FINAL

PHASE I SITE CHARACTERIZATION REPORT

FOR

**BOULDER CITY BYPASS NATURALLY OCCURRING ASBESTOS (NOA) PROJECT
PHASE I (RAILROAD PASS TO SILVERLINE ROAD)**

Prepared for:

NEVADA DEPARTMENT OF TRANSPORTATION
Environmental Services Division
1263 South Steward Street
Carson City, Nevada 89712

Agreement Number P034-14-13

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Additional copies of the Boulder City Bypass NOA Phase I Site Characterization Report can be made available for further distribution.

ACRONYMS AND ABBREVIATIONS

>	Greater than
<	Less than
≥	Greater than or equal to
µm	Micrometer
%	Percent
±	Plus or minus
ABS	Activity-based sampling
AC	Air Conditioning
AHERA	Asbestos Hazard Emergency Response Act
ATEM	Asbestos TEM Laboratories, Inc.
BCB	Boulder City Bypass
bgs	Below ground surface
BMP	Best management practice
cc^{-1}	Per cubic centimeter
COC	Chain-of-custody
COPC	Chemical of potential concern
CFR	Code of Federal Regulations
CSM	Conceptual site model
DRI	Desert Research Institute
EPA	United States Environmental Protection Agency
EPC	Exposure point concentration
ESC	Erosion and sediment control
ET	Exposure time
fibers cc^{-1}	Fibers per cubic centimeter
FHWA	Federal Highway Administration
FSDS	Field Sample Data Sheet
GPS	Global Positioning System
HASP	Health and safety plan
HQ	Hazard Quotient
ID	Identification
IRIS	Integrated Risk Information System
ISO	International Organization for Standardization
IUR	Inhalation unit risk
Kleinfelder	Kleinfelder, Inc.
L	Liters
L/min	Liters per minute

ACRONYMS AND ABBREVIATIONS (Cont.)

MCE	Mixed-cellulose ester
mph	Miles per hour
NDOT	Nevada Department of Transportation
NEA	Negative exposure assessments
NIOSH	National Institute for Occupation Safety and Health
NOA	Naturally occurring asbestos
NRCS	Natural Resources Conservation Service
NVLAP	National Voluntary Laboratory Accreditation Program
OSHA	Occupational Safety and Health Administration
PCM	Phase contrast microscopy
PCMe	Phase contrast microscopy equivalent
PEL	Permissible exposure limit
PLM	Polarized light microscopy
PPE	Personal protective equipment
QA	Quality Assurance
QA/QC	Quality assurance/quality control
QAPP	Quality assurance project plan
QC	Quality control
RAGS	Risk Assessment Guidance for Superfund
RfC	Reference concentration
RME	Reasonable maximum exposure
RTC	Regional Transportation Commission of Southern Nevada
SAP	Sampling and analysis plan
SPT	Standard Penetration Test
SSC	Site Safety Coordinator
STEL	Short-term exposure limit
Structures cc^{-1}	Structures per cubic centimeter
TEM	Transmission Electron Microscopy
Tetra Tech	Tetra Tech, Inc.
TWA	Time weighted average
TWF	Time Weighting Factor
UNLV	University of Nevada, Las Vegas
USDA	United States Department of Agriculture
USGS	United States Geologic Survey
UCL	Upper confidence limit
Volpe	Volpe – The National Transportation Systems Center
wt%	Weight percent

EXECUTIVE SUMMARY

Tetra Tech completed contracted tasks for the Nevada Department of Transportation (NDOT) Boulder City Bypass (BCB) Phase I site characterization project. The objective of the site characterization project was to define the concentrations of naturally-occurring asbestos (NOA) in soils and bedrock materials that will be disturbance during road construction and determine the potential NOA levels during that construction. The NOA concentration determinations are needed to support an initial estimate of the human health risks from potential exposures to NOA, specifically for the construction workers and community residents. This objective was met as described in this report.

The site characterization technical tasks began on April 11, 2014 and involved:

1. Preparing draft and final versions of the Sampling and Analysis Plan (SAP), Quality Assurance Project Plan (QAPP), and Health and Safety Plan (HASP);
2. Completing the site characterization field work with a team of 10 field scientists over 3.5 weeks in May and June, 2014;
3. Submitting more than 150 solid media samples, 50 ambient air samples, and 20 opportunity-based samples for analysis to two certified asbestos laboratories;
4. Completing this Site Characterization Report to document the findings, provide risk estimates, and construction mitigation and monitoring measures.

Tetra Tech worked directly under contract and at the direction of NDOT, and in cooperation and with input from other government and private entities, including the Regional Transportation Commission of Southern Nevada (RTC), Federal Highway Administration (FHWA), Volpe—The National Transportation Systems Center, Kleinfelder, Inc. (Kleinfelder), CDM Smith, and the Clark County Air Quality Department.

Ambient Air Results: Three months of ambient air results are shown on Figure 5-2 and in Table 5-1. Asbestos results are reported as total phase contrast microscopy equivalent (PCMe) structures per cubic centimeter (structures cc^{-1}); PCMe results include all regulated asbestos types and non-regulated amphiboles that meet the PCMe structure criteria of greater than (>) 5 µm in length, greater than or equal to (≥) 0.25 µm in width, and with an aspect ratio of 3:1 or greater. The highest total PCMe asbestos concentration of 1.41E-03 structures cc^{-1} was recorded at Station 4 from June 10 – 15, 2014. Of the 36 samples collected over the 3 months of sampling, actinolite was detected 26 times, non-regulated amphiboles were detected 4 times, and chrysotile, tremolite, and anathophyllite were each detected once.

Seven of 36 ambient air samples exhibited no detectable asbestos. Each of the four stations exhibited at least one sample with no asbestos.

Station 1 generally had the lowest concentrations of total PCMe asbestos during the three months of air monitoring. Less asbestos was found in the surface and subsurface soils on the northern end of the project area which may have an effect on the results at Station 1. Station 2 consistently recorded between zero and three total PCMe structures for each 5 days of sampling. Station 3 had somewhat variable results: two events with no detectable PCMe structures and the other events with one to four total PCMe structures. Station 4 ambient air typically had the highest number of total PCMe structures and resulting asbestos concentrations of the four Phase I stations. The land uses and large playa in the area surrounding Station 4 likely have an impact on ambient air results.

Ambient air PCMe results were compared to wind and precipitation data for each of the 5-day sampling periods. The predominant winds were from the southwest and south during May through August and may have transported dust with asbestos from potential source areas onto the south end of the site. Precipitation appears to have an effect on the ambient air PCMe concentrations as revealed by the low PCMe concentrations at all four stations during Period 8 when there was 0.5 inch of rain.

Solid Media Results: More than 150 solid media samples were collected from the BCB Phase I project area. Samples of surface soil, subsurface soil, alluvium materials, and bedrock were collected and analyzed for asbestos concentrations. Results for all solid media samples are in Table 5-2. Analytical results indicate low concentrations of NOA, in the form of actinolite, are present in some surface and subsurface soils, alluvium materials, and bedrock in the Phase I project area. The source of the actinolite is likely derived from the parent materials and bedrock in and adjacent to the Phase 1 alignment.

Sixty-six samples were collected across the Phase I project area to characterize the surface soils. Ten had detectable polarized light microscopy (PLM) concentrations of less than (<) 0.25% (the lowest reporting level above non-detection) and 56 were non-detect. Twelve surface soil samples were then analyzed by the transmission electron microscopy (TEM) and all had total PCMe concentrations below the analytical detection limit (ranged from <0.0162% to <0.0175%). The distribution and concentrations of NOA in soils indicate only low levels of NOA are found in the upper 6 inches of the Phase I surface soils. NOA concentrations may be more prevalent in the soils in the central and southern portions of the project area. Only one location in the northern portion of the project had NOA in the surface soil.

