual O&M costs include annual site inspections.
- Periodic costs are costs that occur only once every few years (e.g., 5-year reviews and updating MMPs). These costs may be either capital or O&M costs, but because of their periodic nature, it is more practical to consider them separately from other capital or O&M costs in the estimating process.
- The present value of each alternative provides the basis for the cost comparison. The present value cost represents the amount of money that, if invested in the initial year of the remedial action at a given rate, would provide the funds required to make future payments to cover all costs associated with the remedial action over its planned life. Future O&M and periodic costs are included and reduced by the appropriate present value real discount rate (7%) as outlined in *A Guide to Developing and Documenting Cost Estimates during the Feasibility Study* (EPA 540-R-00-002, July 2000). Inflation and depreciation were not considered in preparing the present value costs.

Development Approach for Information Provided in Cost Summary Tables

The cost summary tables are organized by the three major cost categories: capital costs, annual O&M costs, and periodic costs. Costs are totaled for each major work activity. Contingency and professional/technical services are applied within the cost summary tables after subtotaling the costs for major work activities. Percentages used for contingency and professional/technical services costs are based on the recommended ranges presented in Section 5.0 of *A Guide to Developing and Documenting Cost Estimates During the Feasibility Study* (EPA 2000), unless otherwise noted within the cost summary tables.

The general approach in the cost summary tables include the following:

- As described in Section 5.4, percentages used to determine contingency were based on the recommended ranges within Exhibit 5-6 of *A Guide to Developing and Documenting Cost Estimates During the Feasibility Study* (EPA 2000).
- As described in Section 5.5, percentages used to determine project management, remedial design, construction management were based on the recommended ranges within Exhibit 5-8 of *A Guide to Developing and Documenting Cost Estimates During the Feasibility Study (EPA 2000).*
- The percentage used to determine technical support was based on the recommended ranges within Section 5.5 of *A Guide to Developing and Documenting Cost Estimates During the Feasibility Study (EPA 2000).*
- As described in Section 5.6 of *A Guide to Developing and Documenting Cost Estimates During the Feasibility Study*, contingency is generally not applied to institutional control cost elements. However, due to the complexity of the site and the numerous property owners involved at the site, a 20% contingency (10% Scope, 10% Bid) was applied to account for uncertainties relating to implementation of institutional controls.
- Capital costs for implementation of institutional controls did not include professional/technical service cost markups for remedial design and construction management because there are no design or construction elements involved in these capital costs.

Development Approach for Information Provided in Present Value Tables

The present value of each alternative provides the basis for the cost comparison. The present value cost represents the amount of money that, if invested in the initial year of the remedial action at a given rate, would provide the funds required to make future payments to cover all costs associated with the remedial action over its planned life. Future O&M periodic costs are included and reduced by the appropriate present value discount rate as outlined in *A Guide to Developing and Documenting Cost Estimates during the Feasibility Study* (EPA 2000a). Per the guidance, the present value analysis was performed on remedial alternatives using a 7 percent discount (interest) rate over the period of evaluation for each alternative. Per guidance, inflation and depreciation were not considered in preparing the present value costs.

The general approach shown in the present value tables include the following:

- As discussed in A Guide to Developing and Documenting Cost Estimates during the Feasibility Study (EPA 2000), the real discount (interest) rate used for present value analysis in the FFS depends on whether the Site is classified as a federal facility site. Federal facility sites are former or current installations operated or controlled by a federal government agency and identified by EPA's Federal Facilities Restoration and Reuse Office (FFRRO). Based on a cursory review, the areas within the Site are not a federal facility identified within FFRRO's site inventory. In addition, the guidance specifically mentions that although a federal-lead site cleaned up by EPA using the Superfund trust fund (i.e., fund-lead sites) may be an analogous situation to a federal facility site being cleaned up using Superfund authority, there is always a chance that a potentially responsible party (PRP) could remediate the Site. Thus, per guidance a real discount rate of 7 percent should be used in calculating present value costs for all non-federal facility sites. A 7 percent real discount rate was used to develop present value costs for each retained alternative over the period of evaluation for each alternative since there is PRP involvement and the site or areas within the site are not identified as federal facilities in the FFRRO site inventory.
- The project duration for each alternative is longer than the period of evaluation for present value analysis (Years 0 through 50 as selected by EPA). The guidance indicates in those situations that site-specific justification for the selected period of evaluation should be provided. It is likely that all remedial alternatives would require an indefinite duration of O&M (evaluated as periodic costs within these estimates). However, evaluation of long durations of O&M is cumbersome and is generally not necessary for comparative evaluation between alternatives because of the effects of cost discounting in later years under present value analysis. The period of analysis for the FFS is assumed to be 50 years, because the increase of present value cost due to small periodic expenditures for maintenance and monitoring after 50 years is minimal relative to the accuracy range of the estimates.
- In addition, a "no-discounting" scenario is included for the present value analysis of each alternative as recommended by the guidance for long-term projects (e.g., project duration exceeding 30 years). A non-discounted constant dollar cash flow over time demonstrates the impact of a discount rate on the total present value cost and the relative amounts of future annual expenditures. Non-discounted constant dollar costs are presented for comparison purposes only and should not be used in place of present value costs in the Superfund remedy selection process.

FFS Detailed Analysis Cost Estimate Organization

The detailed analysis cost estimates are organized into the following sections:

- Detailed Analysis Cost Estimates
- Attachment A – Methodology and Organization of Detailed Analysis Cost Estimates, Feasibility Study, Uravan Uranium Project (Union Carbide Corp.)

  This is the memorandum you are currently reading that summarizes the approach to developing the detailed analysis cost estimates within the FFS for the Uravan Uranium Project (Union Carbide Corp.).

Appendix D

Review of Umetco Risk Assessment, Alternative Soils Standards, and Residual Contamination

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 8
1595 Wynkoop Street
DENVER, CO 80202-1129
Phone 800-227-8917
http://www.epa.gov/region08

Ref: R8-Uravan August 31, 2017

MEMORANDUM FOR RECORD

SUBJECT: Review of Umetco Risk Assessment, Alternative Soils Standards, and Residual Contamination

FROM: Steven Merritt, MHP, CIH - Radiation Safety Officer / Industrial Hygienist
U.S. Environmental Protection Agency (EPA) - Region 8

TO: Frances Costanzi - Remedial Project Manager
U.S. Environmental Protection Agency (EPA) - Region 8

Ms. Costanzi:

I have reviewed the relevant documents necessary to comment on the residual risks associated with the various remediation areas following the Uravan Remedial Action conducted by Umetco Minerals Corporation under Consent Decree (CD) with CDPHE between 1986 and 2010. I appreciate the opportunity to evaluate both the historical documents and the draft documents being developed now by EPA, our contractor CDM Smith, and Umetco Minerals Corporation (Umetco) for the purpose of conducting this review. The intent of this review is threefold: first, to determine the contemporary validity of the radiation and chemical risk assessments conducted as part of the Uravan Remedial Action; second, to determine whether the actions taken by Umetco are sufficiently protective of human health and the environment using current Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) risk assessment methodologies; and third, to make recommendations on which remediation areas with residual contamination may require institutional controls (ICs) to be sufficiently protective of human health and the environment.

