REVISED DRAFT FINAL

ENGINEERING EVALUATION / COST ANALYSIS

GRANT GROVE BURN DUMPSITE

SOLID WASTE MANAGEMENT UNIT NO. 38

SEQUOIA AND KINGS CANYON NATIONAL PARKS

FRESNO COUNTY

CALIFORNIA

PREPARED FOR:

NATIONAL PARK SERVICE
PACIFIC WEST REGIONAL OFFICE
333 BUSH STREET, SUITE 500
SAN FRANCISCO, CALIFORNIA 94104

ORDER NO. P16PD01174

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ACRONYMS

2,3,7,8-TCDD	2,3,7,8-tetrachlorodibenzo-p-dioxin
ADD	average daily dose
AGS	Advanced Geological Services, Inc.
AIS	Aerial Information Systems
ALM	Adult Lead Model
amsl	above mean sea level
ARAR	Applicable or Relevant and Appropriate Requirement
ATSDR	Agency for Toxic Substances and Disease Registry
AUF	area use factor
Avatar	Avatar Environmental, LLC
BERA	baseline ecological risk assessment
BS	blind sample
BSD	blind sample duplicate
BTV	background threshold values
BW	body weight
CalEPA	California Environmental Protection Agency
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
cm	centimeter
COC	contaminant of concern
COPC	contaminant of potential concern
COPEC	contaminant of potential ecological concern
CSEM	conceptual site exposure model
CSF	cancer slope factors
CSM	conceptual site model
cy	cubic yards
DL	detection limit
DOI	Department of the Interior
DQCR	daily quality control report

DQO	data quality objective
DRO/ORO	diesel range organics/oil range organics
DTSC	Department of Toxic Substances Control
DVR	data validation report
DW	dry weight
ECM	Environmental Cost Management, Inc.
ED	exposure duration
EE/CA	Engineering Evaluation/Cost Analysis
EF	exposure frequency
EM	electromagnetic terrain conductivity
EPC	exposure point concentration
ERA	ecological risk assessment
ESL	ecological screening level
ESV	ecological screening values
ET	exposure time
Geocon	Consultants, Inc.
GPR	ground penetrating radar
HASP	Health and Safety Plan
HI	hazard index
HQ	hazard quotient
IEUBK	Integrated Exposure and Uptake Biokinetic Model
IRIS	Integrated Risk Information System
ISM	incremental sampling methodology
KM	Kaplan-Meier
LADD	lifetime average daily dose
LANL	Los Alamos National Laboratory
LCS	laboratory control sample
LCSD	laboratory control sample duplicate
LDC	Laboratory Data Consultants, Inc.
LOAEL	lowest observed adverse effect level
mg/kg	milligram per kilogram

mg/kg-day	milligram per kilogram per day
mg/L	milligrams per liter
MS	matrix spike
MSD	matrix spike duplicate
MRL	Minimal Risk Level
NCP	National Oil Pollution and Hazardous Substances Contingency Plan
NOAEL	no observed adverse effect level
NPS	National Park Service
NTCRA	non-time critical removal action
O&M	operation and maintenance
OSRTI	Office of Superfund Remediation and Technology Innovation
OSWER	Office of Solid Waste and Emergency Response
PA	Preliminary Assessment
PAH	polycyclic aromatic hydrocarbon
PPRTV	Provisional Peer Review Toxicity Value
PRG	preliminary remediation goal
QC	quality control
RAA	remedial action alternative
RAO	removal action objective
RCRA	Resource Conservation and Recovery Act
RfC	reference concentration
RfD	reference dose
RME	reasonable maximum exposure
ROS	regression on order statistics
RPD	relative percent difference
RSL	Regional Screening Level
SAP	Sampling and Analysis Plan
SEKI	Sequoia and Kings Canyon National Parks
SI	Site Inspection
Site	Grant Grove Dump Site Solid Waste Management Unit No. 38
SLERA	screening level ecological risk assessment

SMDP	scientific/management decision points
SOW	Statement of Work
SRE	Streamlined Risk Evaluation
STLC	solubility threshold limit concentration
SVOCs	semi-volatile organic compounds
SW	solid waste
SWMU	solid waste management unit
TBC	to be considered
TCLP	Toxicity Characteristic Leachate Procedure
TEQ	toxic equivalent
THQ	target hazard quotient
TPH	total petroleum hydrocarbons
TR	target risk
TRV	toxicity reference value
TRW	Technical Review Work Group for Lead
µg/dL	micrograms per deciliter
$\mu g/m^3$	micrograms per cubic meter
UCL	upper confidence limit
URF	unit risk factor
USEPA	United States Environmental Protection Agency
USL	upper simultaneous limit
WET	California Waste Extraction Test

Executive Summary

Avatar Environmental, LLC (Avatar) was retained by the National Park Service (NPS) to conduct an Engineering Evaluation/Cost Analysis (EE/CA) at the Grant Grove Dumpsite Solid Waste Management Unit (SWMU) No. 38 located within the Sequoia and Kings Canyon National Parks (SEKI) (Site) in Fresno County, California (see Figure 1). Using their authority under the Comprehensive Environmental Response, Compensation, and Liabilities Act (CERCLA), the NPS is engaging in a non-time critical removal action (NTCRA) at the Site.

The Grant Grove Burn Dumpsite SWMU No. 38 was used as a domestic waste burn pit from 1929 to 1965. The former incinerator at SWMU No. 38 was built in the 1960s but was never used as an incinerator. Records indicate that the incinerator was dismantled in 1975. The Site was used for 36 years as a burn and burial pit for burnt domestic waste and is currently being used by the NPS as a staging area for construction materials.

In 2013, the California Department of Toxic Substances Control (DTSC) completed an Assessment Report (DTSC, 2013) and concluded that further environmental investigation was needed at SWMU No. 38 to determine the nature and extent of any release of hazardous waste or hazardous waste constituents from the Site. A Preliminary Assessment (PA) also conducted in 2013 indicated that complete pathways of potential contaminant exposure to human and ecological receptors exist for soil, sediment, and surface water in the vicinity of the Site. Lastly, a 2015 Site Inspection (SI) recommended the preparation of an EE/CA for the selection of an NTCRA alternative for the Site.

The human health Streamlined Risk Evaluation (SRE) concluded that leaving the waste material associated with the Site in its present condition does not pose an unacceptable risk to reasonably anticipated current and/or future human health receptors. The ecological SRE concluded that potential adverse effects based on exposure to cadmium, chromium, copper, lead, mercury, vanadium, zinc, and 2,3,7,8-tetrachlorodibenzo-p-dioxin toxic equivalent (2,3,7,8-TCDD-TEQ) exist for ecological receptors.

Removal actions evaluated in this EE/CA are based on the following removal action objectives:

1. Remove waste debris (ash, glass, ceramics, concrete, metal) from the Site surface and subsurface,
2. Prevent or reduce the potential for human and ecological exposure to contaminants of concern (COCs) in soil, and
3. Prevent or reduce potential migration of COCs via surface runoff, erosion, and wind dispersion.

The removal action alternatives (RAAs) based on the above removal action objectives (RAOs) for this EE/CA included 1) Alternative 1 – No Action, 2) Alternative 2 - Capping with Impermeable Material, and 3) Alternative 3 - Excavation and Off-Site Disposal. These remedial action alternatives (RAAs) were evaluated based on the following criteria:

The effectiveness of RAAs were evaluated using the following criteria:

- Overall protection of public health and the environment
- Compliance with applicable or relevant and appropriate requirements (ARARs)
- Long term effectiveness and permanence
- Reduction of toxicity, mobility or volume through treatment, and
- Short term effectiveness

The implementability of RAAs were evaluated using the following criteria:

- Technical feasibility
- Administrative feasibility
- Availability of services and materials, and
- State and community acceptance

The cost of RAAs were evaluated using the following criteria:

- Direct capital costs,
- Indirect capital costs, and
- Ongoing operation and maintenance (O&M) costs

1. INTRODUCTION

Avatar Environmental, LLC (Avatar) was retained by the National Park Service (NPS) to conduct an Engineering Evaluation/Cost Analysis (EE/CA) at the Grant Grove Dumpsite Solid Waste Management Unit No.38 (Site) located within the Sequoia and Kings Canyon National Parks (SEKI) in Fresno County, California. Under purchase order #P16PD01174, Avatar Environmental, LLC and Geocon Consultants, Inc. (Geocon), a subcontractor to Avatar, have prepared this EE/CA to evaluate potential human and ecological risk and, if needed, potential response activities for the Site.

This EE/CA has been prepared in accordance with the Comprehensive Environmental Response, Compensation, and Liabilities Act (CERCLA) and the U.S. Environmental Protection Agency (USEPA) *Guidance on Conducting Non-Time-Critical Removal Actions* (NTCRAs) (USEPA, 1993a) and associated guidance from NPS. This EE/CA is also prepared in accordance with the requirements provided in Section 300.415(b)(4)(i) of the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) (USEPA, 1994a).

1.1 AUTHORITY

Pursuant to Sections 104(a)(1) and (b)(1) of CERCLA, 42 U.S.C. 9604(a)(1) and (b)(1), whenever there is a release or substantial threat of release of a hazardous substance into the environment, the President is authorized to act, consistent with the NCP, to remove or arrange for the removal of such hazardous substance or take any other response action, including appropriate investigation, deemed necessary to protect public health or welfare of the environment. Section 104(a) and (b) response authority (including the authority to perform an NTCRA) has been delegated to the Secretary of the Department of the Interior (DOI) pursuant to Executive Order 1258, 52 Fed. Reg. 2923 (1987), and further delegated to NPS by DOI Departmental Manual Part 207, Chapter 7, with respect to property under the jurisdiction, custody, or control of NPS.

1.2 PURPOSE AND OBJECTIVES

The NPS has determined that a removal action may be required at the Site and therefore an EE/CA must be completed. The goal of an EE/CA is to fill any data gaps related to the potential nature and extent of contamination, assess potential human health or ecological risks, determine if a removal action is needed, identify the objectives of a removal action and analyze the proposed alternatives to satisfy these objectives for cost, effectiveness, and implementability.

Section 300.415(b)(2) of the NCP establishes the criteria for determining the appropriateness of a removal action. The following are applicable criteria that support the determination to consider a removal action at the Site:

- Actual or potential exposure to nearby human population, animals, or the food chain from hazardous substances or pollutants or contaminants;
- Actual or potential contamination of drinking water supplies or sensitive ecosystems;
- High levels of hazardous substances or pollutants or contaminants in soils largely at or near the surface that may migrate and;
- Weather conditions that may cause hazardous substances or pollutants or contaminants to migrate or be released.

Previous Site investigations found contaminants of potential concern (COPCs) in exceedance of screening criteria, posing a potential danger to the human population and the surrounding environment. Based on these findings, NPS has determined that the use of removal action authority at SEKI to investigate, abate, prevent, minimize, stabilize, mitigate, and/or eliminate the release or threat of release of hazardous substances at or from the Site is appropriate. Additionally, NPS has determined that a planning period of at least six months exists before on-Site activities must be initiated. Therefore, NPS has authorized the conduct of an EE/CA pursuant to and in accordance with Section 300.414(b)(4) of the NCP. The Approval Memorandum (Appendix A; available upon request) provides the authorization for this EE/CA.

The objectives of this EE/CA are to determine the nature and extent of contamination, characterize background concentrations of metals, assess potential risks posed to human and ecological receptors from exposure to such contamination, and identify and evaluate removal action alternatives (RAAs) to address unacceptable risks.

2. SITE CHARACTERIZATION

2.1 SITE DESCRIPTION AND BACKGROUND

The Grant Grove Burn Dumpsite Solid Waste Management Unit (SWMU) No. 38 is located north of the community of Wilsonia and Grant Grove Village, west of Generals Highway and northeast of the horseback riding facility. The Site is located at latitude 36°44'46.97"N, longitude 118°58'1.46"W, at an elevation of approximately 6,620 feet above mean sea level (amsl) (see Figures 1 and 2). The burn pit was measured at 200 feet by 170 feet with an unknown depth.

2.2 SITE HISTORY

Sequoia National Park, the second-oldest national park in the U.S. (Yellowstone being the oldest), was established on September 25, 1890, and spans 404,063 acres. Among its natural resources is Mount Whitney at 14,494 feet amsl, the highest point in the contiguous 48 United States. The neighboring park, Kings Canyon National Park, was established on March 4, 1940, and covers 461,901 acres. Kings Canyon incorporated General Grant National Park, established on October 1, 1890, to protect the General Grant Grove of giant sequoias. Sequoia National Park is south of and connects with Kings Canyon National Park. Since 1943, Sequoia and Kings Canyon National Parks have been administered together by the NPS.

2.3 GRANT GROVE BURN DUMPSITE HISTORY

The Grant Grove Burn Dumpsite SWMU No. 38 was used as a domestic waste burn pit from 1929 to 1965. The former incinerator at SWMU No. 38 was built in the 1960s but was never used as an incinerator. Records indicate that the incinerator was dismantled in 1975. The Site was used for 36 years as a burn and burial pit for domestic waste and is currently being used by the NPS as a staging area for construction materials. NPS personnel frequently visit the area, which is not secured from trespassers and park wildlife. Two drainage swales extend from the Site perimeter downslope to the northwest and to the southwest.

2.4 SITE ENVIRONMENTAL CONDITIONS

2.4.1 Geology and Hydrology

SEKI is located on the western side of the Sierra Nevada mountain range, which is primarily composed of the igneous family of granites (NPS, 2013). SEKI also contains areas of metamorphic limestone or marble (NPS, 2013). SEKI soils derived from this igneous and metamorphic rock are generally granular in nature and relatively thin. SEKI contains a significant portion of the Sierra Nevada range. A second ridge of mountains within SEKI is the Great Western Divide with peaks higher than 12,000 feet. The majority of the mountains and canyons within SEKI consist of granite, diorite, and monzonite, however, small sections of the park also contain metamorphic rocks which include schist, quartzite, phyllite, and marble (NPS, 2017a).

SEKI contains roughly 3,200 lakes and ponds and approximately 2,600 miles of rivers and streams (NPS, 2017a). The headwaters of SEKI typically originate between 8,900 to 12,100 feet (2,700 to 3,700 meters). Water may flow through wet meadows and small alpine lakes and streams, and rapidly join to form larger streams and rivers (NPS, 2013). The four major river systems are: (1) the South Fork of the San Joaquin, (2) the North Fork of the Kern, (3) the South and Middle Forks of the Kings, and (4) the five forks of the Kaweah. These rivers provide for agricultural, recreational, and industrial activities in areas surrounding SEKI. At higher elevations, the amount of water stored as a result of snowpack increases through mid-April and melt-off typically begins in April and continues through May or June (NPS, 2013). Snowfields, forests, lakes and streams collect, store, and release the water supplied from winter storms and make water available throughout the dry summer months for agricultural, recreational, and electrical power uses, among others (NPS, 2017a).