Subsurface alluvium materials exhibited similar NOA results similar to surface soils. Of the 20 subsurface samples analyzed, only two had PLM concentrations of <0.25% and 18 were non-detect.

Three of the four samples also analyzed by TEM had NOA concentrations less than the analytical detection limit. One sample (SB-17) analyzed by TEM detected one large chrysotile structure that yielded a concentration result of 6.83% by weight. The SB-17 asbestos result is likely from a manmade chrysotile material associated with cultural debris or from the numerous utility pipelines in the project area.

Five outcrop samples had NOA detections of <0.25%. One of the outcrop samples had a total PCMe concentration of 0.20%. This was the highest actinolite concentration for all Phase I solid media. That outcrop sample (BR-5) was collected from an area underlain by quartz monzonite with dacite dikes also mapped nearby.

Twenty-five hollow-stem, rock core, and discrete bedrock samples were collected from across the Phase I project area. The highest PLM concentrations were <0.25% and more than 50% of the samples were non-detect. The TEM result for one sample (G48QM11) was a total PCMe concentration of 0.025%, slightly above the detection limit.

Opportunity-Based Sampling Results: Tetra Tech completed opportunity-based sampling during sampling of solid media (surface soil, sub-surface soil, and rock) and driving activities throughout the project area. The opportunity-based samples were collected to provide some initial estimates of potential exposures and risks to workers' health during construction. Opportunity-based samples were collected from the field sampling personnel, the backhoe and drill rig operators, and a lone driver travelling on project area roads. Samples were collected during a period with no rainfall (end of May through mid-June). Water was used to suppress dust during the subsurface sampling with a backhoe and during the drilling operations.

Tasks of each participant during the opportunity-based sampling included a full range of activities from sample location setup, sample mixing, and placing the sample in the containers to driving and sitting in a truck. The analytical results of the opportunity-based sampling are in Table 5-3 and show the concentrations of total PCMe asbestos. The highest concentration of total PCMe asbestos was 6.86E-03 structures cc^{-1}, found during surface soil sampling in the south-central portion of the project area. Seven other opportunity-based samples had detectable levels of total PCMe asbestos at lower concentrations and nine samples had no detectable asbestos.

Risk Estimates for the BCB Phase I Project: Preliminary risk estimates were developed to assess potential risk to construction workers from inhalation of ambient outdoor air and outdoor air containing dust disturbed by construction activities (Section 6.0). The cancer risk from exposure to ambient air ranged from 3E-08 to 7E-07 and the overall average from 3 months of sampling was 2E-07. The calculated risks from ambient air are less than the point of departure of 1E-06 for carcinogens. The cancer risk from exposure for specific opportunity-based sampling scenarios ranged from 2E-06 to 8E-06 and is within, and at the low end of, the EPA risk management range of 1E-06 to 1E-04.

The BCB Phase I site characterization revealed non-detectable to very low concentrations of NOA in the soils, alluvium and subsurface materials, and bedrock that are planned to be disturbed during road construction. Opportunity-based sampling indicated that future potential risks for construction workers, from exposures to airborne NOA in dust from construction, may be within, and at the low end of the risk management range of 1E-06 to 1E-04. Dust from the road construction activities can be adequately mitigated and monitored if contractors comply with existing and project-specific regulations. Early efforts to establish a risk-based perimeter air monitoring program, complete additional construction-specific activity sampling, and develop and specify mitigation measures will help ensure project is completed safely.

1.0 INTRODUCTION

Tetra Tech, Inc. (Tetra Tech) completed site characterization services for the Nevada Department of Transportation (NDOT) under Agreement P034-14-13 to determine the presence of naturally occurring asbestos (NOA) along the Phase I portion of the Boulder City Bypass (BCB) project (Figure 1-1). Tetra Tech received the notice to proceed on April 11, 2014. The objective of the site characterization was to define the concentrations of NOA in soils and bedrock materials that would be disturbed, and determine potential NOA levels in airborne dust from the construction to support an initial estimate of the human health risks from potential exposures to NOA, especially for the construction workers.

The technical services tasks included:

1. Preparing the Sampling and Analysis Plan (SAP), Quality Assurance Project Plan (QAPP), and Health and Safety Plan (HASP);
2. Completing the site characterization field work;
3. Submitting the samples for analysis;
4. Completing an initial risk estimate;
5. Preparing construction mitigation and monitoring measures; and
6. Providing the necessary financial and project management duties.

Tetra Tech completed the SAP/QAPP to help guide the project work activities and tasks. The SAP/QAPP was finalized and approved on May 23, 2014. Tetra Tech began the site characterization field work on May 27, 2014 and completed the solid media sampling on June 13, 2014. Ambient air monitoring, part of the site characterization, began on May 8, 2014 and is ongoing. This monitoring will continue until construction begins in spring 2015 and possibly beyond. Solid media (soil and rock) and air samples were shipped to one of two asbestos certified laboratories for analysis. The risk estimates and construction mitigation and monitoring measures are included in this report.

Tetra Tech worked directly under contract and at the direction of NDOT, but in cooperation and with input from other government and private entities, including the Regional Transportation Commission of Southern Nevada (RTC), Federal Highway Administration (FHWA), Volpe—National Transportation Systems Center (Volpe), Kleinfelder, Inc. (Kleinfelder), and CDM-Smith.

Key Tetra Tech personnel responsible for the site characterization, risk estimations, and mitigation and monitoring activities were:

- J. Edward Surbrugg, Ph.D., Technical Project Manager, Soil Scientist
- Steve DelHomme, P.E., Engineering Project Manager
- Mark Stockwell, Site Characterization Team Leader
- Steve Bradley, CEG, CEM, Site Geologist
- Deborah Kutsal, Testing and Analytical Team Leader
- Rob Tisdale, Ph.D., Risk Assessment Team Leader
- Becki Dano, CEM, Ambient Air Team Leader

The sections of this Report are:

Section 1.0 – Introduction
Section 2.0 – Problem Definition/Background
Section 3.0 – Site Characterization Methods
Section 4.0 – Deviations from the SAP and QAPP
Section 5.0 – Site Characterization Findings
Section 6.0 – Preliminary Worker Human Health Risk Estimates
Section 7.0 – Construction Mitigation Measures and Monitoring
Section 8.0 – Project Summary
Section 9.0 – References

Tables and figures follow the text.

Appendix A has copies of all field forms including the logbooks and Appendix B contains copies of the laboratories electronic data deliverables.

2.0 PROBLEM DEFINITION/BACKGROUND

The site description and background, site geology, soils information, conceptual site model, and identification of exposure pathways for evaluation in the human health risk estimates are discussed in this section.

2.1 SITE DESCRIPTION AND BACKGROUND

The BCB highway project involves the construction of approximately 14.75 miles of new freeway (proposed Interstate 11) beginning just east of Henderson, Nevada, extending south of Boulder City and tying to the Hoover Dam Bypass-Nevada interchange on US 93 near the Arizona border. The project will include the construction of a four lane access controlled freeway with several new interchanges and bridges all constructed in semi-mountainous to mountainous terrain. The project will be built in two phases: Phase I (approximately 2.75 miles) beginning near Railroad Pass and extending southeast to

Silverline Road, and Phase II (12 miles) extending from Silverline Road trending east to northeasterly around Boulder City until tying to the Hoover Dam Bypass-Nevada Interchange.