Review of Uravan Project Risk Assessment Methodology and Soil Cleanup Objectives

As part of the Remedial Action Plan (RAP) developed pursuant to the Consent Decree with CDPHE, Umetco Minerals Corporation developed a detailed risk assessment methodology[1] in 1999 which was used to establish soil cleanup objectives for the Uravan Project. This methodology established four different soil cleanup categories based upon the risk and dose assessments for area-specific land use scenarios and set concentration limits for each constituent of concern for each category. These four categories serve as the basis for evaluating the protectiveness of the remedy and determining the need for institutional controls.

[1] Umetco. 1999a. Site-Specific Soil Cleanup Objectives: Rationale Document for Uravan Project, Colorado and Appendix A – Risk Assessment Methodology for the Uravan Project. June 1999.

Category 1 – RAP Soil Criteria were intended to achieve cleanup of radioactive and metal constituent concentrations to the levels existing prior to any operations at Uravan. They incorporate surface gamma exposure rates, and background radionuclide and metals concentrations proximal to the site. *Category 2 – Risk-Based Objectives for Residential Land Use Scenarios* were intended to be the conservative criteria to assure protection of human health for unrestricted residential land use scenarios. Meeting these objectives assures the protection of human health potentially associated with any residual soil contamination. These objectives were based on meeting relevant and appropriate CDPHE regulatory standards for radium-226 radionuclide concentrations, including thorium-230 ingrowth over 1000 years, achieving background concentrations for arsenic, and meeting EPA risk-based values for residential land use for all other metals, including uranium. Category 1 and Category 2 soil cleanup objectives are more conservative than or generally consistent with, respectively, the prevailing regulations and EPA CERCLA risk-assessment methodology used for uranium mill tailings sites with radiological and heavy metals contamination available at the time the RAP was developed.

Category 3 – Site-Specific Risk/Dose Based Objectives were developed to ensure compliance with U.S. Nuclear Regulatory Commission (NRC) regulations governing Uranium Mill Tailings Radiation Control Act (UMTRCA) Title II areas that will become the long-term responsibility of the Department of Energy's (DOE) Legacy Management (LM) program and use institutional controls to restrict future land use. These objectives were intended to limit the total effective dose equivalent (excluding radon and radon progeny) to less than 100 mrem for individual members of the public. To achieve this goal, dose-based soil concentrations were developed assuming that the dose from each radionuclide summed from all pathways is less than 25 mrem per year. The Category 3 objectives were then calculated using site-specific and exposure scenario-specific assumptions combined with the reference doses. Exposure scenarios include recreational visitors, monitoring workers, and ranchers. *Category 4 – Alternative Concentration Objectives* were a contingency for performing a more detailed area-specific risk assessment in the event that the Category 3 risk/dose-based soil cleanup objectives couldn't be attained during the remedial action. Since there were no remediation areas at the site where residual contamination exceeded any Category 3 criteria, the Category 4 risk assessments weren't ever necessary. As such, the Category 3 and 4 criteria were not considered as part of the CERCLA Radiological Risk Assessment procedures and discussions that follow.

Shortly after the risk assessment methodology was developed for the Uravan Project in 1999, the EPA promulgated guidance for environmental exposures to low-level radioactivity and published conservative radiological risk coefficients for many of the radionuclides of concern at the site[2]. While EPA's Preliminary Remediation Goals (PRG) Calculator for Radionuclides is now used in CERCLA Radiological Risk Assessment, the relevant and appropriate state and federal regulations for the cleanup of UMTCRA sites (40 CFR 192.12) still apply here for radium 226. The Category 2 risk-based soil cleanup objectives identified by Umetco and approved by CDPHE under the RAP for radium 226 activity concentrations (7.1 pCi/g from 0-15 cm soil depth and 17.1 pCi/g at soil depths greater than 15 cm) are in line with the requirements of 40 CFR 192.12. The Category 2 risk-based soil cleanup objectives developed for thorium 230 activity concentrations (14 pCi/g from 0-15 cm soil depth and 17.1 pCi/g at soil depths

[2] EPA. 1999. Cancer Risk Coefficients for Environmental Exposure to Radionuclides. Office of Radiation and Indoor Air. EPA 402-R-99-001, September 1999.

greater than 15 cm) account for radioactive ingrowth of radium 226 over a 1,000-year time horizon and are consistent with other radiological remedial actions performed by EPA in Region 8, which were also considered protective of human health and the environment.

With respect to arsenic concentrations at the site, the natural background concentrations prevalent throughout the site (21.4 mg/kg) are much higher than those found in the current EPA Region III Risk-Based Concentration (RBC) Table (0.68 mg/kg). As such, the background Category 1 concentration for arsenic is set as the default Category 2 concentration. For the site- specific residual uranium contamination, the principal health effect associated with uranium ingestion in a residential exposure scenario is chemical toxicity, not radioactive carcinogenic toxicity. Therefore, the Category 2 concentration is set at 220 mg/kg, which is below the EPA Region III RBC Table value of 230 mg/kg for residential soils. These risk-based objectives for uranium and all metals in Category 2 are lower (more conservative) than those shown in the EPA Region III RBC Table due to the inclusion of the dermal exposure pathway.

Reasonably Anticipated Future Land Use and Potential Contaminant Exposure Pathways

There are currently no residential exposure pathways associated with the Uravan Project. The former Town of Uravan has been removed as part of the remedial action and the nearest resident is several miles from any of the remediation areas. That said, it may be possible for remediation areas achieving the soil cleanup objectives and being deemed "unlimited use/unrestricted exposure" (UU/UE) to have no institutional controls that would prohibit future residential developments. In these instances, a simple zoning or land usage change might allow for residential structures to be built in these areas. Given the size of some of these remediation areas and the variability in the residual contamination present therein, estimating residential risk using simple averaging is not appropriate and better spatial resolution of contamination down to typical residential parcel size of 0.5 acres is needed.

Table 3.1.3-4 of the Draft Uravan Completion Review Report documents the reasonably anticipated future land ownership and the soil cleanup criteria status by remediation area. Per the table, there are 12 remediation areas classified as UMTRCA Title II areas that will become the long-term responsibility of the Department of Energy's (DOE) Legacy Management (LM) program, in whole or in part. In these remediation areas, DOE will be implementing land use controls and restricting access/usage to radiation workers, whose exposures will be governed by OSHA and the NRC under a general license. For this reason, only occupational exposure scenarios will be evaluated in these remediation areas.

The Bureau of Land Management (BLM), Montrose County, and the State of Colorado Department of Transportation (CDOT) will likely take possession of the remaining areas, including the Windblown Areas, the Water Storage Ponds, the Town Area, Northeast Highway 141, the CDOT Highway 141 Right of Way, Hieroglyphic Canyon and Atkinson Creek Streambeds. In all these areas, recreational and rancher exposure scenarios were evaluated using average residual contamination concentrations to determine exposure risks. For Hieroglyphic Canyon and Atkinson Creek Streambeds, residential exposure scenarios were also evaluated for reference. While development for residential use is highly unlikely in any of these areas, the land ownership and land use controls aren't yet in place, so highlight these potential risks reinforces IC recommendations. Also, in many areas, only partial data exist, so a complete risk assessment is not possible, but an estimate is made and IC conclusions are drawn accordingly.