Groundwater is typically restricted to localized fractures in bedrock, if at all (Environmental Cost Management, Inc. [ECM], 2015). Based on the elevation profile, the groundwater flow direction is to the northwest of the Site. As discussed in the 2015 Final SI, one water production well exists upgradient of the Site (see Figure 1) and 39 upgradient groundwater wells have been installed in the town of Wilsonia (Figure 1) with depth to groundwater ranging from 10 to 250 feet below ground surface (ECM, 2015). At the time of the initial Site visit conducted in June 2016 and during the August 2016 and July 2017 sampling events, there was no evidence of surface water or groundwater in the streambed or surrounding areas. However, periods of heavy rain and snowmelt may lead to the presence of surface water at the Site.

2.4.2 Climate, Vegetation, and Wildlife

2.4.2.1 Climate

Climate within SEKI can vary greatly based on altitude. Summer in the Site vicinity (between 6,000 and 7,000 feet amsl) consists of warm days and cool evenings. These elevations receive an average of 40-45" (102-114 centimeters [cm]) of precipitation annually. The majority of precipitation occurs during the winter, resulting in significant snow accumulation between December and May. Average winter temperatures can range from 24 °F-50 °F, whereas average summer temperatures range from 36 °F - 76 °F (NPS, 2017b).

2.4.2.2 Vegetation

The extreme topographic differences and elevation gradients (1,360 to 14,494 feet amsl) within SEKI contribute to the diverse vegetation present within the Park (NPS, 2017a). Based on the NPS SEKI species list database (Appendix B; available upon request), approximately 1,492 different vascular plants are present within SEKI (NPS, 2017c). These species make up unique plant communities including giant sequoia groves, montane forests, alpine habitats, and oak woodlands and chaparral. SEKI is characterized by red fir, lodgepole, foxtail, and whitebark pine forests, as well as diverse mixed-conifer forests which include ponderosa pine, incense-cedar, white fir, sugar pine, and scattered groves of giant sequoia.

Numerous wet meadows can be found in the montane, subalpine and alpine zones where the soil is too saturated to support tree growth. These meadows support a diverse collection of grasses, sedges and wildflowers, which provide essential habitat for wildlife. Dryland meadows also exist within SEKI and support wildlife at higher elevations. A short growing season and harsh winter conditions in the rocky alpine zone exclude all but the hardiest of plants and give way to low-growing, perennial herbs (NPS, 2017a).

More than 200 different vascular plant taxa are known from the Grant Grove area. Common trees include white fir, incense cedar, sugar pine, ponderosa pine, giant sequoia, jeffrey pine, and black oak. Common shrubs include greenleaf manzanita, mountain whitethorn, chinquapin, Sierra mountain misery, and Sierra gooseberry. Common herbs include violet draperia, Hartweg's iris, Sequoia bedstraw, Coville's groundsmoke, white flowered hawkweed, and whisker brush. Vegetation types (Aerial Information Systems [AIS], 2007) mapped within 0.25 miles of the project Site are:

- Greenleaf Manzanita-Bush Chinquapin-Whitethorn Ceanothus Shrubland Superalliance
- Intermittently to Seasonally Flooded Meadow
- Ponderosa Pine Woodland Alliance
- White Fir Forest Mapping Unit
- White Fir-(California Red Fir-Sugar Pine-Jeffrey Pine)/Whitethorn Ceanothus-(Greenleaf Manzanita) Forest Mapping Unit
- White Fir-Sugar Pine/Greenleaf Manzanita-Whitethorn Ceanothus Forest Mapping Unit
- White Fir-Sugar Pine-Incense-cedar Forest Superassociation
- Willow spp. Riparian Shrubland Mapping Unit
- Willow spp./Meadow Shrubland Mapping Unit

Vegetation data from four plots within 0.25 miles of the project Site contained the following twenty-seven taxa:

- arrowleaf ragwort (Senecio triangularis)
- California azalea (Rhododendron occidentale)
- campanulate onion (Allium campanulatum)
- canyon live oak (Quercus chrysolepis)
- chinquapin (Chrysolepis sempervirens)
- Coville's groundsmoke (Gayophytum eriospermum)
- green leaf manzanita (Arctostaphylos patula)
- incense-cdear (Calocedrus decurrens)
- little prince’s pine (Chimaphila menziesii)
- mountain whitethorn (Ceanothus cordulatus)

- pink flowererd stickseed (Hackelia mundula)
- ponderosa pine (Pinus ponderosa)
- quill cryptantha (Cryptantha affinis)
- round leaf snowberry (Symphoricarpos rotundifolius)
- Scouler’s willow (Salix scouleriana)
- Shelton's coyote mint (Monardella sheltonii)
- Sierra gooseberry (Ribes roezlii var. roezlii)
- spotted coralroot (Corallorhiza maculata)
- sugar pine (Pinus lambertiana)
- umbellate pussy paws (Calyptridium umbellatum)
- water leaf phacelia (Phacelia hydrophylloides)
- western bracken fern (Pteridium aquilinum var. pubescens)
- western needlegrass (Achnatherum occidentale californicum)
- white fir (Abies concolor)
- white stemmed gooseberry (Ribes inerme var. inerme)
- white-veined wintergreen (Pyrola picta)
- Yosemite rock cress (Arabis repanda var. repanda)

The whitebark pine is a candidate for federally threatened and endangered status under the Endangered Species Act. Species of concern within habitats similar to the project area in SEKI include Fresno bird’s beak (*Cordylanthus tenuis* ssp. *barbatus*), California pinefoot (*Pityopus californica*), inconspicuous monkeyflower (*Mimulus inconspicuous*), and Tulare gooseberry (*Ribes tularense*) although none of these are known to be present at the project Site.

2.4.2.3 Wildlife

Mammals

Based on the NPS SEKI species list database (Appendix B), there are currently approximately 71 different mammal species present within SEKI (NPS, 2017c). Commonly observed species include the following:

- Mule Deer
- American Black Bear
- Brazilian Free-tailed Bat
- Big Brown Bat
- Hoary Bat
- California Myotis
- Yuma Myotis
- American Pika

- Long-tailed Vole
- Big-eared Woodrat
- Brush Mouse
- Deer Mouse
- Botta's Pocket Gopher
- Mountain Pocket Gopher
- Yellow-bellied Marmot
- California Ground Squirrel
- Golden-mantled Ground Squirrel
- Alpine Chipmunk
- Lodgepole Chipmunk
- Douglas's Squirrel

Of these, both the rodent and bat populations are particularly diverse due to an extreme elevation gradient that ranges from 1,370 feet below park headquarters to 14,494 feet at the top of Mt. Whitney (NPS, 2017a). There are 27 species of rodents including mice, squirrels, gophers, chipmunks, marmots, wood rats, and porcupine. Seventeen species of bats use these parks, including several species of concern such as the pallid bat, big brown bat, spotted bat, silver-haired bat, western red bat, California myotis, long-eared myotis, little brown myotis, fringed myotis, long-legged myotis, Yuma myotis, and the Western pipistrelle. In addition to the above bat species, coyote, Pacific fisher, American badger, ringtail, and brush rabbit are all federal species of concern within SEKI. The American pika is a candidate for California threatened species of concern (NPS, 2017c). The Sierra Nevada bighorn sheep is federally listed as an endangered species.

Birds

The 865,964 acres of SEKI provide habitat for approximately 212 different bird species as presented in Appendix B (NPS, 2017c) and has earned SEKI the designation of a Globally Important Bird Area (NPS, 2017a). While some bird species live in the parks year-round, others only use the parks for breeding or as a stopover on their migration routes. Commonly observed species include the following:

- Sharp-Shinned Hawk
- Red-Tailed Hawk
- White-Throated Swift

- Anna's Hummingbird
- Band-Tailed Pigeon
- American Kestrel
- Black-Headed Grosbeak
- Western Tanager
- Northern Raven
- Steller's Jay
- Dark-Eyed Junco
- Red Fox Sparrow
- California Towhee
- Golden-Crowned Sparrow
- White-Crowned Sparrow
- Lesser Goldfinch
- Violet-Green Swallow
- Oak Titmouse
- Mountain Chickadee
- Yellow-Rumped Warbler
- Nashville Warbler
- Ruby-Crowned Kinglet
- Golden-Crowned Kinglet
- Wrentit
- House Wren
- Western Bluebird
- American Robin
- Western Screech Owl

There are approximately 49 species of concern within SEKI as presented in Appendix B (NPS, 2017c). Of these, the Swainson's hawk, bald eagle, willow flycatcher, and the great grey owl are California listed threatened and/or endangered species of concern and the black-backed woodpecker is a candidate for California listed threatened and endangered species of concern (NPS, 2017c). The northern spotted owl is federally listed as a threatened species.

Amphibians, Fish, and Reptiles

Amphibians, fish, and reptiles occur at all elevations within SEKI both perennially and seasonally. Based on the NPS SEKI species list database (Appendix B), currently there exists approximately 12 amphibians, 11 fish, and 21 reptile species within SEKI (NPS, 2017c). Commonly observed species include the following:

Amphibians

- Ensatina
- California Newt
- Kings River Slender Salamander

Fish

- Rainbow Trout
- Brook Trout

Reptiles

- Northern Alligator Lizard
- Southern Alligator Lizard
- Rubber Boa
- Common Kingsnake
- Striped Racer
- Pacific Gopher Snake
- Western Aquatic Garter Snake
- Western Terrestrial Garter Snake
- Western Fence Lizard
- Gilbert's Skink
- Western Whiptail
- Western Rattlesnake

Species of concern within SEKI include the ring-necked snake, Western toad, Mount Lyell salamander, and Kern River rainbow trout. The northern distinct population segment of the mountain yellow-legged frog and the Sierra Nevada yellow-legged frog are federally listed as endangered species, and the Yosemite toad is federally listed as a threatened species (NPS, 2017c).

Nonnative trout were introduced to high-elevation lakes and streams within SEKI from 1870 to 1988 to attract more anglers. This introduction has led to the rapid decline of the mountain yellow-legged frog populations due to predation (both mountain yellow-legged grog and Sierra Nevada yellow-legged frog). In addition to the trout introduction, the recent epidemic of amphibian chytrid fungus (*Batrachochytrium dendrobatidis*) has also been linked to the declining populations (NPS, 2017a).

2.5 PREVIOUS INVESTIGATIONS

2.5.1 Assessment Report

In March 2013, the California DTSC completed an Assessment Report (DTSC, 2013) that included six SWMUs in SEKI. The DTSC Assessment Report concluded that further environmental investigation was needed at SWMU No. 38 to determine the nature and extent of any release of hazardous waste or hazardous waste constituents from the Site. The DTSC Assessment Report also documented a Site visit conducted by DTSC and the NPS staff at SWMU No. 38 on October 18, 2012. Observed waste material around the downslope perimeter of the Site consisted of ash debris, old bottles, ceramic plates, broken glass, and metal. Although the NPS indicated that the area was partially excavated and backfilled with clean fill during dismantling of the incinerator, the burn pit material remains mostly in place. The DTSC Assessment Report stated: "this area is considered a potential environmental concern and further investigation is warranted".

2.5.2 Preliminary Assessment

In November 2013 a Preliminary Assessment (PA) that included SWMU No. 38 was conducted (ECM, 2014). The scope of the investigation included a review of available local, state, and federal agency file information; a preliminary evaluation of potential impacts to Site media; an identification of potential migration routes, exposure pathways, and receptors; a Site reconnaissance; and interviews with the NPS personnel. The results of the PA indicated that complete pathways of potential contaminant exposure to human and ecological receptors exist for soil, sediment, and surface water in the vicinity of the Site.

2.5.3 Site Inspection

A Site Inspection (SI) performed in June 2015 (ECM, 2015) quantified the concentrations of COPCs in the waste material, assessed potential impacts to the surface soil adjacent to the waste material, and assessed sediments downgradient from the Site. Soil samples upgradient of the Site were collected using an Incremental Sampling Methodology (ISM) to obtain background concentrations of metals in native surface soil near to the Site. The Site and background sampling locations for the SI investigation are presented on Figure 2. The SI Report recommended the preparation of an EE/CA for the selection of an NTCRA alternative for the Site.

2.6 EE/CA FIELD INVESTIGATION METHODS AND RESULTS

EE/CA field activities were conducted on 22 August 2016 through 24 August 2016, as well as 19 July 2017 through 20 July 2017 in compliance with the July 2017 Final EE/CA Work Plan, which included the Final Site-specific Health and Safety Plan (HASP) and Final Sampling and Analysis Plan (SAP) as appendices (Avatar, 2017). There were no temporal issues (i.e., snow cover or rainfall events) present at the time of either field events impacting the representativeness of Site conditions.

Figures 2 and 3 present the soil sample locations for the EE/CA investigation. Figure 2 presents the locations of the current EE/CA investigation, as well as the SI soil sample locations. Figure 3 presents the Site plan including composite sample locations and the geophysical investigation features. Figure 4 presents the geophysical survey line locations and Figures 5 through 9 present the plan view and cross sections for trenches T1 through T4. Appendix C (available upon request) provides documentation from the field activities including the Daily Quality Control Report (DQCRs), field log book entries, Geophysical Investigation Report, and a photo log for both the August 2016 and July 2017 field sampling events.

One objective of the EE/CA field investigation was to quantify the area and depth of waste dump material and adjacent impacted soil. This objective was satisfied through the use of geophysical tools, potholing, and trenching to determine the dimensions and volume of the former waste dump. This information was plotted on Google Earth to characterize the areas and volumes were estimated using direct observation and the profile areas of geophysical transects and trenches.

Advanced Geological Services, Inc. (AGS) performed the geophysical investigation, which included seismic refraction, ground penetrating radar (GPR) and electromagnetic terrain conductivity (EM) surveys to assess the thickness and extent of buried refuse at the Site. Seismic refraction was performed to delineate an upper low-velocity layer corresponding to buried refuse. GPR was performed to assess refuse thickness by imaging the top-of-bedrock surface. EM surveying was performed to look for conductivity anomaly(ies) indicative of buried refuse. The AGS findings are presented in Appendix C and include the following:

- Buried refuse appears to occur in two lobes separated by the granitic ridge angling northwest away from the Site's central plateau (Figure 4).