This Site Characterization Report covers only the Phase I project area. The Phase I will extend from the existing US 93/95 highway on the south edge of Henderson, cross under the railroad tracks near the Railroad Pass Casino, and continue southeasterly toward US 95 where it will cross the existing Silverline Road. It includes a frontage road, ramps, and an interchange to connect to the existing US 93/95 near the Railroad Pass Casino. There are multiple private and City of Henderson utilities within the alignment, including high voltage electrical transmission lines, natural gas, fiber optic, sewer, and water lines and several access or maintenance roads in this area. Based on preliminary plans provided by NDOT, construction in the Phase I alignment will require cuts into soil and bedrock of up to 120 feet below the ground surface and placement of fill material up to 45 feet thick above the ground surface (Figure 2-1).

In late 2013, University of Nevada, Las Vegas (UNLV) researchers published a study (Buck 2013) identifying actinolite asbestos in the rocks and soils in the Boulder City area. Sampling by the Phase II contractor (Kleinfelder) identified actinolite and other asbestos types in several locations in the Phase II area. Kleinfelder's findings (Kleinfelder 2014) generally supported UNLV's results and showed some areas with actinolite asbestos concentrations in the Phase II soil and volcanic rock units, along with a few areas with low concentrations of other asbestos types (Kleinfelder 2014).

The presence and potential concentrations of actinolite asbestos in the Phase I soils and rocks, and the potential health effects of the asbestos minerals if disturbed, was not known and was a primary focus for the site characterization. Tetra Tech developed a scientific field and opportunity-based SAP/QAPP to guide activities necessary to determine the presence and concentrations of asbestos in the ambient air, soil and rock materials. Site characterization included estimations of potential human health risks to construction workers from exposures to NOA in ambient air and during some construction activities. The site characterization results, initial risk estimates, and construction mitigation and monitoring measures in this report will help NDOT ensure the highway construction is completed in compliance with regulatory requirements and in a manner protective of the health and safety of construction workers and the public at large. The site characterization results and conclusions will help NDOT and the other involved agencies determine: (1) if changes to the highway construction design and schedule (due to the nature and extent of NOA) are necessary, (2) if changes are significant enough to necessitate a supplemental environmental impact analysis, and (3) the need for, and types of, dust mitigation measures to be employed during construction activities.

2.2 SITE SOILS AND GEOLOGY

This summary of the site soils is based on the Soil Survey of Clark County Area, Nevada (U.S. Department of Agriculture [USDA], Natural Resources Conservation Service [NCRS] 2006). Detailed soil mapping units were used, along with the geology maps, to identify and select the surface and subsurface soil sampling locations (Figure 2-2).

The Clark County area is in the Basin and Range Province with isolated mountain ranges rising about the alluvium-filled desert basins (Peterson, 1981). Many of the basins are closed basins with no external drainage, including the Eldorado Valley with its prominent playa southwest of Boulder City. Railroad Pass is at the north end of the Eldorado Valley and is a narrow transitional zone between the Black Mountains on the west, River Mountains on the east, the Eldorado Valley to the south, and the Las Vegas Valley to the north. Piedmont slopes have formed along the bases of the Black Mountain and River Mountain ranges.

Soils in the Phase I project area formed in parent materials that reflect the local bedrock lithology and landform position. Three generally main soils associations (groups) have been mapped in the Phase I Right of Way; (1) soils developed from mountain slopes in colluvium or residual bedrock, (2) soils developed on hill slopes and fan slopes in mixed alluvium or weathered bedrock, and (3) soils developed on gentle sloping fans remnants in mixed alluvium. Local bedrock lithology along the Black Mountain and Railroad Pass hills includes schist, gneiss, and coarse-grained igneous rock complexes with Tertiary volcanic scattered throughout the area (Longwell et al. 1965).

The main soil mapping unit on the mountain slopes and hills in the project area is the Nipton-Haleburu-Rock Outcrop association (Map Unit 141). Slopes range from 15 to 50%. Nipton-Haleburu-Rock Outcrop soils are typically very shallow only 4 to 14 inches deep. The bedrock is described as weathered volcanic and metamorphosed volcanic rock.

Two soils types are mapped on hill slopes and fan slopes in the project area; the Canutio-Akela complex, 2 to 15% slopes (Map Unit 500) and the Canutio-Akela complex, 15 to 50% slopes (Map Unit 505). These soils are very similar with the only difference being the degree of slope. The depth to lithic bedrock is 39 to 60 inches and the bedrock is described as weathered residuum form basalt or andesite materials.

Two soils types are also mapped for gently sloping areas on fan remnants and in the bottom of the drainages. The Caliza-Pittman-Arizo complex soil, 0 to 8% slopes (Map Unit 182) and Caliza very cobbly loamy sand, 4 to 8% slopes (Map Unit 183) cover substantial areas of the Phase I project site. These soils were developed from mixed alluvium and are deeper than 80 inches to bedrock. The typical soil profile may contain 2 to 8 inches of a fine sandy loam or loamy sand textured horizon over gravelly to extremely gravelly coarse sand.

The following summary of the site geology is based on geologic mapping and sampling during the site characterization described in Section 3.2. A general understanding of regional and site geologic setting was initially developed through reviewing published United States Geologic Survey (USGS) and USDA map data, the Geotechnical Design Report prepared by NDOT Geotechnical Engineering for BCBP Phase I and the Draft Geotechnical Report prepared by Kleinfelder Inc. (2014) for the Phase II portion of the project. The regional geologic setting of the Rail Road Pass area and Phase I of the alignment consists of relatively thin Quaternary alluvial deposits overlying intrusive igneous and volcanic rocks that underlie the River Mountains to the east of Rail Road Pass and the McCullough Range to the west. The Quaternary alluvial deposits include Older (Qoa) and Younger (Qa) Alluvium. The Older alluvium is the predominant geologic unit observed in the alignment (Figures 2-2a and 2-2b). Further descriptions of the geologic and soil materials encountered are:

Artificial fill (Qaf) and Undocumented fill (Quf) are present at various locations in the alignment. Much of the current US 93/95 roadway, the former US 95 south roadway, and existing improvements in the southwestern portion of the alignment are supported by Qaf. The designation for artificial fill is used for material that was specifically placed to support improvements such as roadways, buildings etc. Other disturbed areas in and adjacent to the alignment, such as the active and former gravel or rock operations west of the project contain tailings contain material that has been mapped as undocumented fill (Quf). Undocumented fill includes all materials that were man placed, but with no specific structural intent. Both the Qaf and Quf materials are believed to have come from local or nearby sources, and are similar in composition to the native soil and rock materials.

The younger alluvium (Qa) (Holocene to Pleistocene age) consists of unconsolidated to partly consolidated, silt, sand, and gravel. Younger alluvium was mapped primarily in the southern portion of the proposed frontage road alignment, near Silver Line Road. The maximum thickness in the project area is estimated to be approximately 20 feet.

Talus and hillslope deposits composed of angular to subangular, poorly sorted cobbles and boulders of locally derived material were observed along the western and northern boundaries of the alignment, at the base or flanks of the McCullough and River Mountains. These deposits are currently included in the alluvial (Qoa and Qal) formations and are not specifically shown on the site geologic maps. The deposits were observed in the smaller drainages flowing from the west and north adjacent hillside and generally ranged from 3 to 10 feet thick along the edges of the Phase I boundaries. The deposits were generated by weathering and downslope movement from the adjacent topographic high areas and contain a significant percentage of coarse gravel, rocks and boulders.

The older alluvial deposits (Qoa) that underlie a majority of the project are characterized by moderately to poorly sorted sand, silt, clay, and gravel. They are poorly bedded to massive and weakly to moderately consolidated. Where undisturbed, the surface has slight to well-developed desert pavement. Much of the surface in the project area has been disturbed, and there are several unimproved roads related to electrical, gas and water utilities that are in the alignment.