Review of Remedial Action and Residual Contamination Category 1 & 2 Exceedances

During the remedial action, most of the contaminants of concern were removed from nearly all the remediation areas to below the Category 1 soil cleanup objectives, which would permit UU/UE designation for those parcels. However, there were also several remediation areas with at least one contaminant of concern above the Category 1 soil cleanup objectives, meaning that background equivalent concentrations had not been achieved for that contaminant. Some remediation areas, including B-Plant, Mill Hillside, and County Road E-22 had exceedances of Category 2 soil cleanup objectives for Arsenic, Ra-226, and/or Th-230, meaning that residential land use exposures would exceed acceptable risks. Since all of the remediation areas with Category 2 exceedances will be transferred to Department of Energy (DOE) Legacy Management (LM), residential exposures would not be anticipated. Residual contamination soil concentrations and activity concentrations by remediation area can be found in Table 1, on page 5. Exceedances and future ownership by remediation area are summarized in Table 2, on page 6.

The only remediation areas that clearly met the 1999 Soil Cleanup Objectives for Category 1 were the Town Dump, which will remain under DOE LM control due the potential for groundwater contamination, and the Water Storage Ponds, which will be transferred either to BLM or Montrose County. Of the other remediation areas that will be transferred outside of DOE LM control going to BLM, Montrose County, and/or the State of Colorado, there were typically minor exceedances of Uranium or Vanadium. The radiological risk and dose calculations and the chemical risk assessment associated with these exceedances are discussed below, as are the recommended institutional control necessary for the remedy to be protective under CERCLA.

Table 1

Summary of Confirmation Soil Sampling Results

Soil Cleanup Objectives	Unit Area m^2	One-Meter Gamma Exposure Rate, Avg. µR/hr	Surface Soil Ra-226 Conc, Avg. pCi/g	Ra-226 pCi/g	Th-230 pCi/g	U-Nat pCi/g	U-Nat mg/kg	U-Nat pCi/g	As mg/kg	Cd mg/kg	Pb mg/kg	Mo mg/kg	Ni mg/kg	Se mg/kg	V mg/kg	Zn mg/kg
Category 1	N/A	20	7.1	7.1 [2]	7.1 [2]	2.8	8.4	2.84E+00	21.4	2	164	2.3	25.1	11.2	60.1	422
Maximum Concentration	N/A			17.1 [3]	17.1 [3]											
Category 2	N/A			7.1 [2]	14 [2]	74.3	220	7.43E+01	21.4	75	400	370	1400	370	520	22000
Maximum Concentration	N/A			17.1 [3]	43 [3]											
Category 3 Recreational Visitor	N/A			58	58	1891.1	5.60E+03	1.89E+03	*site specific*	1.90E+03	*-4*	9.40E+03	3.40E+04	9.40E+03	1.30E+04	5.60E+05
Maximum Concentration	N/A															
Remediation Area																
Atkinson Creek Crystal Disposal Area [5], surface	31,367	13.6	3.4	1.4	3.8	1.1	3.2	1.0806508	3.5	0.5	6.8	2.9	4.2	0.2	15.5	21.3
Club Ranch Ponds, surface	446,018	19.3	4.4	2.94	9.83	2.2	6.45	2.1781868	7.79	1.1	41.85	2	6.88	0.51	58.29	88.63
subsurface		N/A	N/A	1.25	8.3	1.4	4.14	1.398092	7.51	1.09	37.45	2.04	10.79	0.53	39.75	89.08
River Ponds [6]	27,959	N/A	N/A	As allowed by RAP Section 4.3.2.(3), no soil sampling required as area excavated below water table												
Club Mesa Spray Area	307,845	N/A	7.1	As allowed by RAP Section 4.5.2.(3), no soil sampling required as area excavated to bedrock												
A-Plant, surface	66,416	15.8	4.2	2.5	2.7	2.3	6.9	2.3301533	2.4	0.3	7	0.7	5	0.2	63.8	21
subsurface		N/A	N/A	3.1	4.7	4.1	12.2	4.1199812	2.9	0.3	9	1	5	0.2	72.3	26
A-Plant North, [6] surface	32,397	19.5	3.7	2.54	5.36	4.2	12.35	4.1706367	6.54	0.50	11.15	1.00	6.71	0.76	48.77	30.00
subsurface		N/A	N/A	2.88	5.27	3.9	11.68	3.9443755	6.19	0.50	10.18	1.00	6.86	0.84	40.87	25.43
B-Plant, [7] surface	345,835	28.8	13.4	8.6	13.5	7.5	22.1	7.4632447	7.7	0.6	8.6	1.4	3.6	0.7	86.3	17.4
subsurface		N/A	N/A	8.3	9.6	3.2	9.5	3.2081821	33.3	0.2	12.3	5.7	18	1.2	79.8	29
Historic Structures Area	39,827	16.0	3.2	No soil samples were collected in this area, however direct measurements have shown that it meets RAP criteria.												
Windblown Area, Area E, [8] surface	5161035	16.1	N/A	6.9	13.8	8.6	25.4	8.5776658	4.5	0.5	14	ND	5.3	0.5	111.7	46.3
Mill Hillside, [8] surface	92,385	35.1	22.0	17.1	22.6	20.5	60.6	20.464825	7.2	0.5	12.8	1.4	20.3	1.8	194.3	39.5
subsurface		N/A	N/A	10.5	12.7	11.2	33.3	11.245523	6.3	0.3	8.8	1.1	10	1.3	124	31
County Road Y-11	92,168	N/A	4.5	No soil samples were collected in this area												
County Road EE-22 [9], surface	51,085	18.2	4.9	29.6	39.3	19.7	58.4	19.721877	8.2	0.5	22.1	1.5	5	3	259	43
subsurface		N/A	N/A	29.2	39.6	20.0	59.2	19.99204	9.2	0.7	49	1.3	6	2	320	39.8
Water Storage Ponds, surface	18,332	15.7	3.0	2.3	2.8	2.3	6.7	2.2626126	6.5	ND	8.8	1.1	4.9	ND	35	26
subsurface		N/A	N/A	1.8	1.7	1.7	5	1.6885169	6.3	ND	7.7	1.1	5	ND	29	27
Town Area, surface	127,901	16.9	4.3	2.9	4.9	3.4	10.2	3.4445745	7.4	0.6	38	1.6	8	1.2	45	129
subsurface		N/A	N/A	2.9	4.7	2.9	8.7	2.9380194	7.6	0.6	41	1.6	6	1	40	118
Atkinson Creek Streambed	N/A	N/A	N/A	1.9	2.5	0.9	2.8	0.9455695	7	1	6.1	2	3.9	0.8	18.3	33.4
Hieroglyphic Canyon Streambed	2,100 m*	25.5^	13.8	No confirmation investigation necessary as remedial activities performed as prescribed in *Materials Identification and Removal Plan*												
Northeast Highway 141 including Right of Way, surface	167024	16.9	8.0	4.4	6	2.7	8.1	2.7353974	5.8	0.36	19.8	0.89	4.5	0.41	28.2	45.5
subsurface		N/A	N/A	2.8	4	1.8	5.3	1.7898279	6	0.3	15.3	0.92	5.2	0.24	23.1	44.7
CDOT Highway 141, subsurface	N/A	17.9	4.1	3.1	4.1	2.9	8.5	2.8704787	8.8	0.7	16.7	1.3	5.5	0.2	40	55.7
Town Dump, surface	115,331	13.8	2.5	1.4	3.2	2.1	6.1	2.0599906	5.1	ND	9.7	1.6	6.5	ND	32	29
subsurface		N/A	N/A	1.8	2.6	2.0	5.8	1.9586796	5.5	ND	11	1.8	6.7	ND	32	31

Notes: Text= Category 1 Exceedance Text= Category 2 Exceedance

* Distance along streambed centerline.