- Seismic refraction data, along with backhoe trench and hand-auger findings, indicate that refuse thickness ranges from less than one foot to greater than 10 feet. Refuse thickness is indicated by a black dashed line on the velocity layer models (Figure 3 of the AGS Geophysical Investigation Report).

- Because the "silty brown sand" found in Geocon's backhoe trenches exhibits the same seismic velocity as buried refuse, they cannot be distinguished with seismic refraction alone. Accordingly, AGS's interpretation of refuse thickness and extent is based on both the seismic results and Geocon's backhoe/hand-auger findings. The interpreted extent of buried refuse is indicated by a red dashed line on Figure 4.

- Rough estimates of refuse volume are 2,600 cubic yards (cy) for the northern lobe and 2,200 cy for the southwestern lobe, totaling 4,600 cy.

- An estimate of the volume of debris surrounding the Site refuse areas based on the area of observed surficial debris shown on Figure 17, is 2,800 cy.

The refuse area was characterized by composited samples comprising subsamples of visually-homogenous layers of relatively fine-grained sediment having a volume of less than 1,000 cubic yards. The debris area was characterized via samples composited from subsamples within an area of less than one acre. Both areas were sampled for 17 metals, TPH, PAHs, pesticides and herbicides, and dioxins/furans, as defined in the Final SAP. Section 2.6.1 below discusses the results of this characterization.

2.6.1 Soil Investigation Results

2.6.1.1 SI Investigation – Former Burn Dump Area

Tables 1a through 1d of the 2015 SI Report present the analytical results of the two decisions units (DUs) (DU1 and DU2) evaluated within the Former Burn Dump Area using an ISM sampling methodology (Appendix D; available upon request). As shown in Tables 1a through 1d, ORO, five herbicides, fourteen pesticides, fifteen dioxin/furan congeners, one PCB, and all of the metals with the exception of copper were detected in at least one of eight soil samples. No semi-volatile organic compounds (SVOCs) were detected at either of the two DUs.

2.6.1.2 EE/CA Investigation – Former Burn Dump Area

Table 1 presents the analytical results of the four soil samples located within the Former Burn Dump Area. These analytical results were similar to those observed at the locations discussed above. As shown, diesel range organics (DRO), motor oil range organics (ORO), one pesticide, nine dioxin/furan congeners, and twelve metals were detected in at least one sample. No SVOCs were detected among the four locations.

The 2015 SI DUs within the Former Dump area were evaluated using an ISM sampling approach which is not directly comparable to the composite samples collected as part of the EE/CA investigation. Nevertheless, it is worth discussing the results of both soil investigations within this area as they inform nature and extent of contamination as discussed below.

2.6.1.3 SI Investigation – Drainages

As discussed in the 2015 SI report, four dry stream channel samples were collected to assess any impacts to the drainages from potential off-Site migration. These four samples (SEKI-GG-SS-01 through SEKI-GG-SS-04) were collected from three separate drainages as presented in Figure 2. The following summarize the dry stream channel analytical results presented in the SI:

- Northern drainage (SEKI-GG-SS-01): Detected analytes included DRO, ORO, one PAH, 14 dioxin/furan congeners, five pesticides, and eleven metals (see Tables 1a through 1d of the SI report presented in Appendix D).

- Central drainage (SEKI-GG-SS-02 and SEKI-GG-SS-03): Detected analytes included DRO, ORO, four PAHs, sixteen dioxin/furan congeners, two herbicides, ten pesticides, and eleven metals (see Tables 1a through 1d of the SI report presented in Appendix D).

- Southern drainage (SEKI-GG-SS-04): Detected analytes included ORO, 12 dioxin/furan congeners, 1 herbicide, eight pesticides, and fourteen metals (see Tables 1a through 1d of the SI report presented in Appendix D).

Note that no SVOCs or PCBs were detected among the four locations.

2.6.1.4 EE/CA Investigation - Drainages

The Avatar team collected four subsurface waste material samples to delimit the extent of COPC migration down the three dry creek drainages which included the following:

- Northern drainage (GG-SO-01 - 100 feet down drainage from SI sample): Detected analytes included DRO, ORO, and ten metals (see Table 1).

- Central drainage (GG-SO-02 - 100 feet down drainage from SI sample and GG-SO-03 - 200 feet down drainage from SI sample): Detected analytes included ORO, 2 dioxin/furan congeners, and ten metals (see Table 1).

- Southern drainage (GG-SO-04 - 100 feet down drainage from SI sample): Detected analytes included ORO, 2 dioxin/furan congeners, and ten metals (see Table 1).

Note that no SVOCs, pesticides, or herbicides were detected among the four drainage locations.

In addition to individual sample analytical results discussed previously, Table 1 also presents a statistical data summary including the frequency of detection, the range of detected concentrations, the maximum detected location, the range of detection limits (DLs), the average, and the standard deviation for all of the Site soil data collected as part of the EE/CA investigation.

2.6.2 Nature and Extent of Contamination

A comparison of the SI and EE/CA contamination observed in the drainages with that detected in the Former Burn Dump Area indicates that contaminants are migrating down-gradient from the Former Burn Dump Area within all three drainages. However, contaminants detected within the Former Dump Area are detected at lower concentrations within all three drainages. Specifically, the EE/CA analytical results found DRO in the northern drainage, ORO in all three drainages, dioxin/furans in the central and southern drainages only, and metals in all three drainages. The presence of these contaminants is consistent with the findings in the Former Dump Area. Note that although herbicides and pesticides were detected within the Former Dump Area and the three drainages in the SI investigation, they were not detected in the EE/CA investigation. This inconsistency may be the result of higher laboratory DLs used in the EE/CA investigation. Nevertheless, the EE/CA DLs did in fact meet their data quality objectives (DQOs) as discussed further in Section 2.7.1.

2.6.3 Former Burn Dump Area Characterization

To evaluate the in-situ refuse for off-Site disposal, two 4-point composite samples (GG-SO-05 and GG-SO-06) and two 2-point composite samples (GG-SO-07 and GG-SO-08) were collected representing approximately 7,400 cy of refuse material from the accumulated debris around the edge of the platform and within the platform, as well as the debris field to the north and southwest of the buried refuse. Due to the heterogeneity present in each type of material, composite sampling was used to evaluate the general character of the refuse and debris potential waste streams. The characterization performed was intended to assess whether Site refuse and debris may or may not be hazardous, and was not intended to characterize either potential waste stream for direct disposal.

While the soil has not been characterized for disposal, concentrations of lead in refuse and debris at the Site may meet the criteria for RCRA hazardous waste since concentrations greater than 100 mg/kg were detected. Based on the presence of total lead at concentrations greater than 20 times the federal hazardous waste limit of 5.0 milligrams per liter (mg/L) in composited samples collected from the debris and refuse areas, these materials may be required to be disposed of in a RCRA Class I landfill. However, due to the length of time the lead-containing material has been exposed at the Site, leachable lead concentrations may be relatively low.

2.6.4 Background Sampling

Although background locations were characterized as part of the 2015 ECM's SI Report, these samples were collected using an ISM sampling approach and would not be applicable for comparison in the current investigation which used discrete and composite sampling approaches. The ISM approach is a highly structured type of composite sampling which results in a better estimate of mean values for a defined area than is achieved by discrete sampling. However, ISM does not provide an understanding of the distribution of concentrations at a site. If background ISM data are compared to Site ISM data, it is possible to determine if the Site is different from background. However, should it be necessary to clean up to background, it is necessary to collect discrete background samples so that an upper end value for background can be estimated. Therefore, discrete surface soil background samples were collected for comparison purposes within this EE/CA. In order to assess background conditions, fifteen (15) surface soil samples (GG-BG-01 through GG-BG-15) from a depth interval of 0-3 inches below grade were collected, as illustrated in Figure 2. Table 2 provides a summary of the background surface soil sample analytical results. Of the 17 metals, antimony and selenium were not detected in any of the collected background samples. Of the remaining 15 metals, cadmium and silver were only detected in a single background sample, molybdenum was detected in five, and the remaining 12 metals were detected in all 15 of the collected surface soil background samples.

Table 3 presents the background soil summary statistics and a comparison of the Site maximum detected concentrations and the Site-specific background threshold values (BTVs). BTVs were calculated using USEPA's ProUCL software program in accordance with the USEPA ProUCL 5.1 User's Guide (USEPA, 2015a). The BTVs were based on 95% Upper Simultaneous Limits (USLs) based on left-censored data with multiple DLs as recommended in the USEPA ProUCL Technical Guidance Manual (USEPA, 2015b) and are presented in the output provided in Appendix E (available upon request). Note that BTVs were not calculated for antimony, cadmium, selenium, and silver due to either lack of detections within the background dataset (antimony and selenium) or an inadequate number of detected concentrations to calculate a BTV (cadmium and silver). Barium, cobalt, and nickel had detected concentrations below their respective BTVs and are therefore not attributable to Site contamination and were not carried forward into the human health and ecological SREs. The remaining analytes (beryllium, cadmium, chromium, copper, lead, mercury, silver, vanadium, and zinc) were evaluated in both the HH and ecological SREs.

Figure 10 provides a graphical representation of the detected Site soil concentrations in exceedance of their respective BTVs. Exceedances exist for beryllium, chromium, copper, lead, mercury, vanadium and zinc. Sample locations GG-SO-05 and GG-SO-08 had the most exceedances (5), followed by GG-SO-06 with 4 exceedances, and GG-SO-01 and GG-SO-07 which each had one exceedance. Sample locations GG-SO-02, GG-SO-03, and GG-SO-04 did not have any BTV exceedances.

2.7 DATA QUALITY AND USABILITY

2.7.1 Data Quality Objectives

DQOs were developed to ensure that data collected for the current investigation are of sufficient quality to support their intended use for decision making requirements during the execution of the EE/CA. Field data characterizing subsurface waste material and surface soil background concentrations were collected to define the nature and extent of contamination, support the SREs in determining the potential risk to human or ecological receptors, and assist in the development and evaluation of remedial alternatives, as needed. The DQOs were established to assure that field measurements, sampling methods, and analytical data provide information that is comparable and representative of actual field conditions, and that the data generated during the EE/CA process is technically defensible. DQOs related to the types of data collected (subsurface waste material and surficial background soil), field activities, and sampling methods are discussed in detail above in Section 2.6. Representativeness of the data and how the data were used are discussed separately as they relate to the human health and ecological evaluations. The following subsections discuss the analytical data DQOs.

2.7.1.1 Data Validation

Data validation establishes through independent review that the data generated by the field sampling and laboratories are complete, compliant with the required methods and standard operating procedures, within accepted quality assurance/quality control limits, usable for established DQOs, and are properly documented.

All data were validated based on USEPA Stage 2A data validation guidelines including the specific activities listed below. Based on project DQOs, Stage 2A data validation was deemed appropriate and conducted for verification and validation based on completeness and compliance checks of sample receipt conditions, as well as sample-related QC results. Data validation memoranda were generated for all laboratory analytical data upon completion of the review. Stage 2A data validation activities included the following:

- Review of chain-of-custody documents to verify sample identities.
- Review of sample log-in documents to verify any noted potential problems with custody seals, container integrity, sample preservation, labeling, etc.
- Review of sample dates, extraction/digestion dates, and analysis dates to determine if maximum holding times were met or exceeded.
- Review of trip blank data to identify any potential problems with sample container contamination, preservative contamination, laboratory reagent water contamination, or cross-contamination between samples during transport.
- Review of method blank data to determine the presence of any sources of contamination in the analytical process.
- Review of matrix spike (MS) data to evaluate the potential for matrix effects and as a measure of analytical accuracy. MS recoveries were compared against laboratory

acceptance criteria to determine if they were within or outside of warning and control limits for percent recoveries.

- Review of MS/matrix spike duplicate (MS/MSD) data to evaluate sample homogeneity and as a measure of analytical precision. MS/MSD data were compared to laboratory acceptance criteria for the maximum relative percent difference (RPD).

- Review of any blank spike data (if available) as a measure of analytical accuracy. Recoveries were compared against laboratory acceptance criteria to determine if they were within or outside of warning and control limits for percent recoveries.

- Review of blank spike and blank spike duplicate [BS/BSD or laboratory control sample/laboratory control sample duplicate (LCS/LCSD)] data (if available) as a measure of analytical precision. BS/BSD data were compared to laboratory acceptance criteria for the maximum RPD.

- Review of surrogate recovery data to access extraction efficiency, effectiveness of sample introduction, and possible loss during cleanup activities. Surrogate recoveries were compared to laboratory acceptance criteria to determine if they were within or outside of acceptable limits.

The Stage 2A validation was conducted in accordance with:

- USEPA, Contract Laboratory Program National Functional Guidelines for Chlorinated Dibenzo-p-Dioxins and Chlorinated Dibenzofurans, Data Review, September 2011.

- USEPA, National Functional Guidelines for Superfund Organic Methods Data Review, September 2016.

- USEPA, National Functional Guidelines for Inorganic Superfund Data Review, August 2014.

- USEPA SW 846, Third Edition, Test Methods for Evaluating Solid Waste, update 1, July 1992; update IIA, August 1993; update II September 1994; update IIB, January 1995; update III, December 1996; update IIIA, April 1998; IIIB November 2004; update IV, February 2007; update V, July 2014.

The Data Validation Reports (DVRs) present data validation findings and results for the associated samples. Where specific guidance was not available, the data were evaluated in a conservative manner consistent with industry standards using professional experience.

2.7.1.1.1 August 2016 – Site Soil Samples

Soil samples collected from the Site were analyzed by TestAmerica laboratory using the following USEPA SW methods:

- CAM 17 Metals by USEPA Methods 6010B and 7471A
- Dioxins and Furans by USEPA Method 8290
- Total petroleum hydrocarbons (TPH) in the diesel and motor oil ranges (TPH-DRO and -ORO) by USEPA Method 8015B
- Polycyclic aromatic hydrocarbons (PAHs) by USEPA Method 8270C-SIM
- SVOCs by USEPA Method 8270C
- Chlorinated Herbicides by USEPA Method 8151A, and
- Organochlorine Pesticides by USEPA Method 8081A

Appendix F (available upon request) contains the laboratory data packages provided by TestAmerica, as well as the DVRs provided by Laboratory Data Consultants, Inc. (LDC). The following summarizes the data validation findings for the August 2016 sample analyses:

- All samples were received in good condition and cooler temperatures upon receipt met validation criteria. All technical holding times were met.
- Laboratory blanks were analyzed as required by the method. No contaminants were found in the laboratory blanks.

- Sample GG-ER-01 was identified as an equipment blank. No contaminants were found with the exception of lead.