The Tertiary-age intrusive rocks (Ti) in the project area consist mostly of a quartz monzonite that is reported to be similar to Boulder City pluton (Felger and others, 2013). The rock outcrops are jointed, but generally not brecciated. The largest outcrops in the alignment were observed in the low hill along the western boundary Frontage Road (Station 56 + 00 to 64 + 00[Figure 2-2]) and to the east of US 93 / 95 (Sta 155 + 00 to 166 + 00). These rocks are a light-gray, fine to medium grained, faintly to distinctly porphyritic, non-foliated pyroxene bearing quartz monzonite containing biotite and hornblende as the primary mafic constituents. Locally, the hornblende may be quite distinct displaying large elongated crystals.

Volcanic flows, domes, breccia, and volcanogenic sedimentary rocks (Trv) are present in the upper elevations of the River Mountain, east of Rail Road Pass and north of US Highway 93/95 in the eastern portion of Phase I. These are reported to be a complex unit of dacite, rhyolite and andesite flows and domes, and intercalated tuffs and tuffaceous sedimentary rocks, with an estimated maximum thickness of approximately 1,000 feet. Another intrusive complex was mapped in the area by Anderson (1977) that consisted of complexly altered, brecciated and sheared transition zone that separates the quartz monzonite intrusive rocks (Ti) and the volcanic rocks (Trv). Recent mapping by Felger shows this unit as composite plutons (Trip) consisting of plugs and dikes of porphyritic dacite, andesite, and rhyodacite. During this investigation these transition zone rocks were observed in cut slopes along the north side of US 93/95 and the cut slopes east and north of the Railroad Pass Casino parking lot. Mapping during the investigation noted these materials were present on the south side of the existing Highway 93 / 95 alignment east of the casino to the current off ramp for Highway 95. This unit appears to extend farther south and east than previously indicated in regional mapping as shown on Figure 2-2b. Dacite dikes were observed locally in areas previously believed to be underlain only by the Tertiary-age intrusive quartz monzonite. Two of these dikes are shown on the geologic Map (Figure 2-2b) in the hillside east of stations 150 + 00 and 165 + 00. The quartz monzonite bedrock showed sign of weak hydrothermal alteration locally where either the dacite dikes, faulting or shear zones were present. Mapping adjacent to a mine adit near the top of the hill east of Sta 155 + 00, where minor turquoise mineralization was observed, showed weak argillic alteration along a small near vertical shear zone. Some hornblende crystals in the adjacent quartz monzonite were distinctly elongated.

Based on site mapping, the structural setting in the Phase 1 portion of the project appears to be more complex than indicated on regional mapping. A north-south trending system of faults or fault breccia's was identified in the Ti quartz monzonite rocks along the western boundary of the project. The zone was mapped up to approximately 160 feet wide with the eastern boundary off-setting alluvial sediments, suggesting relatively recent movement along the zone. Several minor faults were observed in this zone, with the general trend of the zone ranging from N25 W to N 55 W in the northern portion of Phase 1, trending in a more northeasterly direction in the southern portion of the project area. The faults or shears are generally high angle with dips normally in a southeasterly direction. Evidence of weak hydrothermal or contact alteration, possibly related to dacite dikes in the quartz monzonite rocks, was observed in this brecciated or sheared zone. Near the small adit in the southeastern portion of the project, hornblende crystals in some quartz monzonite float were distinctly elongated, suggesting there was alteration of the quartz monzonite and possibly the hornblende.

2.3 CONCEPTUAL SITE MODEL AND IDENTIFICATION OF EXPOSURE PATHWAYS FOR EVALUATION IN THE HUMAN HEALTH RISK EVALUATION

Figure 2-3 is the conceptual site model (CSM) for potential human exposure to NOA in the Phase I portion of the project. The CSM summarizes information on potential release and transport mechanisms for NOA, affected environmental media, potential exposure pathways, and potentially exposed receptors. The primary potential pathways for inhalation exposure to NOA were identified based on expected construction activities (Tetra Tech 2014). These pathways include inhalation of outdoor ambient air and outdoor air near (and potentially downwind of) disturbed soil. Additional potential exposure pathways include inhalation of indoor air, contacting NOA-containing dust on outdoor surfaces, or ingestion of NOA-containing dust. Evaluation of exposures for off-site receptors such as residents, industrial/commercial workers, and recreationalists (such as all-terrain vehicle riders) is outside the current scope of work for Phase 1.

The primary potential receptor will be a construction worker, assumed to be an adult operating heavy construction equipment (such as earthmovers, backhoes, bulldozers, etc.). The construction worker may also drive a vehicle (e.g., a pickup truck) across the site.

The CSM shows NOA as the primary contaminant source. The primary contaminant release and transport mechanisms include fugitive emissions from construction activities, as well as fugitive emissions from wind, soil redeposited by surface water runoff (including water runoff from mitigation measures and vehicle decontamination washes), and redeposited soil. All these fugitive emissions can potentially result in release of NOA to ambient air.

Secondary contamination can result from redeposition of NOA suspended in ambient air to surface soil and other outdoor surfaces. Another potential secondary contamination mechanism is transport of NOA on worker clothing or vehicles, which could then be released to surfaces and indoor air in off-site locations such as businesses and residences.

The CSM should continue to be refined as additional data are acquired for Phase I and the understanding of transport and exposure pathways is improved. The following sections identify the inhalation exposure pathways considered complete for the BCB project, pathways that are considered incomplete, and pathways with an uncertain magnitude of exposure.

2.3.1 Inhalation Exposure Pathway Considered Complete

The inhalation exposure pathway considered potentially complete is fugitive emissions in outdoor air for construction workers. Analytical data for NOA were collected to provide initial estimates of risk for inhalation exposure pathways that are potentially complete. Initial estimates of human health cancer risks are provided for these pathways in Section 6.0. United States Environmental Protection Agency (EPA) has not yet establishing a dose-response relationship for non-cancer effects from inhalation of asbestos fibers.

The outdoor inhalation pathway considered potentially complete results from mechanisms (naturally occurring and human-caused) that may disturb NOA in soil. Receptors for which this pathway is potentially complete are identified on Figure 2-3. Some activities are more likely to result in soil disturbance and release of NOA to outdoor air, including:

- Wind erosion
- Construction activities (operating heavy construction equipment such as earthmovers, backhoes, bulldozers, loading and dumping, rock crushing, drilling, etc.)
- Driving vehicles (trucks, equipment) across the site

- Blasting activities.

2.3.2 Exposure Pathways Considered Minor or For Which the Magnitude of Exposure is Uncertain

Health risks associated with minor or uncertain pathways will, at a minimum, be qualitatively addressed in the human health risk estimate. Analytical data for NOA collected as part of the ambient air monitoring may be used to evaluate off-site exposures. Evaluation of preliminary health risks associated with Phase I is limited to potential exposure through inhalation of NOA by on-site construction workers. Evaluation of off-site exposures, including those specifically listed above, is outside the current Phase I scope of work. Other potential off-site exposures that may eventually need to be considered include:

- Potential exposure to indoor airborne NOA emitted by dust from construction and sampling. This may be from fugitive dust containing NOA migrating from the site and into indoor residential or work spaces through open windows and doors, or through off-site transport of NOA on worker clothing or vehicles. Collection of wipe or micro vacuum samples from clothing or vehicles is outside the current Phase 1 scope of work.
- Dermal contact with NOA-containing dust on roofing or other outdoor surfaces.

3.0 SITE CHARACTERIZATION METHODS

The sampling and analytical investigative methods used for determining NOA concentrations in Phase I ambient air, surface soil, subsurface soil, bedrock, and opportunity-based samples are in this section.