^ The RAP Sections 4.7.2.4.1, 4.7.2.5.2 and 4.7.2.5.3 requires cleanup of Windblown Area, Atkinson Creek, and Hieroglyphic Canyon that are "concentrated, contaminated deposits" with exposure rates greater than 30 µR/hr. These results are from the characterization surveys as either no remediation or only limited prescriptive remediation was performed and as such no confirmation investigation was completed as noted in the Compliance Reports.

mg/kg= milligrams per kilogram pCi/g = picoCuries per gram ND= Not Detected N/A =Not Applicable/ Not Available

1. The information summarized in this table is from the documents listed in Table 3.1.3-1, unless otherwise noted.
2. Surface cleanup criteria i.e. 0 to 15 centimeters
3. Subsurface cleanup criteria i.e. > 15 centimeters
4. See Table 2-3 in *Site-Specific Soil Cleanup Objectives Rationale Document for Uravan Project, Colorado* , dated June 1999.
5. The have been calculated from information given in *Potential Health Significance of Residual Levels of Metals in Soils at the Atkinson Creek Crystal Disposal Area, Uravan, Colorado, Revision 1* , dated April 12, 1994 to be consistent with the results provided in other reclamation area confirmation reports.
6. Alternate Soils Standards have been approved for the River Ponds, A-Plant North, the Mill Hillside, and County Road Y-11.
7. The B-Plant area will be transferred to the Department of Energy for long-term stewardship and will effectively restrict future use of the land and minimize future exposure.
8. Soils samples were only collected in Area E. Since sampling for windblown, only surface soil samples were collected. Laboratory analyses indicate that soils are NORM rather than windblown licensed materials.
9. Soil samples collected on September 15 – 17, 1998, as part of characterization investigation. Additional sampling not conducted after remedial activities as roadway was immediately backfilled with clean materials so that road traffic could be maintained in accordance with Montrose County requirements. CDPHE inspected excavated area and confirmed that all tailings material were removed.

Confirmatory Soil samples were collected on a 10 x 10-meter grid basis. Surface Soil= 0-15 cm, Subsurface Soil= 15-30 cm

Table 2 – Cleanup Objective Achievements and Future Ownership by Remediation Area

Remediation Area	RAP Table 4.1.2-1, Criterion 1	RAP Table 4.1.2-1, Criterion 2	1999 Soil Cleanup Objectives			Future Ownership
		1999 Soil Cleanup Objective, Category 1 Part 18, Appendix A	Category 2 - Residential Land Use Scenarios	Category 3 - Recreational Visitor Scenarios	Category 4 – Alternative Soils Standards	
Atkinson Creek Crystal Disposal Area	x	All COCs except Mo	Mo			DOE
Club Ranch Ponds	x	All COCs except Th-230	Th-230			DOE
River Ponds	As allowed by RAP Section 4.3.2.(3), no soil sampling was required as it was excavated below water table				x	DOE
Club Mesa Spray Area	As allowed by RAP Section 4.5.2.(3), no soil sampling was required as it was excavated to bedrock					DOE
A-Plant	x	All COCs except V & U-nat	V and U-nat			DOE
Parcel 3 (mouth of Hieroglyphic Canyon, treasure island, etc.)	x	Residual contamination levels are similar to A-Plant area				Either BLM or Montrose County
A-Plant North	x	All COCs except U-nat	U-nat		x (only a small riparian area)	DOE
B-Plant		Cd, Pb, Ni, Se, Zn	Ra-226, Th-230, U-nat, Mo, V	As		DOE
Mill Hillside		As, Cd, Pb, Mo, Ni, Se, Zn	U-nat, V	Ra-226, Th-230	x	DOE
County Road Y-11	No confirmation soil samples were taken; however, direct measurements estimate an average Ra-226 concentration of 4.5 pCi/g.				x	DOE
County Road EE-22	x	As, Cd, Pb, Mo, Ni, Se, Zn	U-nat, V	Ra-226, Th-230		DOE
Water Storage Ponds (as part of Parcel 3)	x	All COCs				Either BLM or Montrose County
Town Area	x	All COCs except U-nat	U-nat			Montrose County
Atkinson Creek Streambed	No remedial action is required for this area. The characterization investigation indicates that this area meets No Further Action criteria.					BLM
Hieroglyphic Canyon Streambed	x	No confirmation investigation was required as remedial activities were conducted as prescribed in *Materials Identification and Removal Plan* for discrete contaminants only.				BLM
Northeast Highway 141 CDOT Highway 141	x	All COCs except U-nat	U-nat			State of Colorado
Town Dump	x	All COCs				DOE
Windblown Area	x	Soil samples were only taken from Area E. There were tailings visually identified and removed from Area J, however it is too difficult to conduct confirmation surveys as it is on the steep canyon wall/cliff side by the County Road EE-22.				BLM (Only the North Forty area will be transferred to DOE)

Significant Radionuclide and Gamma Exposure Rate - Risk Calculations for CSM

For this review, I used two different methods of calculating the radionuclide carcinogenicity risk for residual radioactive contamination present in the various remediation areas at the site. The first was to apply the conceptual site model (CSM) and risk assessment approach outlined in the *1999 Site-Specific Soil Cleanup Objectives: Rationale Document for Uravan Project, Colorado* using the current slope factors for Radium 226, Thorium 230, and Uranium 238 (a mild simplification for the isotopic diversity of natural Uranium) from Federal Guidance Report 13 and the Radionuclide Table from the Health Effects Assessment Summary Tables (HEAST).
The second method utilized the EPA PRG Calculator and select exposure time and duration values from the CSM, along with more conservative default values in the calculator to determine risk from residual contamination.

The radionuclide carcinogenicity risks were calculated for worker, rancher, recreational user, and, where potential exists for land usage or zoning changes, resident exposure scenarios. The protective risk range that is acceptable for any CERCLA exposure scenario is $1x10^{-4}$ to $1x10^{-6}$ excess cancers, with the point of departure at the lower end of the risk range.

Table 3, on page 8, illustrates the results of these calculations, broken down by isotope and exposure pathway, and summed together to get the total radionuclide carcinogenicity risk in the right hand column. A color-coded status indicator is included with the results to highlight the risk range, with green indicating a lower than $1x10^{-6}$ excess cancer risk (default protective), yellow indicating an excess cancer risk between $1x10^{-6}$ and $1x10^{-5}$, red indicating an excess cancer risk between $1x10^{-5}$ and $1x10^{-4}$, and black indicating greater than $1x10^{-4}$ excess cancer risk.