- Surrogates were added to all samples as required by the method. All surrogate recoveries were within QC limits with the exception of the following:

    - PAHs: 2-fluorobiphenyl and nitrobenzene-d5 which were flagged with a UJ.

    - Pesticides: decachlorobiphenyl which was flagged with a UJ.

- MS and MSD sample analysis was performed for PAHs and lead. Percent recoveries were within quality control (QC) limits with the exception of acenaphthene, acenaphthylene, anthracene, benzo(a)anthracene, benzo(b)fluoranthene, chrysene, fluorene, naphthalene, phenanthrene, and pyrene which were all flagged with a UJ.

- RPDs were within QC limits.

- LCS' were analyzed as required by the method. Percent recoveries were within QC limits.

- All internal standard areas and retention times were within QC limits.

- The analyses were conducted within all specifications of their respective method. No results were rejected.

The QC criteria reviewed, other than those discussed above, were met and are considered acceptable. Sample results that were found to be estimated (J) are usable for limited purposes, including risk assessment. Based upon the data validation, all other results were considered valid and usable for all purposes.

2.7.1.1.2 July 2017 – Background Soil Samples

Soil samples collected from the Site background were analyzed by TestAmerica laboratory using the USEPA Methods 6020B and 7470A/7471A for CAM 17 Metals.

The following summarizes the data validation findings for the July 2017 sample analyses:

- All samples were received in good condition and cooler temperatures upon receipt met validation criteria. All technical holding times were met.

- Laboratory blanks were analyzed as required by the method. No contaminants were found in the laboratory blanks with the exception of copper and selenium. Data qualification by the laboratory blanks was based on the maximum contaminant concentration in the laboratory blanks for each analyte. The sample concentrations were either not detected or were significantly greater (>5X blank contaminants) than the concentrations found in the associated laboratory blanks. The exception to this was for selenium in all but one sample which resulted in non-detect qualifiers.

- Samples GG-ER-01 and GG-ER-02 were identified as equipment blanks. No contaminants were found with the exception of copper, lead and zinc in GG-ER-01 and barium, copper, lead, and zinc in GG-ER-02. Sample concentrations were compared to concentrations detected in the field blanks. The sample concentrations were either not detected or were significantly greater (>5X blank contaminants) than the concentrations found in the associated field blanks.

- MS and MSD sample analysis was performed for PAHs and lead. Percent recoveries were within QC limits.

- RPDs were within QC limits.

- LCS' were analyzed as required by the method. Percent recoveries were within QC limits.

- All internal standard areas and retention times were within QC limits.

- The analyses were conducted within all specifications of their respective method. No results were rejected.

The QC criteria reviewed, other than those discussed above, were met and were considered acceptable. Sample results that were found to be estimated (J) are usable for limited purposes, including risk assessment. Based upon the data validation, all other results were considered valid and usable for all purposes.

2.7.1.2 Detection Limit Exceedances

As summarized in the TestAmerica laboratory report presented in Appendix F, due to the nature of the sample matrix, all eight (8) of the Site soil samples could not be concentrated to the final method required volume and were diluted, which resulted in elevated DLs. In some cases, the resultant elevated DLs were above human health and/or ecological screening criteria. Several COPCs were reported as non-detect in all Site samples, however some had DLs in exceedance of the human health (antimony, arsenic, and thallium) and ecological (antimony, arsenic, selenium, thallium, and endrin) screening criteria. The implications of these exceedances are discussed further in the uncertainty analysis for the human health and ecological screening evaluations.

3. STREAMLINED RISK EVALUATION (SRE)

3.1 HUMAN HEALTH SRE

As discussed in USEPA's *Guidance on Non-Time-Critical Removal Actions Under CERCLA* (USEPA, 1993a), the HH SRE is intermediate in scope between the limited risk evaluation undertaken for emergency removal actions and the conventional baseline assessment typically conducted for remedial actions. The SRE is intended to justify taking an interim removal action and identifying what current or potential exposure should be prevented, in addition to projecting the potential risk occurring if no cleanup action is taken at the Site. The results of the SRE inform decision makers about whether an interim cleanup action is required at the Site and what exposures need to be addressed by the action, and if necessary, define appropriate cleanup levels. Because NPS uses EE/CAs as final removal action decision documents, this human health evaluation includes additional aspects of the USEPA Risk Assessment process and includes the following components:

1. **Hazard Identification**. The Hazard Identification includes a review of the available data, provides a description of the guidelines and approach for data reduction and evaluation, and identifies the COPCs.

2. **Exposure Assessment.** The exposure assessment presents the physical setting (i.e., local land and water uses), a Conceptual Site Model (CSM) that includes the source(s) of contamination, the affected media, and the current and future exposure scenarios and their associated exposure pathways, calculation of exposure point concentrations (EPCs), and calculation of exposure doses for potential Site receptors.

3. **Toxicity Assessment.** The toxicity assessment presents the toxicity values used to estimate carcinogenic and noncancer (i.e., systemic) effects from each of the selected COPCs.

4. **Risk Characterization.** The risk characterization presents the results of the integration of the exposure and toxicity assessment sections in the form of estimated excess lifetime cancer risks and noncancer hazard quotients (HQs)/indices (HIs).

5. **Uncertainty Analysis.** The uncertainty analysis presents a discussion regarding the uncertainties inherent in the risk assessment process associated with the exposure parameters, toxicity values, and other processes used to determine risks.

3.1.1 Hazard Identification

3.1.1.1 Data Reduction

A summary of available data is discussed previously in Section 2.6. Only subsurface soil data exist for evaluation in this EE/CA. Although the Site data collected satisfy the DQO of identifying the nature and extent of contamination and characterizing waste material, they are not directly representative of human health receptor exposures. Typically, subsurface soils are used to evaluate receptor exposure to soils from activities that involve disturbances of deeper soils such as construction activities resulting in the re-mixing and re-distribution of subsurface soils to the ground surface. However, fill was observed at multiple depths ranging from 6-inches to approximately 4 feet. Therefore, based on the presence of fill and sampling depths recommended in the Statement of Work (SOW), subsurface soils were evaluated for both current and future receptors for the sake of this investigation.

The soil data utilized in this evaluation consist of validated analytical results of known and sufficient quality for use in quantitative risk calculations (see Section 2.7). The following briefly summarizes the data reduction process for use in the HH and ecological SREs:

1. None of the analytical results were qualified as rejected (“R”) during the data validation process, which would have been removed from consideration based on their potential unreliability.

2. Estimated values (J-qualified) were incorporated at the reported value.

3. All U-qualified results represent non-detect concentrations. Non-detects, at their full DL, were incorporated into the calculation of average concentrations as well as 95% upper confidence limits (UCLs).

4. If a contaminant was not detected in any sample, it was not identified as a COPC. However, because antimony, arsenic, and thallium were never detected but had minimum DLs in exceedance of their respective human health screening criteria, whether these contaminants are COPCs is unknown. These contaminants are, therefore, discussed further in the Uncertainty Analysis.

3.1.1.2 Selection of Contaminants of Potential Concern

The COPC selection process, as presented in Table 4, was conducted to identify a subset of contaminants that were detected in the soil that could pose a potential risk to human receptors who might contact the affected media. The approach used in this HH SRE to determine if a contaminant was a COPC included a comparison of the maximum detected concentrations to the USEPA's Residential Soil Regional Screening Levels (RSLs) (USEPA, 2017). For screening purposes, a target hazard quotient (THQ) for noncancer-based RSLs of 0.1 was conservatively used. This was done to account for the potential additive effects of multiple contaminants impacting similar target organs. A target risk (TR) for cancer-based RSLs of one-in-a-million (expressed as $1x10^{-6}$) was used. When an analyte did not have a screening criterion available, a suitable surrogate analyte was identified and the screening value for the surrogate analyte was used in the COPC selection process. The analytes for which surrogate screening values were used are noted on the COPC screening table (Table 4). If the maximum detected concentration was less than the Residential Soil RSL, the analyte was eliminated from further consideration in the HH SRE. If the maximum concentration exceeded the RSL, the contaminant was identified as a COPC.

Based on detected concentrations in exceedance of the Residential Soil RSL, Site COPCs for human health consist of lead, vanadium, 2,3,7,8-TCDD TEQ, and ORO. Additionally, Figure 11 provides a graphical representation of the detected concentrations and human health screening criteria exceedances. Note that barium, cobalt, and nickel were removed from consideration in the HH SRE based on detected concentrations being below background. As shown, limited exceedances of lead, vanadium, 2,3,7,8-TCDD TEQ, and ORO exist for the human health SRE. Sample location GG-SO-06 had two exceedances (lead and 2,3,7,8-TCDD TEQ) and GG-SO-01 and GG-SO-08 had one exceedance (ORO and vanadium, respectively). The remaining locations did not have any human health screening criteria exceedances.

3.1.2 Exposure Assessment

3.1.2.1 Conceptual Site Model

A CSM describes the contaminant sources, the release and transport mechanisms, the receiving media, the exposure media, the exposure routes, and the potentially exposed receptors. The primary objective of the CSM is to identify complete and incomplete exposure pathways. A complete exposure pathway has all of the above-listed components, whereas an incomplete pathway is missing one or more. Figure 12 illustrates the human health CSM that was developed for the Site and was utilized in the HH SRE. Each component of the CSM is discussed in the following sections.

The primary sources of contamination at the Site are related to the burn and burial pit for domestic waste activities that occurred from 1929 to 1965 as discussed in Section 2.3. Generally, contaminants may be released from soil by mechanisms such as storm water runoff, wind erosion of surface soil, leaching and infiltration to the subsurface, migration through the subsurface soil to the water table, or excavation within areas of contamination. Once released from the source, contaminants can be transported to and in media such as groundwater, air, surface water, or sediment.

Based on the review of the current and potential land and water uses and the results of previous investigations, the primary exposure media of potential concern to human receptors at the Site consist of surface and subsurface soils. Direct contact with soils (soil ingestion and dermal absorption) and inhalation of particulates are the potential exposure routes for current and future human health receptors.

As discussed in the 2015 SI and as discussed previously in Section 2.4.1, the groundwater exposure pathway was not considered a complete exposure pathway and was not quantitatively evaluated for human health receptors. In addition to the depth to groundwater and upgradient location of the nearest groundwater wells, the 2015 SI performed leachate testing to further refine the CSM and to address the potential leaching of lead from impacted soil to groundwater. The SI investigation submitted the ISM sample with the highest lead concentration to the laboratory to assess the potential for leaching of metals to groundwater. Solubility threshold limit concentration (STLC) testing was performed and resulted in a non-detect, indicating that leaching of metals does not pose a threat to Site groundwater.

As shown on Figure 12, potentially complete exposure pathways (source(s), release and transport mechanism(s), contaminated media, potential exposure routes, and receptors) exist at the Site. Potential current and future exposed human health receptors include NPS Park Workers (NPS staff and subcontractors) and child and adult recreational visitors/trespassers.

3.1.2.2 Exposure Point Concentrations

EPCs are the COPC concentrations that a receptor is assumed to contact during exposure to Site media of concern. The subsections below present the methods used to calculate the EPCs using USEPA's ProUCL software program, Version 5.1.002 (USEPA, 2016b). ProUCL calculates 95% UCLs using 15 different computation methods, 5 parametric and 10 non-parametric. Parametric methods rely on the estimation of parameters (such as the mean or the standard deviation) describing the distribution of the variable of interest in the population; non-parametric methods do not.

Non-detects, at their full DL, were imported into ProUCL as part of the full dataset and were treated as non-detects. ProUCL then used the DLs in order to use the regression on order statistics (ROS) and Kaplan-Meier (KM) methods for estimating population parameters (i.e., mean and standard deviation) and estimating values below their DLs. These estimations were then used to calculate the appropriate parametric or non-parametric UCL. The UCLs were selected as guided by the ProUCL recommendation. If the recommended UCL exceeded the maximum detected concentration, the maximum concentration was selected as the EPC.

As discussed in the ProUCL User's Guide (USEPA, 2015), decisions based upon statistics computed using discrete data sets of small sizes (e.g., < 6) cannot be considered reliable enough to make remediation decisions that affect human health and the environment. Although only eight (8) samples were collected, the current investigation takes into consideration ProUCL's recommendation that a data set collected from a Site population (e.g., area of concern, exposure areas, decision units) should be representative of the Site area under investigation. This DQO has been met with the samples collected for this investigation, which also exceed ProUCL's minimum required sample size of 6.

Supporting documentation (ProUCL outputs) for the calculation of the UCLs is presented in Appendix E. The soil EPCs used in the HH SRE are presented in Table 9.

3.1.2.3 Exposure Equations and Parameters

This section presents the equations and parameters that were used to estimate the chronic daily intakes (exposure doses) of the COPCs for each receptor through the applicable exposure pathways. Where Site-specific information was available, that information was used in the estimates of exposure. In particular, SEKI staff provided input regarding NPS worker and recreational visitor/trespasser exposure frequencies (EF), exposure durations (ED), and exposure times (ET) (see Tables 5 through 8). In the absence of Site-specific information, exposure was estimated using standard default values recommended by USEPA. The exposure equations and assumptions are presented in Tables 5 through 8 for the NPS park worker and child and adult recreational visitors/trespassers, respectively.

Exposure doses are dependent upon the magnitude, frequency, and duration of exposure. They are estimated by combining the COPC concentration (i.e., the EPC) and the exposure parameters. The exposure doses are expressed as intakes in milligrams of COPC per kilogram of body weight per day (mg/kg-day). Two types of doses were calculated in this HH SRE. The first, the lifetime average daily dose (LADD), which is averaged over a 70-year lifetime, was used to estimate cancer risk. The second, the average daily dose (ADD), which is averaged over the actual ED for each receptor, was used to estimate noncancer health effects.

The USEPA RSL calculator was used to obtain the LADD and ADD for both the park worker and recreational visitor/trespasser scenarios (USEPA, 2018). The RSL Calculator is a tool provided by USEPA to assist Remedial Project Managers, On Scene Coordinators, risk assessors and others involved in decision-making concerning CERCLA hazardous waste sites in determining whether levels of contamination found at a Site may warrant further investigation or site cleanup, or whether no further investigation or action may be required. The exposure parameters used in the calculator are based on default and/or Site-specific exposure parameters and factors that represent Reasonable Maximum Exposure (RME) conditions for long-term/chronic exposures and are based on the methods outlined in USEPA's Risk Assessment Guidance for Superfund, Part B Manual (1991) and USEPA’s Soil Screening Guidance document (2002). The RSL Calculator is updated frequently to reflect any changes in the toxicity and chemical-specific parameters and the current investigation incorporates the most recent updates as presented in the November 2017 RSL update (USEPA, 2018). The RSL Calculator output based on the exposure assumptions provided in Tables 5 through 8 are provided in Appendix G (available upon request).