3.1 AMBIENT AIR

Four ambient air sample stations were selected across the project area based on the need to provide good geographic coverage and to collect useful data for winds blowing from different directions. The predominant winds in the Henderson and Boulder City areas tend to blow from the south south-west to south south-east, depending on the tracks that the storms follow. Sample station BC-AA-1 is on the north end of the project; station BC-AA-4 on the south end; station BC-AA-2 near the center; and station BC-AA-3 on the far eastern end, closest to Boulder City (Figure 3-1). The selected station locations will ensure good spatial coverage of the project area. Once the sampling stations were placed, the global positioning system (GPS) coordinates of each station were recorded.

3.1.1 Sample Station Set-Up

Tetra Tech constructed the outdoor ambient air sampling stations generally following the design shown on Figure 3-2. Each station was assigned a number, and a sign with the address and a phone number to call in case of an emergency was placed on the fencing. The stations were fenced and locked, and the sample housing units were locked. The sampling pumps used were SKC, Inc. AirChek 52 pumps with adjustable flow rates of 1 to 3 liters per minute (L/min). The air pumps were powered by deep-cycle batteries that were recharged between uses.

All stations were designed to allow for collection of samples from an adult breathing height; approximately 5 feet above ground level. Sample cassettes were connected to the sampling pumps using lengths of ¼-inch diameter tubing. Figure 3-2 shows the station setup and connection of the cassettes to the pump.

3.1.2 Collection Interval and Flow Rates

To ensure that samples captured long-term averages, each sample was collected over 5 days (120 hours). Initially, a target volume of 14,400-liters (L) of air (collected at 2 L/min) was collected for each sample during periods 1 through 4. Tetra Tech adjusted this target volume based on filter overloading issues observed after sampling period 4. A new target volume of 10,800 L (collected at 1.5 L/min) was chosen for all samples collected during periods 5 and forward to address the potential overloading issues. The new target volume changed the necessary number of grid openings counted during laboratory analysis (90 for 10,800 L versus 67 for 14,400 L) but remained low enough to still enable the laboratory to reach the analytical sensitivity of 0.00004 structures per cubic centimeter (structures cc^{-1}).

Meteorological data (wind speed, direction, temperature, humidity, and precipitation) was collected from the Henderson and Boulder City weather stations throughout the 3-month ambient air sampling program. Although not considered necessary for the calculation of risks, these data may be used to help evaluate and understand temporal patterns of outdoor ambient air results and sample representativeness.

3.1.3 Sample Schedule and Numbers

Ambient air was sampled on a regular 10-day schedule (5 days on and 5 days off). This produced nine field samples per station over the initial 3 months (May to August).

NDOT BCB PHASE I
AMBIENT AIR SAMPLE PERIODS

Sample Period 1:	May 8 – May 13, 2014
Sample Period 2:	May 19 – May 24, 2014
Sample Period 3:	May 30 – June 4, 2014
Sample Period 4:	June 10 – June 15, 2014
Sample Period 5:	June 21 – June 26, 2014
Sample Period 6:	July 3 – July 8, 2014
Sample Period 7:	July 14 – July 19, 2014
Sample Period 8:	July 25 – July 30, 2014
Sample Period 9:	August 5 – August 10, 2014

During the first two periods, each station was checked once each day for visible loading of filters and proper pump flow rates.

After each 5-day sampling period, the locations remained idle for 5 days. This schedule provided the necessary information to complete assessments and statistical evaluations of potential NOA ambient air concentrations across the Phase I project area.

3.1.4 Sample Collection and Analysis

Samples were collected using 25-millimeter diameter, 0.8 micrometer (µm) pore size (mixed-cellulose ester [MCE] filters). This pore size was selected based on previous outdoor ambient air sampling experience and allowed for sampling a relatively large volume of air (up to 14,400 L) without excessive filter overloading and resulting pump backpressure.

Prior to initial sample collection and prior to each subsequent sampling, Tetra Tech calibrated each pump according to the manufacturer's (SKC) instructions to ensure proper flow rate. Each air sampling pump was calibrated at the start of each sampling period using a Bios DryCal® DC-Lite primary calibration source. Pre-calibration was considered complete when plus or minus (±) 5% of the desired flow rate was attained, as determined by three measurements with the calibrator using a cassette reserved for calibration (from the same lot of the sample cassettes to be used in the field). Field calibrations were taken between the pre- and post-calibrations with a rotameter calibrated from the primary calibration source.

Samples were securely packaged and delivered to EMSL laboratory for analysis at the end of each 5-day sampling. A custody seal was placed on each end of each sampling cassette. Samples were shipped by overnight delivery service and the samples were secured for shipment in a rigid container with sufficient packing material (bubble wrap) to prevent dislodging the collected fibers from the cassette filters. Tetra Tech prepared a hard copy of the chain-of-custody (COC) to accompany each shipment of samples.

The ambient air and quality assurance/quality control (QA/QC) samples were analyzed for asbestos fibers using International Organization for Standardization (ISO) TEM Method 10312. All asbestos structures detected with a length greater than 0.5 µm and an aspect ratio ≥ 3:1 were recorded. The laboratory results (see Section 5.1) include both regulated asbestos types (Chrysotile, Amosite, Actinolite, Tremolite, Anthophyllite, and Crocidolite) and non-regulated amphiboles. The laboratory reports provide the total number of phase contrast microscopy equivalent (PCMe) structures, fibers, bundles, and the total countable concentrations.

Field documentation for the ambient air sampling included completing Field Sample Data Sheet (FSDS), taking photographs, and completing sample custody documentation.

3.2 SURFACE SOIL/SUBSURFACE SOIL AND BEDROCK

Tetra Tech sampled to determine the presence and concentration of NOA in surface and subsurface soil and rock in the proposed construction area. Surface soil samples were collected throughout the length and width of the alignment on a biased grid basis as shown on Figure 3-3. Subsurface samples were collected from proposed excavation areas in sedimentary soils by either trenching or hollow-stem auger drilling methods. Samples of bedrock materials were collected using either rock coring or rock outcrop methods. Table 3-1 summarizes the number of surface soil, subsurface soil, and bedrock samples collected for Phase I. Figure 3-3 shows the locations of the surface soil sampling units, soil test pits, hollow-stem auger locations, core drill and rock outcrop sampling sites.

A combination of biased sampling and unbiased composite and grab sampling was used to characterize the rock and soil materials to be encountered during construction. The primary purpose of this sampling program was to collect representative samples of existing surficial soils where fill is to be placed and subsurface soil and rock where cuts are planned and to determine if there is NOA. A secondary goal was to obtain a further understanding of the occurrence of NOA in the alignment to develop mitigation measures or controls that would minimize disturbance of the NOA or reduce potential health risks during or after construction. The sampling and analytical methods and materials used for this site characterization were in the SAP and QAPP (Tetra Tech 2014). The boundaries of the geologic and soil map units were initially obtained from electronic sources and overlaid onto the project aerial map prior to initiating the sampling program. Although some boundary discrepancies were noted between the published data and actual geologic and soil units due to the different map scales, site geology and soil unit boundaries were verified and adjusted based on mapping during the field investigation.

3.2.1 Surface Soil Sampling

The general surface soil sampling strategy was to collect a series of unbiased 30-point composite samples in the alignment where soil disturbance is planned. The project area was divided into 65 biased grid areas with similar surface soil and lithology (i.e., each grid area was mapped as a unique soil or bedrock type) based on recent USGS geologic mapping (Felger 2013 and Anderson 1977) and USDA soil maps (USDA-NRCS 2006). Each grid area was mapped by the field team lead with surface features, topography and other conditions (vegetation, debris, drainage channels, etc.) noted in the daily field log. The soil samples were collected from a representative area in each grid. Surface soil sample methodology consisted of 30-point composite samples collected from each grid. No suspect NOA was seen in the soil (fines) or coarse materials (gravel or rock) during sampling, so no biased samples of those materials were collected. Stainless steel trowels were used to collect approximately 50 grams of soil from the 0- to 6-inch below ground surface interval at each aliquot location to obtain approximately 1.5 kilogram (kg) of soil matrix or fines. Coarse gravel and rocks exceeding approximately ½ inch in diameter were removed from the sample by hand. Coarse rock removed from each sample was logged by the geologist in the field and the material retained if further evaluation is required.