The results of these calculations indicate that the rancher exposure scenarios (highlighted in blue) are all well below $1x10^{-6}$ excess cancer risk for remediation areas anticipated to be outside the DOE LM control, indicating that these residual levels are protective. Similarly, the excess cancer risk for recreational exposure scenarios (highlighted in green) are within the $1x10^{-5}$ to $1x10^{-6}$ risk range for remediation areas where these exposures are anticipated. Occupational exposures (highlighted in orange) are expected to fall in within the $1x10^{-5}$ to $1x10^{-6}$ excess cancer risk range for remediation areas where these exposures are anticipated. The highest occupational exposure excess cancer risk calculated was for the Mill Hillside remediation area, which had the highest residual activity concentrations in soil. These calculations illustrate that Radium-226 and daughter products are the primary driver for risk in nearly all instances, owing to their shorter half-lives and radon mobility.

Residential exposures were evaluated only for the Atkinson Creek Crystal Disposal Area and the Hieroglyphic Canyon Streambed. In these instances, the risk ranged from $3.39x10^{-5}$ at Atkinson Creek to $1.30x10^{-4}$ at Hieroglyphic Canyon. The latter exposure scenario represents an unacceptable residual excess cancer risk, especially considering the data gaps for Uranium and Thorium residuals associated with this remediation area. Since the data available for the Hieroglyphic Canyon Streambed only includes Radium-226 activity concentrations, this calculation highlights the risk concerns associated with the variability of radiation levels and lack of comprehensive areal activity concentration data at the site. It also underpins the need to evaluate residual risk using smaller parcels of land, especially when considering residential or other chronic exposures.

Table 3 – Calculated Radionuclide Risk via Uravan CSM found in 1999 Soil Cleanup Methodology

	Th-230 Inhalation Cancer Risk	Th-230 Soil Ingestion Cancer Risk	Th-230 External Exposure Cancer Risk	Th-230 Summation of Cancer Risk	Ra-226 Inhalation Cancer Risk	Ra-226 Soil Ingestion Cancer Risk	Ra-226 External Exposure Cancer Risk	Ra-226 Summation of Cancer Risk	U-238 Inhalation Cancer Risk	U-238 Soil Ingestion Cancer Risk	U-238 External Exposure Cancer Risk	U-238 Summation of Cancer Risk	Total Radionuclide Carcinogenicity Risk
Atkinson Creek Crystal Disposal Area	6.14E-10	4.61E-08	2.05E-10	4.69E-08	2.24E-10	1.49E-07	1.90E-06	2.05E-06	5.73E-11	1.36E-08	8.10E-09	2.18E-08	2.12E-06
	1.62E-08	1.34E-06	2.98E-09	1.36E-06	5.90E-09	4.34E-06	2.77E-05	3.20E-05	1.51E-09	3.97E-07	1.18E-07	5.17E-07	3.39E-05
Club Ranch Ponds	1.59E-09	1.19E-07	5.29E-10	1.21E-07	2.90E-10	1.93E-07	2.46E-06	2.65E-06	1.16E-10	2.74E-08	1.63E-08	4.39E-08	2.81E-06
River Ponds [4]	-	-	-	-	-	-	-	-	-	-	-	-	-
Club Mesa Spray Area[5]	-	-	-	-	4.67E-10	3.11E-07	3.96E-06	4.27E-06	-	-	-	-	*4.27E-06*
A-Plant	4.37E-10	3.27E-08	1.45E-10	3.33E-08	2.76E-10	1.84E-07	2.34E-06	2.53E-06	1.24E-10	2.94E-08	1.75E-08	4.70E-08	2.61E-06
A-Plant North	8.67E-10	6.50E-08	2.89E-10	6.61E-08	2.43E-10	1.62E-07	2.07E-06	2.23E-06	2.21E-10	5.26E-08	3.13E-08	8.40E-08	2.38E-06
Historic Structures Area	-	-	-	-	2.11E-10	1.40E-07	1.79E-06	1.93E-06	3.96E-10	9.40E-08	5.59E-08	1.50E-07	*2.08E-06*
B-Plant [6]	2.18E-09	1.64E-07	7.27E-10	1.67E-07	8.82E-10	5.87E-07	7.48E-06	8.07E-06	1.16E-10	2.74E-08	1.63E-08	4.39E-08	8.23E-06
Windblown [7,8]	1.26E-09	1.95E-07	4.34E-10	1.97E-07	-	-	-	-	2.57E-10	1.26E-07	3.75E-08	1.64E-07	*3.61E-07*
	3.72E-10	2.79E-11	1.24E-10	5.24E-10	-	-	-	-	7.58E-11	1.80E-11	1.07E-08	1.08E-08	*1.13E-08*
Mill Hillside [9]	6.44E-07	2.74E-07	1.22E-09	9.19E-07	1.45E-09	9.64E-07	1.23E-05	1.32E-05	1.16E-10	2.74E-08	1.63E-08	4.39E-08	1.42E-05
County Road Y-11	-	-	-	-	2.96E-10	1.97E-07	2.51E-06	2.71E-06	1.16E-10	2.74E-08	1.63E-08	4.39E-08	*2.71E-06*
County Road EE-22	3.59E-09	4.76E-07	1.23E-09	4.81E-07	1.82E-10	2.15E-07	1.60E-06	1.81E-06	5.91E-10	2.90E-07	8.62E-08	3.77E-07	2.67E-06
	1.06E-09	7.94E-11	3.53E-10	1.49E-09	5.37E-11	3.58E-11	4.56E-07	4.56E-07	1.74E-10	4.14E-11	2.46E-08	2.49E-08	4.82E-07
Water Storage Ponds	2.56E-10	3.39E-08	8.80E-11	3.43E-08	1.12E-10	1.31E-07	9.77E-07	1.11E-06	6.79E-11	3.33E-08	9.89E-09	4.32E-08	1.19E-06
	7.54E-11	5.66E-12	2.51E-11	1.06E-10	3.29E-11	2.19E-11	2.79E-07	2.79E-07	2.00E-11	4.75E-12	2.83E-09	2.85E-09	2.82E-07
Town Area	4.48E-10	5.94E-08	1.54E-10	6.00E-08	1.60E-10	1.88E-07	1.40E-06	1.59E-06	1.03E-10	5.06E-08	1.51E-08	6.58E-08	1.71E-06
	1.32E-10	9.90E-12	4.40E-11	1.86E-10	4.72E-11	3.14E-11	4.00E-07	4.00E-07	3.05E-11	7.23E-12	4.30E-09	4.34E-09	4.05E-07
Hieroglyphic Canyon Streambed [7]	-	-	-	-	5.13E-10	6.04E-07	4.49E-06	5.10E-06	-	-	-	-	*5.10E-06*
	-	-	-	-	1.51E-10	1.01E-10	1.28E-06	1.28E-06	-	-	-	-	*1.28E-06*
	-	-	-	-	2.40E-08	1.76E-05	1.12E-04	1.30E-04	-	-	-	-	*1.30E-04*
Northeast Highway 141	5.48E-10	7.27E-08	1.88E-10	7.35E-08	2.98E-10	3.50E-07	2.61E-06	2.96E-06	8.20E-11	4.02E-08	1.20E-08	5.23E-08	3.08E-06
	1.62E-10	1.21E-11	5.39E-11	2.28E-10	8.77E-11	5.84E-11	7.44E-07	7.44E-07	2.42E-11	5.74E-12	3.42E-09	3.45E-09	7.48E-07
CDOT Highway 141	3.75E-10	4.97E-08	1.29E-10	5.02E-08	1.53E-10	1.80E-07	1.34E-06	1.51E-06	8.61E-11	1.26E-07	3.75E-08	1.64E-07	1.73E-06
	1.10E-10	8.28E-12	3.68E-11	1.56E-10	4.50E-11	2.99E-11	3.81E-07	3.82E-07	7.58E-11	6.03E-12	3.59E-09	3.67E-09	3.85E-07
Town Dump	5.17E-10	3.88E-08	1.72E-10	3.95E-08	1.65E-10	1.10E-07	1.40E-06	1.51E-06	1.09E-10	2.60E-08	1.54E-08	4.15E-08	1.59E-06

Notes:

4. See Table 2-3 in *Site-Specific Soil Cleanup Objectives Rationale Document for Uravan Project, Colorado* , dated June 1999.