3.1.3 Toxicity Assessment

The primary purpose of the toxicity assessment is to identify the toxicity values for the COPCs used in the estimation of potential cancer risks and noncancer health effects. It also provides a description of the terms that are used to estimate toxic effects (i.e., cancer and noncancer effects) along with the data sources. The RSL calculator output provided in Appendix G presents the toxicity values (oral, dermal, and inhalation) for each COPC that were utilized to calculate cancer risks and noncancer health effects.

3.1.3.1 Cancer Effects

For cancer effects, the toxicity values are expressed as either cancer slope factors (CSFs) in units of milligrams of COPC per kilogram of body weight per day $(mg/kg\text{-}day)^{-1}$ or inhalation unit risk factors (URFs) in units of per micrograms of COPC per cubic meter $(\mu g/m^3)^{-1}$. The cancer potency of a contaminant is directly proportional to the CSF/URF value; the higher the CSF/URF, the more potent the contaminant is as a carcinogen.

3.1.3.2 Noncancer Effects

Noncancer effects refer to adverse health effects other than cancer. Noncancer effects can include, for example, central nervous system damage, reproductive effects, and other systemic effects. For noncancer effects, the toxicity values are expressed as either reference doses (RfDs) in units of mg/kg-day for exposure through ingestion and dermal contact or reference concentrations (RfCs) in $\mu g/m^3$ for exposure through inhalation. The premise of noncancer toxicity values is that there is an exposure level below which adverse health effects, even in sensitive populations, are not expected to occur. An RfD or RfC is inversely proportional to the toxic potency of a contaminant.

3.1.3.3 Sources of Toxicity Values

The USEPA RSL Calculator uses the following hierarchy for determining toxicity values:

- Tier 1 – USEPA's Integrated Risk Information System (IRIS)
- Tier 2 – USEPA's Provisional Peer Review Toxicity Values (PPRTVs)
- Tier 3 – Other toxicity values including California EPA (CalEPA) values, Agency for Toxic Substances and Disease Registry (ATSDR) Minimal Risk Levels (MRLs), and toxicity values developed by various State agencies.

3.1.4 Risk Characterization

The objective of the risk characterization is to integrate the information developed in the exposure assessment and the toxicity assessment to provide an estimate of the potential risk associated with exposure to COPCs. Both cancer risks and noncancer health effects were evaluated in the HH SRE. Carcinogenic risks were calculated for those COPCs with evidence of carcinogenicity and for which CSFs or URFs are available. Noncancer health effects were evaluated for COPCs (i.e., including carcinogens) for which RfDs or RfCs are available.

3.1.4.1 Cancer Risk

Potential cancer risks were calculated by multiplying the estimated LADD for a COPC through an exposure route by the CSF or URF, as follows:

$$\text{Risk} = \text{LADD} * \text{CSF or URF}$$

Where:

LADD = Lifetime average daily dose; intake averaged over a 70-year lifetime as mg/COPC/kg-body weight per day or $\mu g/m^3$

CSF = COPC- and route-specific cancer slope factor $(mg/kg\text{-}day)^{-1}$

URF = COPC-specific inhalation unit risk factor $(\mu g/m^3)^{-1}$

Cancer risks were summed across the relevant pathways for a given receptor and exposure scenario to yield a cumulative lifetime risk for that specific scenario. USEPA's cancer risk range is an increased risk of developing cancer, based on a plausible upper-bound estimate of risk. In general, the USEPA considers excess cancer risks that are below about 1 chance in 1,000,000 (1E-06) to be so small as to be negligible and do not require remedial action, and risks above 1E-04 to be sufficiently large that some sort of remediation is desirable. Excess cancer risks that range between 1E-06 and 1E-04 are generally considered to be acceptable. The NPS cancer risk goal is an increased risk of developing cancer, based on a plausible upper-bound estimate of risk, of less than or equal to 1 in 1,000,000 (1E-06).

3.1.4.2 Noncancer Health Effects

Potential noncancer health effects were evaluated by the calculation of HQs and HIs. An HQ is the ratio of the ED ADD through a given exposure route to the COPC-specific RfD or RfC. The HQ-RfD/RfC relationship is illustrated by the following equation:

$$HQ = ADD/RfD \text{ or } RfC$$

Where:

HQ = Hazard quotient.

ADD = Average daily dose; estimated daily intake averaged over the exposure duration (mg/kg-day).

RfD = Reference dose (mg/kg-day).

RfC = Reference concentration (μ/m^3).

HQs were summed to calculate HIs for each scenario. HIs were calculated for each exposure route, and a total HI was calculated based on exposure to the COPCs from all exposure routes for each receptor. HIs of less than one indicate that adverse health effects associated with the exposure scenario are unlikely to occur and that remedial action is not warranted.

3.1.4.3 Risk Characterization Results

Table 9 summarizes the cancer and non-cancer HIs for both the NPS park worker and the child and adult recreational visitor/trespasser scenarios. The total soil cancer risks for the NPS park worker and the recreational visitor/trespasser were well below USEPA's acceptable cancer risk range and NPS' cancer risk goal with cancer risks of 2.1E-08 and 2.7E-08, respectively. Note that 2,3,7,8-TCDD TEQ was the only carcinogenic COPC and was the sole contributor to the total cancer risk. The total soil HIs were significantly less than the noncancer threshold of 1.0 with total HIs of 0.002, 0.006, and 0.0006 for the NPS park worker, child recreational visitor/trespasser, and adult recreational visitor/trespasser, respectively.

3.1.4.4 Lead

Lead is one of the most well-known human toxins, with no known physiological use in humans. The most vulnerable receptors for lead are human fetuses and young children and blood lead concentrations are the best-known predictor of adverse effects. Therefore, USEPA has developed both child and fetal models for estimating blood lead concentrations from environmental exposure to lead. The child model is called the Integrated Exposure and Uptake Biokinetic (IEUBK) model and the fetal model, which estimates fetal blood lead concentrations for a pregnant woman, is called the Adult Lead Model (ALM) (USEPA, 2003, 2009).

The ALM slope factor approach focuses on estimating fetal blood lead concentrations in pregnant women exposed to lead-contaminated soil in non-residential scenarios. The ALM estimates the 95th percentile blood lead concentration among fetuses born to women having site exposures. Blood lead levels are compared to the established blood lead level of concern of 10 micrograms per deciliter (µg/dL). An additional step in the process estimates the probability that blood lead levels will exceed 10 µg/dL. USEPA's risk reduction goal for lead is that individuals exposed would have no more than a 5 percent probability of exceeding the level of concern of 10 µg/dL.

The lead average concentration (111 mg/kg), as well as default parameters recommended by the Technical Review Work Group for Lead (TRW) were used in the ALM. Although the default soil ingestion rate for the ALM is 50 milligrams per kilogram (mg/kg), this value is based on a central tendency value for non-contact-intensive activities. For this evaluation, it was assumed that an NPS worker or recreational visitor/trespasser may have more contact-intensive activities at the Site and therefore a soil ingestion rate of 100 mg/kg was assumed for both receptors (USEPA, 2014c). Default recommended values were assumed for all of the remaining input criteria. The ALM estimated that the 95th percentile blood lead concentration among fetuses born to women NPS park workers and adult recreational visitors/trespassers exposed to soil at the Site would be 1.5 µg/dL (Appendix H, available upon request). This estimate is less than USEPA's established level of concern of 10 µg/dL. The probability that the fetal blood lead concentration exceeds 10 µg/dL is 0% for both the NPS park worker and adult recreational visitors/trespasser exposed to soil. USEPA's target probability is 5 percent or less. Because of recent scientific evidence that has demonstrated adverse health effects at blood lead concentrations below 10 µg/dL down to 5 µg/dL, and possibly lower, the USEPA Office of Superfund Remediation and Technology Innovation (OSRTI) is developing a new soil lead policy to address this new information (USEPA, 2009). The results of the ALM indicate that adverse effects are not anticipated for fetuses of pregnant NPS workers or recreational visitors/trespassers exposed to lead in soil at the Site assuming even the more conservative 5 µg/L level of concern. The input parameters used, the results of the ALM, and estimated blood lead levels are presented in Appendix H.

In order to address child recreational visitor/trespasser exposure to lead in soil at the Site, the USEPA IEUBK model was used (USEPA, 1994b and 2007a). The IEUBK Model is designed to estimate blood levels of lead in children (under 7 years of age) based on either default or Site-specific input values for air, drinking water, diet, dust, and soil exposure under a residential scenario. Therefore, the IEUBK model represents a conservative approach to evaluating recreational visitor/trespasser exposure to lead at the Site. An age range of 0-84 months was assumed for the recreational child and the average lead concentration of 111 mg/kg was used for the outdoor soil concentration. Default recommended values were assumed for all of the remaining input criteria. The model results estimated that the geometric mean blood lead concentration among child recreational visitors/trespassers exposed to soil at the Site would be 1.096 µg/dL (Appendix H). This estimate is less than USEPA's established level of concern of 10 µg/dL as well as the more conservative 5 µg/L level of concern. The probability that the child's blood lead concentration exceeds 10 µg/dL is 0.021%, which is less than USEPA's target probability of 5% or less. The input parameters used, the results of the IEUBK, and estimated blood lead levels are presented in Appendix H.

3.1.5 Uncertainty Analysis

The goal of an uncertainty analysis in a risk assessment is to provide to the decision makers (i.e., risk managers) information about the key assumptions, their inherent uncertainty and variability, and the impact of this uncertainty and variability on the estimates of risk. The uncertainty analysis shows that risks are relative in nature and do not represent an absolute quantification. The bullets below identify the relevant uncertainties in the HH SRE process to determine if the calculated risks may have been overestimated or underestimated, and the approximate degree to which this may have occurred.

1. **DL exceedances:** Although not detected in any samples, antimony, arsenic, and thallium had DLs in exceedance of their respective USEPA Residential Soil RSL value. Although these analytes had elevated DLs (minimum DLs of 5.1 mg/kg, 1.5 mg/kg, and 5.1, respectively), the DLs for antimony and arsenic only slightly exceeded their respective RSLs (3.1 mg/kg, 0.68 and mg/kg), while the exceedance for thallium is significant (DL of 5.1 mg/kg and RSL of 0.078 mg/kg). It is possible that Site risks are slightly underestimated for antimony and arsenic, and potentially significantly underestimated for thallium. In order to understand the extent to which Site risks may be underestimated for these metals, the RSL calculator was used to estimate potential cancer risks and noncancer HIs for both the park worker and the recreational user using the minimum DL as the soil exposure concentration. The following summarizes these results:

- Park worker - cancer risk of 4.0E-08 for arsenic, noncancer HIs of 0.0009, 0.0002, and 0.09 for antimony, arsenic, and thallium, respectively.

- Recreational user – cancer risk of 5.1E-08 for arsenic; child noncancer HIs of 0.004, 0.001, and 0.1 for antimony, arsenic, and thallium, respectively; adult noncancer HIs of 0.0003, 0.0001, and 0.01 for antimony, arsenic, and thallium, respectively.

Based on these results, exposure to these metals would not result in unacceptable risks to Site receptors.

2. **The selection of exposure assumptions –** The exposure parameters used to evaluate the NPS worker and recreational visitor/trespasser are based on a RME scenario. A RME scenario is defined as the "maximum exposure that is reasonably expected to occur at the Site". These RME assumptions may contribute to an overestimation of risk.

3.2 ECOLOGICAL SRE

The ecological SRE documents the potential exposure and risks to ecological receptors exposed to soil contamination within the Site. During the SRE process, contaminants of potential ecological concern (COPECs) are identified, the potential for wildlife exposure to COPECs is evaluated, and an analysis of the potential ecological risk is conducted.

This SRE was conducted in accordance with the Final Work Plan (Avatar, 2017). The primary sources of guidance used to develop the Work Plan and subsequent SRE include:

- *NPS Protocol for the Selection and Use of Ecological Screening Values for Non-Radiological Analytes,* Rev. 2, Feb. 18, 2016 *(hereafter, referred to as NPS Protocol)* (NPS, 2016).
- *Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments (hereafter, referred to as the USEPA Guidance) (USEPA, 1997).*
- *The Role of Screening-Level Risk Assessments and Refining Contaminants of Concern in Baseline Ecological Risk Assessments. Office of Emergency and Remedial Response U.S. Environmental Protection Agency. USEPA 540/F-01/014. June 2001 (USEPA, 2001).*

The NPS Protocol (2016) describes the hierarchy and final selection of ecological screening values (ESVs) used in this SRE. The USEPA Guidance (USEPA, 1997) describes a progressive and iterative process that is consistent with and incorporates the basic and fundamental approach to performing ecological risk assessments (ERAs) outlined by USEPA's Risk Assessment Forum in its *Framework for Ecological Risk Assessment* (Framework) (USEPA, 1992) and *Guidelines for Ecological Risk Assessment* (Guidelines) (USEPA, 1998).

The USEPA Guidance outlines an 8-step process for a Baseline Ecological Risk Assessment (BERA) and several scientific/management decision points (SMDPs). An SMDP represents a significant communication point for the interaction of the risk manager and the risk assessment team. The purpose of the SMDP is to evaluate the relevant information and to re-evaluate the scope, focus, and direction of the ERA. The NPS Protocol (2016) and SRE are similar in approach and purpose to the USEPA's first two steps for a BERA. These first two steps are also known as a screening level ecological risk assessment (SLERA).

This SRE or SLERA covers Step 1 – Screening-level problem formulation and ecological effects evaluation and Step 2 – Screening-level preliminary exposure estimates and risk calculation and the first SMDP outlined in the 8-step ERA process (Figure 13).

In Step 1, the following information is provided:

1) a habitat description of areas potentially affected;
2) a discussion of the ecological conditions and potential receptors present at the Site;
3) the preliminary conceptual site exposure model (CSEM) (e.g., pathways by which the receptors may be exposed);
4) the preliminary assessment and measurement endpoints;
5) the data available to evaluate potential ecological risk for the Site; and
6) the medium-specific, screening-level ESVs appropriate for identifying COPECs.

In Step 2, maximum Site contaminant concentrations are compared with the screening-level ESVs to identify COPECs, followed by further assessment of potential ecological risk. Step 2 is divided into two screenings: Level 1 – Initial COPEC Selection; and if needed, Level 2 – Exposure Estimate/Risk Calculation.