Sampling of rock materials to be encountered in proposed cut areas was done using core drilling and surface outcrop sampling methods. The boring locations were marked in the field in advance. Underground Service Alert and NDOT were notified so that the test pits and boring locations were cleared for the presence of subsurface utilities prior to mobilization to the field. Because subsurface utilities or other possible obstructions were identified while clearing the location for Test Pits TP4 and TP5, and hollow-stem boring locations HS3 and HS4, the locations for the test pits and borings were moved to a cleared adjacent location.

The 30 aliquots were placed in a stainless steel bowl, mixed/homogenized, as described in the FSDS, and then placed in re-closable plastic bags for shipment to the lab. Between samplings, all non-disposable sampling tools were decontaminated as specified in the SAP.

3.2.2 Subsurface Soil (Alluvium) Sampling

Shallow unbiased subsurface soil samples were collected from backhoe test pits in areas where proposed road cuts are planned in the alluvium. Twenty test pits ranging from 5 to 10 feet deep were completed with one composite soil sample collected from each test pit. Five-point composite samples consisted of soil aliquots collected from the four sides and from the bottom of each pit by collecting representative soil from the backhoe bucket. Each aliquot was approximately 300 grams and composited vertically from the pit sides and horizontally across the pit floor. The soil aliquots were placed in the bowl, mixed and the coarse gravel and rock greater than ½ inch diameter removed by hand. The test pit soil profile was described and logged by the field team and recorded on the FSDS (Appendix A). Excavated soil was used to backfill the test pit. The backfill was tamped to an unyielding condition using the excavator bucket or wheel rolled to minimize the potential for settlement.

3.2.3 Deeper Alluvium Sampling

Deeper, unbiased, alluvium material samples were collected from planned highway right-of-way areas, where excavations are planned to range from 10 to 40 feet below ground surface (bgs), using hollow-stem auger drilling equipment in areas underlain by unconsolidated or weakly consolidated alluvium. Four borings were completed between stations 86 + 00 to 111+ 00 where the proposed road alignment will cross under the existing railroad tracks. The remaining two borings were where excavations are planned to construct bridge columns or footings for bridges (stations 145 + 00 and 152 + 00). A track-mounted drill, equipped with 6-inch diameter augers, was used to collect the samples with Standard Penetration Test (SPT) samples obtained at intervals of 5 feet. The number of blows required to drive the sampler were recorded for each 6-inch interval. Samples consisted of five representative 300 gram aliquots collected from each SPT sample obtained within each 25-foot interval. The two deepest borings (35 and 45 feet bgs) required two samples to be collected. Five equally spaced aliquots were collected from the secondary sample intervals in these two borings. The split-spoon samples were logged by the field team, and transferred to a re-closable plastic bag for submittal to the off-site laboratory for preparation and analyses. Conditions encountered in each borehole were recorded with major changes in geology noted on the boring logs (Appendix A).

3.2.4 Bedrock Sampling

Biased samples of the intrusive quartz monzonite (Ti) bedrock were collected from two areas in the alignment where significant cuts are planned. The areas between station 60+00 and 67+00 of the western frontage road, and from Station 155+00 to approximately 185+00 of the main highway are underlain by the Tertiary-age quartz monzonite (Figure 3-3). Due to the steep terrain in these two areas, sampling was done using a combination of rock coring, where accessible, and outcrop sampling where access was limited. Outcrop samples were obtained in the upper elevations of the hillside. Biased sampling of the bedrock in planned cut areas using rock coring was done at one location in the eastern portion of the alignment near where the old highway ties into the interchange. This area is underlain by the altered volcanic breccia (Trip).

3.2.4.1 Outcrop Sampling

Fourteen outcrop sample locations were collected from the bedrock cut areas. The geology of the bedrock exposure was mapped by the project geologist prior to identifying the planned sample locations. A sample grid was located in areas that best represented the lithology of that outcrop. All field data was recorded on the daily field data logs, and photographs were taken of the rock exposure along with field sketches documenting the conditions. Discrete samples were obtained from 10 suspect NOA areas such as veins, dikes, shears, or noticeably altered material. Geologically representative rock chip samples were obtained, using a rock hammer and chisel, from spatially regular 3 x 3 grids with 16 aliquots taken at the grid intersections. Each aliquot was approximately 90-grams, resulting in approximately 1.5 kg of rock material in the composite sample. The size of the grid varied from 9 by 9 feet to 30 by 30 feet based on geologic mapping and the size of the exposure.

3.2.4.2 Subsurface Core Sampling

A track mounted core drill, using a triple-barrel NQ (1.77-inch diameter) wire-line core sampler, was planned to be used to collect the samples in seven proposed bedrock areas, but due to the highly fractured nature of the bedrock materials, rock coring sampling was limited to three locations. The borings were completed to a maximum depth of 50 feet bgs. Ten composite samples were obtained and submitted for analysis. Samples consisted of five representative aliquots, of 150 grams each, collected from a geologically similar section of core or 10-foot interval, whichever was less. There were no veins, dikes, or altered sections of rock observed so discrete or biased samples were not submitted for analysis. The cores were geologically logged and photographed, and the aliquots were placed in re-closable plastic bags for submittal to the off-site laboratory for preparation and analyses. The cores were retained in core boxes oriented in the direction obtained during drilling with each core run noted and spacers placed to indicate depth. Lost core sections were noted by spacers labeled “core loss.” The cores were protected from disturbance or movement in the box by placement of a foam insulation or similar material, and then were transported to the project’s designated storage facility. The core holes were plugged and abandoned prior to demobilization by the driller.

3.2.5 Sample Handling and Documentation

The location of each surface and subsurface soil sample was measured and recorded using a hand-held GPS unit. Digital photographs were taken to document the conditions before and after sampling. During sample collection and mixing, the field sampler shielded the soil samples from the wind to avoid potentially losing lighter fractions to the ambient air. At the conclusion of sampling, the stainless steel trowel and bowl were thoroughly cleaned and decontaminated at that sample location. The initial re-closable plastic bag was placed inside a second bag as a precaution. A pre-printed sample label was affixed to the outside of the inner bag and the sample identification (ID) number written on the outside of the inner bag. The outer bag was labeled and marked similarly using the preprinted unique identification numbers.

3.3 Opportunity-Based Sampling

This section describes the methods used for opportunity-based air sample collection during solid media sampling. The opportunity-based samples are not intended to directly correlate with construction activity-based sampling, but may provide insight into expected exposures during construction. All opportunity-based sampling was completed at locations in and along the Phase I area. Table 3-2 shows the activities and the locations where each opportunity-based sample was collected. The opportunity-based air samples included documentation of surficial cover materials, soil type, and other field conditions. The driving activity included all of the reasonably accessible gravel and dirt roads in the Phase I right-of-way west and south of Highway 93/95 and is shown on Figure 3-4.