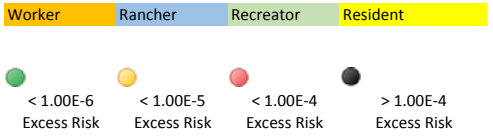
5. The have been calculated from information given in *Potential Health Significance of Residual Levels of Metals in Soils at the Atkinson Creek Crystal Disposal Area, Uravan, Colorado, Revision 1* , dated April 12, 1994 to be consistent with the results provided in other reclamation area confirmation reports.

6. Alternate Soils Standards have been approved for the River Ponds, A-Plant North, the Mill Hillside, and County Road Y-11.

7. The B-Plant area will be transferred to the Department of Energy for long-term stewardship and will effectively restrict future use of the land and minimize future exposure.

8. Soils samples were only collected in Area E. Since sampling for windblown, only surface soil samples were collected. Laboratory analyses indicate that soils are NORM rather than windblown licensed materials.

9. Soil samples collected on September 15 – 17, 1998, as part of characterization investigation. Additional sampling not conducted after remedial activities as roadway was immediately backfilled with clean materials so that road traffic could be maintained in accordance with Montrose County requirements. CDPHE inspected excavated area and confirmed that all tailings material were removed.



For the EPA PRG Calculations, only the exposure time and exposure duration values from the *1999 Site-Specific Soil Cleanup Objectives: Rationale Document for Uravan Project, Colorado* were used for the various exposure scenarios. Default values from the PRG Calculator were used for all other parameters in the calculations and the particulate emission factor associated with the soils at the site were approximated to default values for Las Vegas, NV. At Superfund remedial sites, risks from radionuclide exposures are estimated in a manner analogous to that used for chemical contaminants. The estimates of intake by inhalation and ingestion and the external exposure over the period of exposure estimated for the land use (e.g., 30 years residential, 25 years commercial/industrial) from the exposure assessment were coupled with the appropriate slope factors for each radionuclide and exposure pathway. The total incremental lifetime excess cancer risk attributed to radiation exposure is estimated as the sum of the risks from all radionuclides in all exposure pathways. Therefore, the calculated soil activity concentration was used and the conservative assumption was made that the daughter products from the Uranium 238 decay chain, which includes Thorium 230 and Radium 226, are in secular equilibrium for all remediation area.

Table 4, on page 10, highlights the radionuclide risks calculated for each remediation area and applicable exposure scenario. The residual risk values associated with the EPA PRG Calculator are generally lower than those calculated manually based upon the risk assessment approach used in the *1999 Site-Specific Soil Cleanup Objectives: Rationale Document for Uravan Project, Colorado*, which indicates that the Category 2 approach used is more conservative than the default values in the EPA PRG Calculator.

The results of these calculations indicate that the excess cancer risk for occupational exposures (highlighted in orange) anticipated on all of the remediation areas expected to transfer to DOE LM will be less than $1x10^{-6}$, with the highest value of $1.52x10^{-6}$ in the Mill Hillside remediation area. Furthermore, the calculations of excess cancer risk for recreational exposures (highlighted in green) and rancher exposures (highlighted in blue), which include a fractional contaminated beef consumption risk factor, are all less than $8.63x10^{-6}$, which is the recreational exposure value associated with the County Road EE-22 remediation area.

Residential exposures (highlighted in yellow) were evaluated only for the Atkinson Creek Crystal Disposal Area and the Hieroglyphic Canyon Streambed. In these instances, the excess cancer risk ranged from $2.03x10^{-5}$ at Atkinson Creek to $9.06x10^{-5}$ at Hieroglyphic Canyon. The latter exposure scenario in this case would represent an acceptable residual risk if Radium-226 activity were the only contaminant of concern. However, since the data available for the Hieroglyphic Canyon Streambed only includes Radium-226 activity concentrations and there is no data on Uranium or Thorium, this calculation highlights the risk concerns associated with the variability of radiation levels and lack of comprehensive areal activity concentration data at the site. It also underpins the need to evaluate residual risk using smaller parcels of land, especially when considering residential or other chronic exposures.

Table 4 – Residual Soil Radionuclide Carcinogenicity Risks via EPA PRG Calculator

	Ingestion Risk	Inhalation Risk	External Exposure Risk	Beef Consumption Risk	Total Radionuclide Carcinogenicity Risk
Atkinson Creek Crystal Disposal Area	1.75E-07	6.61E-10	4.42E-08	-	2.20E-07
	1.88E-05	1.66E-08	1.57E-06	-	2.03E-05
Club Ranch Ponds	2.54E-07	1.28E-09	6.52E-08	-	3.21E-07
River Ponds	-	-	-	-	-
Club Mesa Spray Area	3.90E-07	1.83E-09	1.03E-07	-	*4.94E-07*
A-Plant	2.13E-07	7.76E-10	5.41E-08	-	2.68E-07
A-Plant North	2.14E-07	1.13E-09	4.99E-08	-	2.65E-07
Historic Structures Area	1.76E-07	8.26E-10	4.23E-08	-	*2.19E-07*
B-Plant	7.02E-07	2.84E-09	1.91E-07	-	8.96E-07
Windblown	1.88E-06	2.51E-09	4.40E-07	-	*2.32E-06*
	4.68E-07	2.00E-10	7.10E-08	1.29E-09	*5.40E-07*
Mill Hillside	1.20E-06	5.56E-09	3.12E-07	-	1.52E-06
County Road Y-11	2.47E-07	1.16E-09	6.38E-08	-	*3.12E-07*
County Road EE-22	7.02E-06	7.36E-09	1.60E-06	-	8.63E-06
	1.76E-06	5.89E-10	2.58E-07	2.64E-09	2.02E-06
Water Storage Ponds	6.98E-07	6.93E-10	1.54E-07	-	8.52E-07
	1.75E-07	5.55E-11	2.48E-08	3.20E-10	2.00E-07
Town Area	1.02E-06	1.07E-09	2.49E-07	-	1.27E-06
	2.56E-07	8.56E-11	4.02E-08	3.85E-10	2.97E-07
Hieroglyphic Canyon Streambed	3.34E-06	3.61E-09	7.98E-07	-	*4.15E-06*
	8.38E-07	2.89E-10	1.29E-07	1.24E-09	*9.68E-07*
	8.36E-05	9.03E-08	6.92E-06	-	*9.06E-05*
Northeast Highway 141	1.71E-06	1.35E-09	4.56E-07	-	2.17E-06
	4.31E-07	1.09E-10	7.36E-08	6.95E-10	5.05E-07
CDOT Highway 141	9.51E-07	9.40E-10	2.19E-07	-	1.17E-06
	2.39E-07	7.52E-11	3.54E-08	3.64E-10	2.75E-07
Town Dump	1.38E-07	6.52E-10	3.56E-08	-	1.75E-07