Because NPS uses EE/CAs as final removal action decision documents, the Step 2, Level 2 assessment has considered the following documents in the development of the SRE:

- *Guidelines for Ecological Risk Assessment* (USEPA, 1998);
- *Framework for Ecological Risk Assessment* (USEPA, 1992);
- *The Role of Screening-Level Risk Assessments and Refining Contaminants of Concern in Baseline Ecological Risk Assessments* (USEPA, 2001);
- *Wildlife Exposure Factors Handbook, Volumes I and II* (USEPA, 1993b); and
- *Screening Level Ecological Risk Assessment Protocol for Hazardous Waste Combustion Facilities* (USEPA, 1999).

3.2.1 Screening-Level Problem Formulation and Ecological Effects Evaluation (Step 1)

The initial Problem Formulation step in the SRE and USEPA's SLERA includes the evaluation and aggregation of information available for the Site. This initial step provides the basis for the streamlined assessment and consists of a variety of technical components including:

- Description of the Ecological Setting;
- Development of a Preliminary CSEM;
- Selection of Preliminary Assessment Endpoints;
- Description of Site Studies and Available Data;
- Evaluation of Data and Reduction;
- Selection of Ecological Screening Values;
- Identification of COPECs.

3.2.1.1 Ecological Setting

This SRE focuses on the Grant Grove Burn Dumpsite Solid Waste Management Unit No.38, SEKI, Fresno County, California (Figure 1). The burn pit being evaluated measures 200 feet by 170 feet. An overview of Site history and current conditions is presented in Section 2.0 and the Site area is illustrated in Figure 2. Ground cover is sparse with many bare spots, bare rocks exposed, and dirt and gravel mounds. SEKI ecologist, Erik Frenzel, and aquatic ecologist, Danny Boiano, provided Site-specific species information which is summarized in Section 2.4.2 (Frenzel, 2018 and Boiano, 2018). Within the Grant Grove area, common trees include white fir, incense cedar, sugar pine, ponderosa pine, giant sequoia, jeffrey pine, and black oak; common shrubs include greenleaf manzanita, mountain whitethorn, chinquapin, Sierra mountain misery, and Sierra gooseberry; and common herbs include violet draperia, Hartweg's iris, Sequoia bedstraw, Coville's groundsmoke, white flowered hawkweed, and whisker brush (also see photo log in Appendix C).

Through a search on the NPSpecies database (NPS, 2017c) for species occurrence at SEKI, a threatened and endangered species list was compiled. A search was done for threatened, endangered, species of concern, and candidate animal, bird, and vascular plant species found to be present within the park. Results of the search indicate that the mountain yellow-legged frog (*Rana muscosa*) and the rainbow trout (*Oncorhynchus mykiss*) are both threatened or endangered species present in the park. There is one candidate plant species and 7 plant species of concern. There are also 17 mammals and 47 birds found to be species of concern. The search indicates those species that occur or are expected to occur throughout the 866,000 acres of Sequoia and Kings Canyon National Park.

Species of concern within habitats similar to the project area in SEKI, as identified by the Park Biologist, Erik Frenzel, include Fresno bird’s beak, California pinefoot, inconspicuous monkeyflower, and Tulare gooseberry, although none were visible during the Site visit or are known by NPS to be present at the Site. The whitebark pine is a candidate for federally threatened and endangered status under the Endangered Species Act (Frenzel, 2018). The highest concern for mammals and birds would likely be potential effects to the Pacific fisher and the northern spotted owl, given their potential to occur in the project area and their sensitivity to noise and general disturbance, and the highest concern for amphibians, fish, and reptiles would likely be potential effects to the Kings River slender salamander, given its potential to be present in the project area and its sensitivity to ground disturbance (Boiano, 2018).

3.2.1.2 Preliminary Conceptual Site Exposure Model

Based on the study area and potential contaminant migration, a preliminary ecological CSEM was developed and is presented in Figure 14. The ecological CSEM describes contaminant source(s), ecological exposure pathways, exposure media and routes of exposure, and ecological receptors. As discussed in the 2015 SI, based on the depth to groundwater, the upgradient location of groundwater wells to the Site, and the SI STLC analysis, the groundwater exposure pathway is likely incomplete and is therefore not quantitatively evaluated for ecological receptors in the EE/CA. Additionally, although the potential migration of contaminants downstream to nearby surface water bodies exists, surface water analytical data is not available for the Site and was not collected as part of sampling for the EE/CA. At the time of the initial Site visit conducted in June 2016, there was no evidence of surface water, shallow groundwater, small springs, or seeps in the drainages or surrounding areas. However, periods of heavy rain and snowmelt may lead to the presence of surface water at the Site. The CSEM indicates that the sediment exposure pathway is likely incomplete but not confirmed due to lack of sediment at the Site. No sediment data were collected as part of the EE/CA sampling; however, soils were collected from the dry creek drainages in order to evaluate potential downgradient migration of contaminants. As with the HH SRE, although the Site data collected satisfy the DQO of characterizing waste material, they are not directly representative of potential ecological receptor exposures. In the absence of surface soil data and for conservative purposes, the subsurface samples required as part of the SOW were evaluated within the ecological SRE and it was assumed that ecological receptors would be exposed to similar concentrations in surface soils. The uncertainties associated with this assumption are discussed within the Uncertainty Analysis. The ecological SRE employs similar methodologies for data evaluation and reduction as the HH SRE as is discussed in Section 3.1.1.1.

Although suitable habitat necessary to support reptile populations is present at the Site, they were not evaluated quantitatively in this SRE due to a lack of ESVs for these receptors. Lastly, the inhalation of contaminants in fugitive dust by birds and mammals is expected to be a relatively minor source of exposure; and, therefore was not included in the quantitative evaluation.

The SRE cannot evaluate potential adverse effects to every individual plant, animal, or community present and potentially exposed to chemical contamination at the Site. Therefore, receptors that are ecologically significant, of high societal value, highly susceptible, and/or representative of broader groups are typically selected for inclusion in the SRE. Moreover, as part of the SRE, plant and animal (birds and mammals) species are selected to serve as surrogates by which risk to these taxa are evaluated. Multiple trophic levels were evaluated in this SRE. Primary producers (terrestrial plants) were evaluated by comparing soil concentrations to phytotoxicity ESVs; primary, secondary, and tertiary consumers (soil invertebrates and invertivorous birds and mammals) were evaluated by comparing soil concentrations to their respective ESVs, as directed by NPS Protocol. The following is a list of target receptors representative of various trophic levels evaluated in this SRE.

- Vascular plants
- Soil invertebrates
- Invertivorous birds
- Invertivorous mammals

3.2.1.3 Preliminary Assessment Endpoints and Measures of Effect

Endpoints are defined as ecological characteristics (e.g., invertebrate survival) that may be adversely affected by Site contaminants (USEPA, 1992). In the BERA process, two distinct types of endpoints are identified: assessment endpoints and measures of effect (previously named measurement endpoints).

Assessment endpoints, are “explicit expressions of environmental values to be protected, operationally defined as an ecological entity and its attributes” (USEPA, 1998). The assessment endpoints are defined as the ability of the soil environment to support a functioning community that supports multiple trophic levels. The assessment endpoints for receptors evaluated in this SRE include the following:

1. Terrestrial plants: plant growth, yield, or germination
2. Soil invertebrates: growth, reproduction, or activity
3. Invertivorous birds: survival, growth, or reproduction
4. Invertivorous mammals: survival, growth, or reproduction

A measure of effect is defined as “a measurable ecological characteristic that is related to the valued characteristic chosen as the assessment endpoint.” Measures of effect link the conditions existing on Site to the goals established by the assessment endpoints through the integration of modeled, literature, field, or laboratory data (Maughan, 1993).

In the SRE and USEPA’s SLERA (Steps 1 and 2 of a BERA), the COPEC selection process identifies contaminants with the potential to cause harm to the ecological receptors on Site. As such, the preliminary measures of effect for Screening Level 1 (i.e., Step 1) are limited to medium-specific ESVs that are used to determine initial COPECs by comparing the maximum Site concentration for each contaminant to its respective ESV.

3.2.1.4 Ecological Screening Values

ESVs are medium-specific contaminant concentrations considered protective of biota inhabiting that medium. These ESVs are used to select COPECs and are not intended to be used as cleanup goals. At the Site, the potential direct exposure medium is soil, which is paired with soil-based ESVs for comparison. ESVs for the COPEC screening were obtained from NPS Protocol (2016), presented as “SLERA COPEC Selection ESVs” in Tables 5 and 6 of the Protocol. For the COPEC screening of plants and soil invertebrates, the minimum ESV of plant and soil invertebrate “SLERA COPEC Selection ESV” from the NPS Protocol was used. Similarly, for the birds and mammals, the lower of the two ESVs was determined and reported in Table 11. Note that the NPS Protocol had no specific ESV for 2,3,7,8- TCDD-TEQ exposure to mammals or birds. In this assessment, 2,3,7,8-TCDD TEQ for mammals was obtained from the Los Alamos National Laboratory (LANL) ECORISK database (LANL, 2015). A no effect ecological screening level (ESL) for the montane shrew was selected for mammals. For birds, the food-based no observed adverse effect level (NOAEL) for the American robin from Sample et al., (1996) was selected.

3.2.2 Screening-Level Preliminary Exposure Estimates and Risk Calculation

The potential for ecological risk associated with chemical contamination of soil at the Site was assessed using a COPEC selection, followed by the risk calculation approach. This approach serves as the SRE with which to evaluate whether past Site activities and current levels of contamination: 1) clearly indicate little or no potential for adverse effects to ecological resources at the Site; 2) clearly indicate the potential for adverse effects to ecological resources at the Site; or 3) indicate that the available data are inadequate to make a determination.

The objective of this screening process is to determine whether the concentrations at the Site are likely or unlikely to elicit adverse ecological effects or if Steps 3 through 8 of the BERA and/or the collection of additional data are needed. It also provides a final list of COPECs and focuses any further evaluations that may be required.

3.2.2.1 Level 1 Screening – Initial COPEC Selection

For the Level 1 COPEC identification, the maximum detected sample concentration for each chemical in soil was compared with an ESV to identify those chemicals that may pose an ecological risk to receptors inhabiting soil. The COPEC screen is presented in Table 4. A chemical was selected as a COPEC if the maximum detected concentration exceeded the ESV. The COPECs resulting from the preliminary Level 1 screening include beryllium, cadmium, chromium, copper, lead, mercury, vanadium, zinc, and 2,3,7,8-TCDD-TEQ (mammal). Note that based on the Site-specific background evaluation discussed in Section 2.6.4, barium, cobalt, and nickel were below their respective BTVs and were therefore not carried forward in the ecological SRE. Figure 15 provides a graphical representation of the detected concentrations and ecological screening criteria exceedances. Additionally, those COPECs with maximum detected concentrations below their respective background BTVs were not shown as exceedances on Figure 15. Ecological exceedances exist for several COPECs (beryllium, cadmium, chromium, copper, lead, mercury, vanadium, zinc, and 2,3,7,8-TCDD TEQ). Sample locations GG-SO-05, GG-SO-06, and GG-SO-08 had the highest number of exceedances (7, 6, and 6, respectively). Sample GG-SO-07 had 2 exceedances, GG-SO-01 and GG-SO-04 each had a single exceedance, and the remaining samples (GG-SO-02 and GG-SO-03) did not have any ecological screening criteria exceedances.

Based on the fact that COPECs were identified in the Level 1 screen, the SRE proceeded to a Level 2 screening with more Site-specific exposure assumptions.

3.2.2.2 Level 2 Screening – Exposure and Effects Evaluation / Risk Calculation

Receptors selected for a Level 2 screening, along with assessment and measure endpoints include the following:

1. Terrestrial plants: Support of a functioning plant community; Percent samples exceeding ESV based on COPEC soil concentration comparison with literature-based phytotoxicity values.
2. Soil invertebrates: Support of a functioning soil invertebrate community; Percent samples exceeding ESV based on COPEC soil concentration comparison with literature-based effect values.
3. Invertivorous birds: Support of a functioning invertivorous bird community; HQ based on dietary intake of COPECs by birds using Site-specific soil concentrations and literature-based effect values.
4. Invertivorous mammals: Support of a functioning invertivorous mammal community; HQ based on dietary intake of COPECs by mammals using Site-specific soil concentrations and-literature based effect values.

The risk estimation discusses the likelihood that floral and faunal populations inhabiting the Site may be affected by potential exposure to chemical stressors (i.e., COPECs) in soil. The risk evaluation integrates information presented in the exposure assessment and effects (i.e., stressor/response profile) evaluation to estimate the potential ecological risk. In this screening assessment, risks were estimated by comparing single-point estimates of exposure (i.e., a concentration) with respective ESVs and other effects levels.

3.2.2.2.1 ESVs for Abiotic Media and Wildlife

The ecological effects evaluation is the qualitative and quantitative description of the relationship between the stressor and response (effects) in the exposed individuals, populations, or ecosystems (Sheehan et al., 1994), and, more specifically, the relationship between stressors and the assessment and measures of effect identified during the problem formulation step (Norton et al., 1992). The ESVs used in the characterization of ecological effects were taken from the NPS Protocol for plants, soil invertebrates, birds, and mammals, presented as “Refined SLERA ESVs” in Tables 5 and 6 of the NPS protocol (NPS, 2016). The one exception to this is for 2,3,7,8-TCDD TEQ-mammal where the no effect ESL for the montane shrew from LANL (2015) was used.

3.2.2.2.2 Plant and Soil Invertebrate Communities

Comparisons of sample by sample soil concentrations of COPECs with “Refined SLERA ESVs” for plants and soil invertebrates are presented in Table 10.

Based on the results of the sample by sample comparison, the plant community at the Grant Grove Burn Dump Site is at risk of phytotoxic effects from exposure to chromium, copper, lead, vanadium, and zinc in soil (see Table 10). Although five of the eight exceedances for chromium and seven of the eight exceedances for vanadium exceeded their respective ESVs, they were below their background concentrations and therefore not attributable to Site contamination. All of the plant ESV exceedances that were also greater than background concentrations (chromium, copper, lead, vanadium, and zinc) were located within the Former Burn Dump Area. Exceedances located within the drainages (chromium and vanadium) were below their respective background concentrations. Analytical results for the SI drainage locations would also result in this same conclusion.

Based on the results presented in Table 10, the soil invertebrate community is at risk for adverse effects based on chromium, copper, mercury, and zinc. As with the plant community, five of the eight exceedances for chromium and one of the two exceedances for mercury exceeded their respective ESV but were below their background concentrations and therefore not attributable to Site contamination. All of the soil invertebrate ESV exceedances that were also greater than their background concentrations (chromium, copper, mercury, and zinc) were located within the Former Burn Dump Area. Exceedances located within the drainages (chromium) were below their respective background concentrations. Analytical results for the SI drainage locations would also result in this same conclusion.