3.3.1 Solid Media Opportunity-Based Sampling

Opportunity-based sampling was completed during collection of surface soil, shallow subsurface soil, and subsurface rock samples. Opportunity-based samples were collected from the soil and rock samplers and the backhoe and drill rig operators. Sampling area soils were wetted during the backhoe and drilling operations to minimize dust generation; the use of water to minimize dust was considered to be similar to wetting activities to be used during construction. The equipment operators completed a variety of tasks during the complete scenario with some time sitting or standing while operating the equipment. The samplers moved through a variety of positions from bending over to collect soil aliquots, standing or crouching to collect samples from the backhoe bucket, core drilled sections, or rock outcrops, to standing or crouching during aliquot mixing/homogenizing and placement in the bag and back-filling of the pit. By mounting the sample cassette on the shoulder, the samples were collected from the breathing zone of the samplers and equipment operators. The numbers of the surface soil, test pit, or soil borings during opportunity-based sampling were recorded on the FSDS.

3.3.2 Driving Opportunity-Based Sampling

The driver ensured travel was evenly distributed throughout all reasonably accessible areas in the project area. Road conditions were documented during the driving scenario. The opportunity-based sampling driving scenario occurred on existing gravel and dirt roads in the project area. The driver maintained a reasonable speed, (an average of 8 to 10 miles per hour) depending on road conditions. During sampling, the front two windows of the vehicle were fully open, and the back two windows were open approximately 1 inch. All samples were collected from the right shoulder of the driver.

Before the driving scenario began, site conditions (primarily ambient temperature) were considered from a health and safety perspective. Because the most conservative driving scenario sampling results are expected if no air conditioning (AC) is used, the opportunity-based sampling driving scenarios were run during early morning hours when AC was not necessary. At the conclusion of the driving scenarios, one Microvac composite dust sample was collected from five locations in the pickup truck including the floorboard, passenger seat, and dashboard.

It was not possible to replicate the exact path traveled during the four samplings, so the driving routes were documented using a portable GPS unit that recorded the route. All accessible roads in the project area were travelled in each 1-hour driving scenario. Driving and opportunity-based sampling was not performed following any rainfalls.

3.3.3 Pump Calibration

The air sampling pumps were calibrated at the start of each opportunity-based sampling using a Bios DryCal® DC-Lite primary calibration source. Calibration was considered complete when ± 5% of the desired flow rate was attained, as determined by three measurements with the calibrator using a cassette reserved for calibration (from the same lot of the sample cassettes to be used in the field). Field calibrations, conducted between the pre- and post-calibrations were completed using a rotameter calibrated using a primary calibration source.

3.3.4 Opportunity-Based Sample Collection

Opportunity-based sampling was done over a 4-hour interval for Activities 1 through 3 (solid media), and over a 1-hour interval for Activity 4 (driving) at each sample location or area. A summary of the opportunity-based sampling and the number of samples collected are:

- Opportunity-Based Sample Activity 1 – surface soil sampler (5 samples at 960 L each)
- Opportunity-Based Sample Activity 2 – subsurface soil sampler and backhoe operator (4 samples at 960 L each)
- Opportunity-Based Sample Activity 3 – rock sampler and drill rig operator (6 samples at 960 L each)
- Opportunity-Based Sample Activity 4 – driver (5 samples at 600 L each)

Each time interval was continuous and included representative component activities such as sampling and completion of paperwork. Opportunity-based samples were collected by samplers performing the scenario activities as outlined by the project SAP and QAPP (Tetra Tech 2014). At each location, a sampler or equipment operator engaged in the activities in each of the scenarios. All opportunity-based samples were collected using 25 mm diameter mixed-cellulose ester (MCE) filter cassettes with an 0.8 µm pore size. The primary opportunity-based samples were collected using battery-powered sampling pumps capable of operating at 4 L/min. The specific model selected for this sampling was the Sensidyne Gilian BDXII personal Air Sampling Pump. For Activities 1 through 3, the pump flow rate was adjusted to 4 L/min to obtain sample volumes of at least 960 L. The opportunity-based sampling for the driving scenario was done by one driver and the sample was collected using a GAST #1531 pump adjusted to 10 L/min. The sample volume for Activity 4 was approximately 600 L.

The sample cassette was affixed to the shoulder of the sampler so that the cassette was in the breathing zone. The breathing zone can be visualized as a hemisphere approximately 6 to 9 inches around an individual's face. The top cover from the cowl extension on the sampling cassette was removed (i.e., open-face) and the cassette was oriented face down. The samplers/operators monitored the cassettes throughout the scenario to ensure they remained generally toward the activity and were free of obstructions.

The FSDS, field logbook, and associated sketch were completed for each area visited as part of the opportunity-based sampling. Sample information and visual inspection results were recorded in the field logbook and included sketches. Field maps included visual inspection locations and results, surface and subsurface soil and rock sampling locations, and the approximate location of the opportunity-based sampling.

4.0 DEVIATIONS FROM THE SAP AND QAPP

The sampling procedures were continually monitored to ensure that the objectives of the SAP and QAPP (Tetra Tech 2014) were accomplished. Deviations to the procedures in the SAP and QAPP were occasionally necessary to fulfill project objectives or to accommodate unanticipated events or conditions. Changes were implemented for: (1) ambient air sampling, (2) hollow stem auger subsurface soil sampling, (3) rock core sampling, (4) biased rock sampling, and (5) opportunity-based sampling. Deviations were primarily related to adjustments in numbers of samples and locations of samples. There were no significant impacts to completing the stated project objectives from procedural deviations. Development of initial construction worker risk estimates and construction dust mitigation measures were completed as proposed. Table 4-1 provides a summary of all significant deviations. The sections below provide a summary of the various deviations.

4.1 AMBIENT AIR SAMPLING

Ambient air sampling was proposed to occur at four stations over nine 5-day samplings (May-August 2014). All samples were collected as proposed. Each sample consisted of 14,400 L of air for each 5-day sample for the first four samplings. The 14,400 L was based on a pump flow rate of 2 L/min over the 5 days (7,200 minutes). During sampling events 1-4, the laboratory noted several ambient air sample cassettes were nearing the point of overloading (approximately 25%). Overloading conditions result when the filter surface has ≥ 25% loading, when loading conditions are weighted to a single area of the filter, or when loose material is found within the filter cassette body. These conditions make analysis difficult or unrepresentative of sampling conditions and can also lead to issues with the air pump in the field (low flow rates or pump faults). Although the samples were satisfactory for analysis, the laboratory was concerned that future samples could become overloaded and requested that the flow rates be reduced. After discussions with the laboratory, it was decided to reduce the flow rate from 2 L/min to 1.5 L/min. Reduction of the flow rate resulted in 10,800 L of air per sample. To achieve the analytical sensitivity of 0.00004 structures cc^{-1}, the samples required counting 90 grid openings (instead of 67 grid openings) for the analysis. Sampling events 5-9 were run at the reduced flow rate of 1.5 L/min and the analytical sensitivity was achieved for all samples.

4.2 SURFACE SOIL SAMPLING

Surface soil sampling was proposed at 65 locations across the project area. All 65 samples were collected as proposed. A single additional opportunistic sample was collected (SS-66) and analyzed from the southwestern portion of the project area. There were no other deviations related to surface soil sampling.

4.3 BACKHOE SUBSURFACE SOIL SAMPLING

Backhoe subsurface soil sampling was proposed at 20 locations. All 20 samples were collected as proposed. Some of the test pits were moved (up to 50 feet) based on the potential presence of utilities. Movement of the test pit locations had no significant impact on the data collected. There were no other deviations related to backhoe subsurface soil sampling.

4.4 HOLLOW STEM AUGER SUBSURFACE SOIL SAMPLING

Hollow stem auger subsurface soil sampling was proposed at 6 borehole locations (9 subsurface soil samples). All 6 boreholes were drilled, but only 6 samples were collected due to difficult drilling conditions (poor sample recovery). Lithologic data were recorded to 25 feet in three boreholes, 35 feet in two boreholes, and 45 feet in one borehole. Some of the locations were moved (up to 100 feet) based on the potential presence of utilities or access issues related to terrain. Movement of the locations had no impact on the data collected. There were no other deviations related to hollow stem auger subsurface soil sampling.