Worker | Rancher | Recreator | Resident

< 1.00E-6 Excess Risk | < 1.00E-5 Excess Risk | < 1.00E-4 Excess Risk | > 1.00E-4 Excess Risk

Significant Radionuclide and Gamma Exposure Rate - Dose Calculations for CSM

In 2014, EPA updated the recommendation[3] for what is considered a protective dose-based ARAR from 15 to 12 millirem per year (mrem/yr). The new recommendation of 12 mrem/yr for the dose-based ARARs was based on using an updated risk assessment model to achieve the same 3 x 10^{-4} cancer risk as the previous recommendation, which used 15 mrem/yr. That said, dose calculations from site data are not typically used to determine long-term risk at CERCLA sites. Nevertheless, potential radiation dose calculations were performed using maximum, maximum grid, and average residual contamination values for Radium-226 in each remediation area, with dose conversion factors and the CSM values from the *1999 Site-Specific Soil Cleanup Objectives: Rationale Document for Uravan Project, Colorado* to calculate doses for the various exposure scenarios.

These calculations demonstrate the extreme variability of the potential effective dose equivalents depending upon whether spatial averaging or maximum values are used in the calculation. When discussing this data with CDPHE, supplementary information about natural background variability on the site from naturally occurring radioactive material (NORM) was provided. The NORM Report[4] thoroughly identifies and explains the sources of elevated gamma exposure rates within survey grids and helps to explain both historical mining activities nearby and the background radiation variability, especially in the Windblown Areas. Provided the institutional controls restrict any potential residential development of the remediation areas, especially Hieroglyphic Canyon and Atkinson Creek Crystal Disposal Area, the calculations of potential doses indicate that recreational, rancher, and occupational exposure scenarios are sufficiently protective.

The results of these calculations indicate that the effective dose equivalents for occupational exposures to residual Radium-226 contamination on all of the remediation areas expected to transfer to DOE LM is expected to fall within the range of 7 mrem/year to 1,816 mrem/year. The highest value of 1,816 mrem/year was found in the B-Plant remediation area and is based upon maximum activity concentrations in the remediation area. Furthermore, the calculations of dose for recreational and rancher exposures, ranged from 0 to 87 mrem/year, depending upon whether average or maximum activity concentrations were used. Of note, the highest recreational effective dose equivalent came from the Windblown Area.

Doses associated with residential exposures were evaluated only for the Atkinson Creek Crystal Disposal Area and the Hieroglyphic Canyon Streambed. In these instances, the effective dose equivalent ranged from 129 to 2,245 mrem/year at Atkinson Creek and 377 to 404 at Hieroglyphic Canyon. Again, the activity concentration data upon which these calculations are based are limited and the data have considerable gaps. Additional data collection, especially in Hieroglyphic Canyon, is recommended to fully characterize risks for all exposure pathways if residential development is possible based upon future land ownership and land use restrictions.

[3] EPA. 2014. Memorandum. Distribution of the "Radiation Risk Assessment at CERCLA Sites: Q&A." Office of Solid Waste and Emergency Response. OSWER No. 9285.6-20. June 13, 2014.

4 Umetco, 2003. "Characterization of Areas of Elevated Radioactivity Levels, the Windblown Area, Uravan, Colorado (Windblown Characterization Report)." June 2003.

Chemical Exposure Risks

To determine the non-carcinogenic Hazard Index (HI) for the various routes of exposure in the CSM for each remediation area, the residual soil concentrations for the metal contaminants of concern (Arsenic, Cadmium, Lead, Molybdenum, Nickel, Selenium, Uranium, Vanadium, and Zinc) were input into the EPA RSL Calculator. Recall that there were exceedances of the Category 1 and 2 soil cleanup standards for Arsenic, Molybdenum, Vanadium, and Uranium in many of the remediation areas. Unlike the EPA PRG Calculator, the EPA RSL Calculator doesn't have a default exposure pathway scenario for Farmer (Rancher), so the default Residential exposure pathway was substituted for the Rancher exposure to provide an upper bound on chemical exposure risks.

In 2016, EPA promulgated guidance[5] related to the reference dose (RfD) for Uranium that recommends using the ATSDR MRL of 0.0002 mg U/kg/day in place of the outdated IRIS RfD of 0.003 mg U/kg/day. The ATSDR MRL has been applied in the application of the RSL Calculator used in these hazard index calculations.

Table 5, on page 13, outlines the results of these HI calculations for the residual metals concentrations present in each remediation area. A color-coded status is included with the results to highlight the HI range, with green indicating a HI of less than 0.5 (half the default protective recommendation), yellow indicating a HI of between 0.5 and 0.75 (protective), red indicating a HI of between 0.75 and 1.0 (protective), and black indicating a HI of greater than 1.0 (not protective). In most cases ingestion of soils containing elevated Uranium concentrations by children is the driving factor associated with chemical exposure risks at the site.

The results of these calculations indicate that the hazard indices for occupational exposures (highlighted in orange) to residual metals contamination on all of the remediation areas expected to transfer to DOE LM are below 0.00606 for expected adult exposure scenarios. This indicates that residual metals concentrations are not a significant hazard for these occupational exposures. Similarly, the calculations of hazard indices for child and adult recreational exposures (highlighted in green), ranged from 0.00197 to 0.185, with all values well below a HI of 1.

Hazard indices associated with adult and child residential exposures (highlighted in yellow) were evaluated for the Atkinson Creek Crystal Disposal Area and the Hieroglyphic Canyon Streambed, as well as all the areas where ranching is anticipated to occur due to the limitations of the RSL Calculator. In all these instances, the adult non-carcinogenic HI for metals exposure was well below 1, ranging from 0.0247 to 0.435. However, for the child non-carcinogenic HI for metals exposure, the HI ranged from 0.0262 to 4.63. The HI for child residential metals exposure exceeded 1 on the Windblown Area (1.92) and County Road EE-22 (4.63), where residential exposures are unlikely due to DOE LM or BLM institutional controls. Again, this lends support to land use restrictions to prevent future residential development in these areas.

[5] EPA. 2016. Memorandum. Considering a Noncancer Oral Reference Dose for Uranium for Superfund Human Health Risk Assessments. Office of Land and Emergency Management. December 21, 2016.