Potential adverse effects to both plant and invertebrate communities are expected to be localized to within the Site boundary.

3.2.2.2.3 Avian and Mammalian Communities

The EPCs used to evaluate risk in avian and mammalian receptors is the 95% UCL, as described in Section 3.1.2.2 and presented in Table 11. EPCs are the COPEC concentrations that an avian or mammalian receptor is assumed to be exposed to within the Site. The HQ approach used for this evaluation simplifies the comparison process and allows for a more standardized interpretation of the results. The HQ reflects the magnitude by which the sample concentration or dose exceeds or is less than the ESV (i.e., soil screening level, ecological benchmark, criterion or estimated dose). In general, if an HQ exceeds 1, the potential for the exposure to elicit an adverse effect is possible. Although the HQ method does not measure risk in terms of likelihood or probability of effects at the individual or population level, it does provide a benchmark for judging potential risk (USEPA, 1994c).

As part of the HQ determination for mammalian and avian species, an area use factor (AUF) was developed based on the surrogate avian and mammalian species selected for this evaluation (Table 12). The AUF is defined as the ratio of the Site area to the receptor's home range. It is the probability that a receptor will be exposed to contamination throughout its home range. Because home ranges tend to be smaller during the critical period of nesting and fledging, the smallest home/foraging range in the available literature for the target species was used. Home ranges for the surrogate bird (American robin, *Turdus migratorius*) and the surrogate mammal (deer mouse, *Peromyscus maniculatus*) were obtained from the Wildlife Exposure Factors Handbook (USEPA, 1993b). In addition to the Site area, a conservative

AUF was also assumed based on the evidence of species of concern known to be or suspected to be present with the Site vicinity. HQs were calculated as:

$$HQ = (EPC/ESV) * AUF$$

Where:

HQ	=	Hazard quotient (unitless)
EPC	=	exposure point concentration (communities: medium concentration in units of milligram COPEC per kilogram medium) (mg COPEC/kg medium)
ESV	=	ecological screening value (mg COPEC/kg medium)
AUF	=	area use factor (unitless)

As presented in Table 11, avian HQs greater than 1 were found for cadmium (HQ of 1), copper (HQ of 3), lead (HQ of 19), and mercury (HQ of 13). Although vanadium and zinc had HQs greater than 1, their calculated EPC was below the background concentration and are therefore not a concern for Site-related contamination. Mammalian HQs greater than 1 were found for cadmium (HQ of 3), copper (HQ of 2), lead (HQ of 4), zinc (HQ of 11), and 2,3,7,8-TCDD TEQ (HQ of 20). The avian community is at greatest risk for adverse effects based on lead and zinc, while the mammal community is at greatest risk for adverse effects based on 2,3,7,8-TCDD TEQ and to a lesser extent, zinc (see Table 11). Although avian and mammalian receptors would be assumed to be exposed to the entire Site area, it is worth noting that the EPC concentrations are being driven by maximum detected concentrations found within the Former Dump Area (see Table 1). Potential adverse effects to both avian and mammalian species are expected to be localized to within the Site boundary.

3.2.2.3 Chromium VI Evaluation

The NPS terrestrial plant “Refined SLERA ESV” value (1.0 mg/kg) is based on chromium VI toxicity criteria (NPS, 2016). However, the Site soil data was analyzed for total chromium. It is likely that at most, 10% of the total chromium in a sample is attributable to chromium VI. The SRE evaluation in Table 10 conservatively assumes 100% of the total chromium is chromium VI. However, for comparison purposes, Table 13 provides a more realistic evaluation of chromium exposure to terrestrial plants where 10% of the total chromium is assumed to be attributable to chromium VI. Table 10 indicates that three of the total chromium detections exceeded both the background concentration and the terrestrial plant ESV assuming 100% chromium VI contribution. However, as shown on Table 13, when assuming a 10% chromium VI contribution, although 3 out of 8 chromium detections still exceed the terrestrial plant ESV, all eight of the estimated chromium concentrations would be below background. For this reason, Site-related chromium concentrations are likely not a concern for terrestrial plants.

3.2.2.4 Uncertainty Analysis

Based on the requirements of the SOW, only a SRE was conducted as part of this EE/CA evaluation. Only the first 2 steps of USEPA’s BERA, otherwise known as a SLERA, are included in the SRE. Performing steps 3 through 8 of the BERA would likely reduce the perceived risk at the Site. Although Steps 3 through 8 were not conducted, it is important to evaluate the results of this SRE within the context of the uncertainties inherent within the ecological risk assessment process. Uncertainties in SREs may be identified as belonging to one or more of the four following categories: conceptual model formulation uncertainty, data and information uncertainty, and natural variability (stochasticity). These are not discrete categories, and overlap does exist among them. USEPA’s Framework for Ecological Risk Assessment (USEPA, 1992) document provides a more detailed discussion of these generic uncertainty categories. A summary of the most important uncertainties for this SRE is presented in Table 14. The key uncertainties for this ecological SRE are the following:

1. DL exceedances (antimony, arsenic, selenium, thallium, and endrin) as stated in Section 2.7.1.2 contribute to an underestimate of Site ecological risks. In order to understand the extent to which Site risks may be underestimated for these contaminants, minimum DLs were compared to the plant, soil invertebrate, avian, and mammalian refined SLERA ESVs. The following summarize the results of this comparison:

- Antimony: minimum DL to avian ESV resulted in a ratio of 19. All other receptors resulted in an ESV ratios of less than or equal to 1.

- Arsenic: minimum DL to ESV ratios for all receptors were less than 1.

- Selenium: minimum DL to plant, avian, and mammalian ESVs resulted in ratios of 2.9, 2.4, and 1.3, respectively. The soil invertebrate ESV ratio was less than 1.

- Thallium: minimum DL to plant and avian ESVs resulted in ratios of 5.1 and 23, respectively. The soil invertebrate and mammalian ESV ratios were less than 1.

- Endrin: minimum DL to ESV ratios for all receptors were less than 1. Additionally, with the exception of 4,4-DDT, no other pesticides or herbicides were detected in any Site soil samples.

2. DRO and GRO were both detected in Site soils within the drainage areas and the Former Burn Dump Area but did not have NPS ESVs in order to evaluate in the COPEC screening process. These two contaminants were not carried forward in the SRE since there are no ESVs for which to quantify ecological risks. However, elimination of these contaminants as potential COPECs may underestimate ecological risks.

3. In the absence of surface soil data, subsurface soil samples were conservatively evaluated within the ecological SRE. It is uncertain whether this assumption leads to an over- or under-estimate of Site risk.

4. There is uncertainty associated with chromium since the terrestrial plant toxicity criteria is based on chromium VI which is not expected to be at the Site and likely overestimates Site risk.

3.2.3 Risk Summary

The results of the HH SRE indicate that leaving the waste material associated with the Site in its present condition would not result in an unacceptable risk to reasonably anticipated current and/or future human health receptors.

The potential ecological adverse effects indicated in the SRE and resultant contaminants of concern (COCs) are summarized in Table 15. Copper and zinc indicated potential adverse effects for all four receptors and lead indicated potential adverse effects for three receptors (terrestrial plants, avian, and mammalian). Cadmium indicated potential adverse effects for both avian and mammalian receptors, and chromium (soil invertebrates), mercury (soil invertebrates), vanadium (terrestrial plants), and 2,3,7,8-TCDD TEQ (mammalian) indicated potential adverse effects for only one receptor.

As discussed previously in Section 2.6.2, comparison of the SI and EE/CA contamination observed in the drainages with that detected in the Former Burn Dump Area indicates that contaminants are migrating down-gradient from the Former Burn Dump Area within all three drainages. However, based on the findings of the HH and ecological SREs, the Former Burn Dump Area is primarily responsible for unacceptable receptor risks. The HH SRE found that neither the drainages nor the Former Burn Dump Area pose an unacceptable risk to human health receptors. The ecological SRE found that all of the adverse effects to terrestrial plant and soil invertebrates are based on COPEC concentrations within the Former Burn Dump Area only. This same conclusion also applies to the results found as part of the SI investigation.

Furthermore, although avian and mammalian HQs were based on receptor exposure to the entire Site, all of the HQs greater than 1 were a result of concentrations detected within the Former Burn Dump Area. Although contaminant migration from the Former Burn Dump Area to the drainages is evident, the drainages do not pose unacceptable risks to HH and ecological receptors.

3.2.4 Preliminary Remediation Goals

3.2.4.1 HH

Based on Site cancer risks well below the target cancer risk of 1E-06 and noncancer HIs well below the noncancer threshold of 1, COCs were not identified and therefore preliminary remediation goals (PRGs) were not calculated for the HH SRE.

3.2.4.2 Site Specific Ecological Preliminary Remediation Goals

Site-specific PRGs were developed for COPECs in soil as determined by receptor-specific HQs > 1, as presented in Tables 10 and 11. PRGs were developed using the following general approaches:

- Food-chain modeling-based PRGs were developed using avian and mammalian receptor dietary exposure modeling with a specified target risk, solving for the medium concentration. These PRGs were developed using both no observed adverse effect level (NOAEL)- and lowest observed adverse effect level (LOAEL)-based toxicity reference values (TRVs).

- Terrestrial plant and soil invertebrate PRGs were derived from the LANL ECORISK Database based on the geometric mean of the NOAEL and LOAEL ESLs.

PRG calculations and associated input values are presented in Appendix I, Tables I-1 – I-10 (available upon request). Additionally, Figure 16 provides a graphical representation of the detected concentrations and their exceedances of the ecological PRGs. As shown, sample locations GG-SO-05 and GG-SO-06 have the highest number of exceedances with six PRG exceedances. Sample location GG-SO-08 had two exceedances and GG-SO-07 had one exceedance. Drainage samples GG-SO-01 through GG-SO-04 did not have any PRG exceedances.

Contaminant uptake, bioaccumulation, and trophic transfer can expose birds and mammals to COPECs through dietary exposure. As there are no biological data available with which to determine Site-specific uptake, bioaccumulation from soil into biological tissue was estimated using literature-based, chemical-specific uptake factors. Food chain-based PRGs for bioaccumulative contaminants was modeled for invertivorous avian and mammalian species that are expected to potentially forage on or near the Site.

The general soil food chain-based PRG equation is as follows:

$$PRGsoil = (THQ \times TRV) / (FT \times (FIR \times BCF + SIR)$$

Where:

PRG_{soil}	COPEC concentration in soil [mg/kg dry weight (DW)]
THQ	Target hazard quotient (unitless)
TRV	Chemical-specific toxicity reference value [mg/kg body weight (BW)-day]
FT	Species specific fraction of foraging time in the exposure area (unitless)
FIR	Body weight normalized food intake rate (kg tissue/kg BW-day)
BCF	Bioconcentration term (mg COPEC/kg tissue)/(mg COPEC/kg DW)
SIR	Species-specific soil ingestion rate (kg DW/kg BW- day)

Ecological PRGs for the American robin and the deer mouse are shown on Tables I-8 and I-9, respectively. Combined ranges for the food-chain modeling-based soil PRGs for each analyte are displayed on Table I-10. In addition to the mammalian and avian soil PRGs, terrestrial plant and soil invertebrate PRGs were derived based on the geometric mean of NOAEL and LOAEL-based ESLs obtained from the LANL ECORISK Database.

Table 16 summarizes all of the ecological soil PRGs, the background BTV, the final soil PRG based on the higher of the BTV or receptor-specific soil PRG, and the final overall COPEC-specific PRG.

4. IDENTIFICATION OF REMOVAL ACTION OBJECTIVES

The following sections define the objectives of a remedial action, identify requirements that may pertain to the remedial action goals, and evaluate RAAs for the Site soils. The removal action objectives (RAOs) are based on the reported sources of contamination, the nature and extent of contamination, results of the human health and ecological risk evaluations, Site-specific PRGs, and the identified applicable or relevant and appropriate requirements (ARARs) for the Site. RAOs were developed based on these factors, to control the contamination sources and reduce exposure of human and ecological receptors to Site contamination.

The reported source of contamination is unrestricted dumping and low-temperature (non-incinerated) burning of general refuse over a period of approximately 36 years. The refuse disposal area is essentially uncontained – simply covered with soil, at best. Road access to the dump is restricted to authorized vehicles, however the perimeter of the area is crossed by trails used by an adjacent horseback riding concession. Evaluation of fill and debris areas in this assessment has identified elevated concentrations of metals and dioxin in ash and soil within the dump, and in soil within the debris apron surrounding the dump to the north, west and southwest.

Concentrations of lead have been identified exceeding lead solubility thresholds of 10 and 20 times the solubility limit for California hazardous waste and USEPA's Resource Conservation and Recovery Act (RCRA) hazardous waste, as well as ecological PRGs (see Figure 16). Concentrations of several remaining metal COCs (cadmium, chromium, copper, and zinc) and 2,3,7,8-TCDD TEQ (mammal) also exceed ecological PRGs (see Figure 16). Based on these criteria, the RAOs for the Site are:

1. Remove waste debris (ash, glass, ceramics, concrete, metal) from the Site surface and subsurface,
2. Prevent or reduce the potential for ecological exposure to contaminants of concern (COCs) in soil, and
3. Prevent or reduce potential migration of COCs via surface runoff, erosion, and wind dispersion.

The area of COC impact can be divided into a refuse accumulation area and an adjoining debris field, as shown in Figure 17. The refuse accumulation area is where waste and ash are buried and covered by a veneer of soil pushed on top of the refuse. The debris field consists of the approximate area where dump-related debris is found strewn across the ground surface but is not believed to have a depth greater than 6 to 12 inches. Together, these impact areas are estimated to have an area of 2.24 acres and a volume of 7,400 cy.

4.1 IDENTIFICATION OF APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

Consistent with CERCLA Section 121(d) and in compliance with NCP Section 300.415(j), CERCLA removal actions must, to the extent practicable considering the exigencies of the situation, attain ARARs under federal or state environmental or facility siting laws at the completion or during the implementation of the removal action, or both depending on the nature of the requirements. In determining whether compliance with ARARs is practicable, the urgency of the situation, and the scope of the removal action to be conducted may be considered. 40 C.F.R. § 300.415(j).

ARARs consist of cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under federal environmental or state environmental or facility siting laws. *See* 40 C.F.R. § 300.5. These requirements are either “applicable” or “relevant and appropriate”. Applicable requirements are defined by NCP Section 300.5 as those requirements “that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance found at a CERCLA site.” 40 C.F.R. § 300.5. In other words, applicable requirements are laws and regulations that would be enforceable at a particular site even if there was no CERCLA response action taking place. Relevant and appropriate requirements are defined as those requirements “that, while not ‘applicable’ to a hazardous substance, pollutant, contaminant, remedial action location, or other circumstance at a CERCLA site, address problems or situations sufficiently similar to those encountered at the CERCLA site that their uses is well suited to the particular site.”

Only those state standards and requirements that are promulgated, identified in a timely manner, and are more stringent than federal requirements may be applicable or relevant and appropriate. 40 C.F.R. § 300.400(g)(4).

ARARs are normally classified into the following three categories: chemical-specific, location-specific and action-specific. The three categories are described below.

- Chemical-Specific ARARS: usually health- or risk-based numerical values or methodologies which, when applied to site-specific conditions, result in the establishment of numerical values. These values establish the acceptable amount or concentration of a contaminant that may be found in or discharged to the ambient environment.
- Location-Specific ARARs: restrictions placed on the concentration of hazardous substances or the conduct of activities solely because they occur in special locations.
- Action-Specific ARARs: generally, activity- or technology-based requirements or limitations on actions related to hazardous substances, including response actions. In addition to ARARs, NCP Section 300.415(j) also provides that other federal and state advisories, criteria or guidance may, as appropriate, be considered in formulating the removal action. Although not legally binding, these materials are “to be considered” (“TBCs”).

Pursuant to its delegated CERCLA lead agency authority, NPS has identified ARARs and TBCs for the Grant Grove Burn Dump EE/CA. The results of the ARAR analysis, including state ARARs, are summarized in Table 17.

5. IDENTIFICATION AND ANALYSIS OF REMOVAL ACTION ALTERNATIVES

Since the SOW for this project is to address soil contamination, potential RAAs were limited to those which would address ecological receptor COCs in soils. No evaluation was conducted for RAAs that directly address surface water or groundwater contamination. As explained in Section 2.4, the risk to groundwater and surface water is considered to be low. Executing removal action activities for contaminated soil will further protect both surface water and groundwater by removing or controlling the primary contaminant source.

This section presents potential RAAs considered for use in site remediation. Each type of alternative is initially screened for effectiveness and implementability. RAAs initially identified as potentially effective and implementable are further evaluated for their effectiveness, implementability and cost. The screening process for this project follows USEPA guidance for NTCRAs.

RAAs considered for the Site are summarized in Table 18 with a brief description of each technology and subsequent screening evaluation.

5.1 DESCRIPTION OF ALTERNATIVES AND DETAILED ANALYSIS

USEPA guidance for NTCRAs suggests that only the most qualified technologies for treatment of the source contamination be evaluated. The RAAs outlined below represent technologies that can protect human health and the environment for a reasonable range of costs.

5.1.1 Alternative 1 - No Action

5.1.1.1 Description

No Action is described as no monitoring or corrective measures being taken at the Site.

5.1.1.2 Analysis

No Action alternative provides a baseline for alternative comparison.

5.1.1.3 Effectiveness

The effectiveness of Alternative 1 is evaluated using the following criteria:

- Overall protection of public health and the environment
- Compliance with ARARs
- Long term effectiveness and permanence
- Reduction of toxicity, mobility or volume through treatment, and
- Short term effectiveness

Overall Protection of Public Health and the Environment – Under this alternative the Site would remain as it currently exists with no active efforts to minimize contaminated areas or migration pathways. No efforts would be made to reduce any potential risks to human health or the environment. If no action is taken, the COCs in soils would continue to pose a risk to ecological receptors, groundwater and surface water.

Compliance with ARARs – Alternative 1 is not compliant with chemical-specific ARARs; specifically exceeding ecological PRGs. Alternative 1 is also not compliant with location-specific ARARs which require action to conserve endangered species.

Long Term Effectiveness and Permanence - Alternative 1 does not provide long term effectiveness or permanent remedy for the COC-contaminated soils. This alternative does not manage the risks to the environment.

Reduction of Toxicity, Mobility or Volume through Treatment – Alternative 1 does not reduce the toxicity, mobility or volume of contamination at the Site. Site COCs are largely not biodegradable, as evidenced by their presence since burning was last performed and will continue to pose a risk to the environment if not treated.

Short Term Effectiveness – The impact to the environment is not reduced under this alternative. The length of time until protection is achieved is indefinite under this alternative.

5.1.1.4 Implementability

The implementability of Alternative 1 is evaluated using the following criteria:

- Technical feasibility
- Administrative feasibility
- Availability of services and materials, and
- State and community acceptance

No technical or administrative feasibility concerns are associated with this alternative because no action is being taken. No services or materials are required. State and community acceptance is unknown but the alternative is likely to be determined not acceptable based on the exceedances of PRGs protective of ecological receptors.

5.1.1.5 Cost

The cost of Alternative 1 is evaluated using the following criteria:

- Direct capital costs
- Indirect capital costs, and
- Ongoing operation and maintenance (O&M) costs

There are no capital costs or O&M costs associated with the No Action Alternative. However, there could be significant future costs associated with existing impacts or future releases from the unsecured Site.

5.1.2 Alternative 2 – Capping with Impermeable Material

5.1.2.1 Description

Capping technologies, such as impermeable materials (asphalt or concrete) capping or placement of a RCRA cap, are generally used as source control measures and to provide limited protection to human health and the environment through the limiting of contaminant exposure. These technologies are designed to eliminate direct contact from contaminated materials. In addition, such controls are used to divert and minimize infiltration of surface water that may contribute to erosion and/or leachate formation. The cap or cover design is a function of the degree of hazard posed by the contaminated media and may vary from a simple soil cover to a multi-layered RCRA hazardous waste cap as defined in 40 Code of Federal Regulations (CFR) 264.310.

5.1.2.2 Analysis

This RAA requires the capping of all contaminated soils with an impermeable cap, likely a multi-layered RCRA cap. This alternative is often both technically and readily implementable as necessary equipment and construction expertise are readily available. Additionally, compliance with applicable ARARs would be achievable using this technology.

Capping the contaminated soils in their current location would not prove an effective solution due the restricted level space of the Site. Additionally, 1) current use of the Site for the staging of park construction and maintenance materials would be lost, and 2) security of the waste cell structure would require fencing, which would impact the park aesthetic.

5.1.2.3 Effectiveness

The effectiveness of Alternative 2 is evaluated using the following criteria:

- Overall protection of public health and the environment
- Compliance with ARARs
- Long term effectiveness and permanence
- Reduction of toxicity, mobility or volume through treatment, and
- Short term effectiveness

Overall Protection of Public Health and the Environment – Capping would provide a moderate level of protection to human health and the environment by restricting contact with all contaminated materials.

Compliance with ARARs – Alternative 2 could achieve compliance with chemical-specific ARARs through protection from direct contact. The alternative may not be compliant with location-specific ARARs which require a high level of protection to the SEKI Wilderness. Compliance with action-specific ARARs would require approval of design specifications sufficient to reduce impacts to the cap from burrowing animals, weather and other potential destructive mechanisms.

Maintenance would be required for the lifetime of the cap to maintain a high level of protection. Maintenance of a site waste cell would be difficult due to the restricted space, topography and seasonal access restrictions.

Long Term Effectiveness and Permanence - Alternative 2 can provide long term effectiveness but would require exceptional effort to maintain.

Reduction of Toxicity, Mobility or Volume through Treatment – Alternative 2 does not reduce the toxicity or volume of contamination at the Site. A reduction in the mobility of contaminants would be achieved for the lifetime of the cap.

Short Term Effectiveness – This RAA could be completed in a relatively short period of time, estimated at 135 days. A moderate increase in short term risk to human health would be encountered during the grading and installation phase of this RAA due to the increase in dust generation and worker exposure to contaminated soils. Additionally, short-term air quality impacts to the immediate environment may occur during capping activities. Control of fugitive dusts and runoff during rain events would likely be required. Upon completion, the cap could provide an effective barrier, reducing risk to the environment.

5.1.2.4 Implementability

The implementability of Alternative 2 is evaluated using the following criteria:

- Technical feasibility
- Administrative feasibility
- Availability of services and materials, and
- State and community acceptance

Technical Feasibility - Alternative 2 is not technically feasible. While this alternative is well established and has been implemented at numerous sites across the country, it would require significant engineering design to enclose the estimate volume of material within the limited level portion of the Site and is not considered feasible. The actual operating life of a cap at this location would be uncertain.

Administrative Feasibility – Administration of Alternative 2 would require significant maintenance over the long term. Cap maintenance includes regular inspection and repair, reporting and eventual replacement.

Availability of Services and Materials – Services and materials for Alternative 2 are readily available but would have to be imported to the Site at significant cost due to Site remoteness and limited access.

State and Community Acceptance – State and community acceptance of Alternative 2 is unknown, but likely to be resistant based on the location within a wilderness area, and the technical feasibility of construction and maintenance.

5.1.2.5 Cost

The cost of Alternative 2 is not evaluated due to the infeasibility of the solution.

5.1.3 Alternative 3 – Excavation and Off-Site Disposal

5.1.3.1 Description

Excavation and off-Site disposal involves the removal of the contaminated materials, final classification of the waste as RCRA Subtitle C or other regulated hazardous waste, and subsequent disposal at a facility licensed to accept the waste. The type of facility is dependent on the class and concentration of hazardous materials in the waste. Wastes found to exceed State or Federal guidelines for hazardous material must be transported to a RCRA landfill for disposal. Wastes not exceeding the guidelines can be placed in any landfill licensed to accept the waste. All excavated wastes will be managed in accordance with all applicable federal, state and local requirements.

5.1.3.2 Analysis

Off-Site disposal is a tested and widely accepted alternative for contaminated soils. The process involves the delineation, excavation, transport and disposal at a facility licensed to accept contaminated soils. While the soil has not been characterized for disposal, the identified concentrations of lead at the Site may meet the criteria for RCRA hazardous waste since lead concentrations greater than 100 mg/kg were detected. Based on the presence of total lead at concentrations greater than 20 times the federal hazardous waste limit of 5.0 mg/L in composited samples collected from the debris and refuse areas, these materials may be required to be disposed of in a RCRA Class I landfill. Characterization of Site material for disposal will be governed by receiving facility requirements, such as the number and type of samples per a volume unit, and leachate testing procedures such as the California Waste Extraction Test (WET) and the federal Toxicity Characteristic Leachate Procedure (TCLP). Based on the time the lead-containing material has been exposed at the Site, it was assumed that Site material will be disposed of at a Class II landfill. The nearest cost effective RCRA Class II Landfill is Waste Management's McKittrick facility near McKittrick, west of Bakersfield, California. In the event that waste classification results indicate that Site material requires Class I landfill disposal, the costs implications will need to be evaluated.

5.1.3.3 Effectiveness

The effectiveness of Alternative 3 is evaluated using the following criteria:

- Overall protection of public health and the environment
- Compliance with ARARs
- Long term effectiveness and permanence
- Reduction of toxicity, mobility or volume through treatment, and
- Short term effectiveness

Overall Protection of Public Health and the Environment – Removal to an off-Site facility would provide the highest level of protection to the environment as all contaminated materials would be removed.

Compliance with ARARs – Alternative 3 is compliant with chemical-specific ARARs, removing all material exceeding PRGs. Alternative 3 is also compliant with location-specific ARARs which require action to conserve endangered species and action-specific ARARs.

Long Term Effectiveness and Permanence - Alternative 3 provides the highest level of long term effectiveness and is a permanent remedy for the lead-contaminated soils. This alternative effectively eliminates the risks to the environment.

Reduction of Toxicity, Mobility or Volume through Treatment – Reduction in the mobility of the contaminants using Alternative 3 would be achieved by removing wastes to a RCRA or other appropriately licensed facility (based on final characterization), although no reduction of contaminant toxicity or volume would be achieved.

Short Term Effectiveness – This RAA could be completed in a relatively short period of time, estimated at 40 work days (8 weeks), and no permanent facilities would be required. A small increase in short term risk to human health would be encountered during the excavation and transport phase of this work due to the high number of truck trips required and the increase in dust generation.

The following impacts associated with construction activities are considered short-term and should not significantly impact human health.

- Short-term air quality impacts to the immediate environment may occur during excavation of contaminated soils.
- Control of fugitive dusts may be required both on-Site and for trucks on route to the disposal facility.
- The adjacent horse-back riding concession may be impacted by dust, proximity to use trails and noise. Re-routing of some use trails would likely be required.
- Grant Grove loop trail and parking area may be impacted by dust and noise.
- The Crystal Springs and Azalea campgrounds may be impacted by dust and noise.
- Grant Grove Visitor Center facilities may be impacted by noise and truck traffic.
- The selected hauling route to Visalia, CA will likely be impacted by truck traffic.

5.1.3.4 Implementability

The implementability of Alternative 3 is evaluated using the following criteria:

- Technical feasibility
- Administrative feasibility
- Availability of services and materials, and

- State and community acceptance

Technical Feasibility - Alternative 3 is considered a technically feasible presumptive remedy, having been implemented with consistent success at numerous sites. The alternative would require technical oversight to ensure complete removal of soils exceeding PRGs and contractors licensed to perform hazardous waste removal, if the waste is so designated or worker protection levels will be exceeded.

Administrative Feasibility – Implementation of Alternative 3 would require coordination with administrators and regulatory agencies but is a common and well understood approach. The work would be performed entirely within the park and would not require off-Site permitting or coordination.

Availability of Services and Materials – Services and materials for Alternative 3 are readily available.

State and Community Acceptance – Alternative 3 is a presumptive remedy. As such, state and community acceptance of the remedy is considered highly likely.

5.1.3.5 Cost

The cost of Alternative 3 is evaluated using the following criteria:

- Direct capital costs
- Indirect capital costs, and
- O&M costs

The estimated capital cost to implement Alternative 3 is estimated to be $1.97 million and the low-end (-30%) and high-end (+ 50%) cost ranges are presented in Table 19. Detailed backup costs associated with Table 19 are presented in Appendix J (available upon request). It is anticipated that post construction maintenance will be limited to facilitating the survival of restoration measures until vegetation is established and slopes are stable. The estimated volume of soil requiring removal to meet PRGs for site COCs is approximately 7,400 cubic yards (equivalent to 9,888 tons). Site restoration will be required following excavation of contaminated soils for off-Site disposal.

6. COMPARATIVE ANALYSIS OF REMOVAL ACTION ALTERNATIVES

Table 19 summarizes the potential for success of RAAs and compares effectiveness, implementability and cost of each alternative. Costs estimated are based on previously determined soil volumes, contaminant concentrations, and assumptions concerning waste classification.

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