Table 5 – Chemical Risk Assessment Hazard Index Calculations via EPA RSL Calculator

	Ingestion Child HQ	Dermal Child HQ	Inhalation Child HQ	Noncarc. Child HI	Ingestion Adult HQ	Dermal Adult HQ	Inhalation Adult HQ	Noncarc. Adult HI
Atkinson Creek Crystal Disposal Area	-	-	-	-	1.68E-03	6.96E-06	1.25E-06	1.69E-03
	2.62E-01	6.07E-04	5.48E-05	2.62E-01	2.45E-02	1.01E-04	5.48E-05	2.47E-02
Club Ranch Ponds	-	-	-	-	3.79E-03	1.53E-05	3.51E-06	3.80E-03
River Ponds	-	-	-	-	-	-	-	-
Club Mesa Spray Area	-	-	-	-	-	-	-	-
A-Plant	-	-	-	-	3.94E-03	4.17E-06	3.38E-06	3.95E-03
A-Plant North	-	-	-	-	6.05E-03	6.96E-06	3.20E-06	6.06E-03
Historic Structures Area	-	-	-	-	-	-	-	-
B-Plant	-	-	-	-	1.07E-02	8.35E-06	5.57E-06	1.07E-02
Windblown	7.73E-02	2.43E-05	1.26E-05	7.74E-02	7.25E-03	4.05E-06	1.26E-05	7.27E-03
	1.92E+00	6.07E-04	3.07E-04	1.92E+00	1.80E-01	1.01E-04	3.07E-04	1.80E-01
Mill Hillside	-	-	-	-	2.83E-02	6.96E-06	1.41E-05	2.83E-02
County Road Y-11	-	-	-	-	-	-	-	-
County Road EE-22	1.85E-01	2.43E-05	3.16E-05	1.85E-01	1.73E-02	4.05E-06	3.16E-05	1.74E-02
	4.63E+00	8.50E-04	8.22E-04	4.63E+00	4.34E-01	1.42E-04	8.22E-04	4.35E-01
Water Storage Ponds	2.10E-02	-	3.78E-06	2.10E-02	1.97E-03	-	3.78E-06	1.97E-03
	5.24E-01	-	4.03E-04	5.25E-01	4.91E-02	-	4.03E-04	4.95E-02
Town Area	3.17E-02	2.91E-05	5.64E-06	3.17E-02	2.97E-03	4.86E-06	5.64E-06	2.98E-03
	7.92E-01	7.28E-04	1.41E-04	7.93E-01	7.42E-02	1.21E-04	1.41E-04	7.45E-02
Hieroglyphic Canyon Streambed	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-
Northeast Highway 141	2.41E-02	1.75E-05	3.77E-06	2.41E-02	2.26E-03	2.92E-06	3.77E-06	2.26E-03
	5.71E-01	4.37E-04	7.13E-04	5.72E-01	5.35E-02	7.29E-05	7.13E-04	5.43E-02
CDOT Highway 141	2.65E-02	3.40E-05	4.91E-06	2.66E-02	2.49E-03	5.67E-06	4.91E-06	2.50E-03
	6.64E-01	8.50E-04	1.23E-04	6.64E-01	6.22E-02	1.42E-04	1.23E-04	6.25E-02
Town Dump	-	-	-	-	3.13E-03	-	2.07E-06	3.13E-03

Worker	Rancher	Recreator	Resident
<0.5 Hazard Index	<0.75 Hazard Index	<1.0 Hazard Index	>1.0 Hazard Index

Recommendations for Institutional Controls

It is expected that the remediation areas that will transfer to DOE Legacy Management will all have sufficient ICs in place in the form of state environmental covenants, general license conditions, and/or long-term surveillance plans (LTSP) to prevent any harmful exposures to the general public exceeding the relevant excess cancer risk or hazard index constraints. Furthermore, it is anticipated that many, if not all, the DOE LM remediation areas would only involve occupational exposures in short durations on periodic basis as required for monitoring and maintenance activities. These exposures are not unlikely to pose a significant risk. Table 6, on the following page, summarizes and outlines the rationale for the risk-based IC recommendations.

The Town Area and Hieroglyphic Canyon Streambed, which are transferring to entities other than DOE LM, should have ICs put in place to prevent residential exposures due to Uranium soils concentrations and the potential for annual effective dose equivalent exceedances. Some form of IC should also be put in place to mitigate recreational exposures in the Windblown Area E, and the potential for annual effective dose equivalent exceedances there. All other areas transferring to entities other than DOE LM do not require ICs for risk reduction.

I welcome your feedback, any requests for additional information, and advice you may have to help me make this memorandum clearer. I can also make available the RSL and PRG Calculator output spreadsheets if you would like to review that data. Please don't hesitate to contact me via e-mail at merritt.steven@epa.gov or by phone at 303.312.6146 if I can be of further assistance.

Sincerely,

Steven B. Merritt, MHP, CIH
Radiation Coordinator & RSO
EPA Region 8

Cc:
D. Wall, Technical Assistance Unit Chief, EPA Region 8 EPR-S
S. Wharton, Remedial Unit A Chief, EPA Region 8, EPR-SR

Table 6
Summary of Institutional Control (IC) Needs

Remediation Area	IC Needed?	Rationale
Atkinson Creek Crystal Disposal Area	YES	DOE LM - Average Category 1 Exceedance (Mo)
Club Ranch Ponds	YES	DOE LM - Average Category 1 Exceedance (Th), Discrete Category 2 Exceedance (Th)
River Ponds	YES	DOE LM - Alternative Soil Standards Area
Club Mesa Spray Area	YES	DOE LM
A-Plant	YES	DOE LM - Average Category 1 Exceedance (U, Th), Discrete Category 2 Exceedance (U, Th)
A-Plant North	YES	DOE LM - Alternative Soils Standards Area
B-Plant	YES	DOE LM - Exposure and Ra-226 Survey Exceedances, Average Category 1 Exceedance (U, Th, Mo, V), Discrete Category 2 Exceedance (U, Th, V), and Average Category 2 Exceedance (As)
Historic Structures Area	NO	Deleted from Superfund Site. UU/UE - Residential Hazard Index < 1 and Excess Cancer Risk < $1x10^{-6}$
Windblown	YES	Partial DOE LM - Average Category 1 Exceedance (U, Th, V)
Mill Hillside	YES	DOE LM - Category 2 Exceedances, Alternative Soil Standards Area
County Road Y-11	YES	DOE LM - Alternative Soil Standards Area
County Road EE-22	YES	DOE LM - Average Category 1 Exceedance (U, Th, Mo, V), Average Category 2 Exceedance (Ra, Th)
Water Storage Ponds	NO	UU/UE - Residential Hazard Index < 1 and Excess Cancer Risk < $1x10^{-6}$
Town Area	YES	Category 2 Exceedances (U)
Atkinson Creek Streambed	NO	UU/UE - Residential Hazard Index < 1 and Excess Cancer Risk < $1x10^{-6}$
Hieroglyphic Canyon Streambed	YES	No confirmatory sampling following hot-spot removal, Category 2 Exceedances (U, Th, V)
Northeast CDOT Highway 141	NO	Land use restrictions due to right-of-way
CDOT Highway 141	NO	Deleted from Superfund Site.
Town Dump	NO	DOE LM - UU/UE - Residential Hazard Index < 1 and Excess Cancer Risk < 1x10-6

References:

EPA. 1997. Memorandum. Establishment of Cleanup Levels for CERCLA Sites with Radioactive Contamination. Office of Emergency and Remedial Response and Office of Radiation and Indoor Air. OSWER No. 9200.4-18. August 22, 1997.

EPA. 2014. Memorandum. Distribution of the "Radiation Risk Assessment at CERCLA Sites: Q&A." Office of Solid Waste and Emergency Response. OSWER No. 9285.6-20. June 13, 2014.

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