4.5 Rock Outcrop Sampling

Rock outcrop sampling was proposed for 10 locations across the Phase I project area. Fourteen rock outcrop samples were obtained due to the difficulties in rock core recovery. The four additional samples were collected adjacent to the rock core boring locations to supplement the evaluation of the bedrock conditions in proposed cut areas.

4.6 Rock Core Sampling

Rock core sampling was proposed for five locations (21 rock core samples). Coring was conducted at three of the five proposed locations, and only 10 samples were collected due to difficult drilling conditions (non-competent rock) that prevented the rock core bit from properly advancing and providing sufficient representative cores. Geologic data were recorded to 35 feet in RC-1, 16 feet in RC-2, and 4.5 feet in RC-4. The collection of a reduced amount of geologic data from rock coring is not anticipated to be significant as biased rock samples were collected from lower reaches of the hillslopes that are assumed to be representative of geologic conditions at depths approximating the proposed rock core locations. Some of the borehole locations were moved (up to 100 feet) based on the potential presence of utilities or access issues related to terrain. Movement of the rock core locations had little or no impact on the data collected. There were no other deviations related to rock core sampling.

4.7 Biased Rock Sampling

Rock sampling was proposed for up to 15 opportunistic biased locations across the Phase I project area. Fifteen samples were collected with only nine submitted for analysis. The six samples that were not analyzed were inadvertently collected from outside of the project right-of-way, and were eliminated from consideration for analysis. The inability to use the six samples collected from outside the project right-of-way is not anticipated to have a significant impact on the evaluation of geologic conditions across the Phase I project area. There were no other deviations related to biased rock sampling.

4.8 Opportunity-Based Sampling

Opportunity-based sampling was proposed for four activities: (1) Surface Soil Sampling, (2) Subsurface Soil Sampling with Backhoe, (3) Rock Sampler and Drill Rig Operator, and (4) Truck Driver.

Collection of four opportunity-based samples during surface soil sampling was proposed. Five opportunity-based samples were collected during surface soil sampling as timing of other activities dictated the need for more samples during surface soil sampling to compensate for fewer samples collected during other activities.

Collection of six opportunity-based samples during subsurface soil sampling with a backhoe (three for the soil sampler activity and three for the backhoe operator activity) was proposed. As the backhoe sampling was completed faster than anticipated, timing allowed for collecting only two samples for the sampler and two samples for the backhoe operator.

Collection of six opportunity-based samples during rock core sampling with a drill rig operator (three for the soil sampler activity and three for the backhoe operator activity) was proposed. Because the rock core sampling was terminated early due to difficult drilling conditions, timing allowed for the collection of only two samples for the sampler activity and two samples for the drill rig operator activity.

Collection of four opportunity-based samples during the driving activity was proposed. Five opportunity-based samples were collected during driving as timing of other activities dictated the need for more samples during driving to compensate for fewer samples collected during two of the other three activities. Although five opportunity-based driving samples were collected, only two results were reported because three of the sample filters were reported by the laboratory to not be suitable for analysis due to apparent filter manufacturing defects. To compensate for the loss of the three samples, two additional opportunity-based driving scenario samples were collected on August 21, 2014 and submitted to the laboratory.

Overall, 19 opportunity-based samples were collected and analyzed. Data from the opportunity-based samples was sufficient for inclusion in the construction worker estimated risk Section 6.0).

5.0 SITE CHARACTERIZATION FINDINGS

The BCB Phase I site characterization findings for ambient air, solid media (surface soils, subsurface alluvium materials, and bedrock), and opportunity-based samples are provided in Section 5.

5.1 AMBIENT AIR FINDINGS

Tetra Tech compiled 3 months of ambient air sampling data along with weather data for wind and precipitation from the Boulder City area. Asbestos concentrations in the ambient air samples are not intended to provide single event exposure information but rather to determine a long-term exposure value needed for calculating human health risks (see Section 6.0) and for monitoring the performance of mitigation measures. Seasonal variations in weather and other variability in land use and dust-generating events limit the validity for using only three months of asbestos concentrations in ambient air. NDOT and the other project agencies directed Tetra Tech to continue ambient air monitoring through March 2015. Additional ambient air monitoring may also continue after construction begins.

Historical wind data was available from the Desert Research Institute (DRI) website for the Boulder City area. Actual daily wind and precipitation records for each 5 day sampling were obtained from the DRI website and are in Table 5-1 for review and comparison. Wind rose reports for the sampling periods were prepared and are provided on Figure 5-1.

The Boulder City area experiences windy conditions more than 85% of the time with calm conditions only recorded approximately 15% of the time. Boulder City has slightly more wind than the Henderson area that reports calm conditions about 20% of the time. Predominant winds in the Boulder City area blow from the southwest, south-southwest, and north-northeast but are variable due to passing weather fronts and pressure systems. Winds in the Henderson area blow predominantly from the northwest, southwest, and south.

The analytical asbestos concentration value for ambient air to be used for evaluating human health risk is the total PCMe structures cc^{-1}. This value is defined as all regulated asbestos types and non-regulated amphiboles that meet the PCMe structure criteria of greater than 5 µm long, greater than or equal to (≥) 0.25 µm wide, and with an aspect ratio ≥ to 3:1. All four Phase I stations (Figure 3-1) recorded some detectable total PCMe structures in ambient air over the 3 months of sampling (May 8 through August 9, 2014). In contrast, all four Phase I stations also had at least one 5-day sampling with no detectable PCMe structures. Of the 36 samples (from four stations) collected over the 3 months of sampling, 134 actinolite structures were observed, 9 non-regulated amphibole structures were observed, 1 chrysotile structure and 2 anthophyllite structures were observed. The results of 3 months of sampling show inherent temporal variability of NOA in ambient air.

The results of the 3 months of ambient air sampling are provided in graphical view on Figure 5-2 and show the concentrations of total PCMe structures cc^{-1} by Station and Period. The highest total PCMe concentration of 1.41E-03 structures cc^{-1} was recorded at Station 4 from June 10 – 15, 2014, however that filter cassette was overloaded and was prepared and analyzed using an indirect preparation method (not as accurate as the direct preparation method). Indirect preparation does not provide the same sensitivity as direct preparation and may result in reportedly higher concentrations. Data from this sample are considered usable for the risk estimate. Seven samples during the 3 months exhibited no detectable asbestos. Results by station are:

Station 1 had no detectable PCMe asbestos during three of eight periods. Total PCMe concentrations detected ranged from 3.9715E-05 to 1.1915E-04 structures cc^{-1}. Four of the six detected results had only one PCMe structure and one sample had three total PCMe structures. Less asbestos was found in the surface and subsurface soils on the northern end of the project area, which may have an effect on the results at Station 1.

Station 2 had the most consistent results of the four stations. No detected PCMe structures were recorded during the first sampling (May 8-13) only. One to three total PCMe structures were identified in all other samples. Detected total PCMe concentrations ranged from 3.9715E-05 to 1.1915E-04 structures cc^{-1}. The highest total PCMe concentration of 1.1915E-04 structures cc^{-1} (three PCMe structures) was detected during sampling period 4 (June 10-15). Of all periods, the highest average wind speed was recorded during period 4 at 6.7 miles per hour (mph).

Station 3 had somewhat variable results with three periods having no detectable PCMe structures and the other six periods having one to four total PCMe structures. Total PCMe concentrations ranged from 3.9715E-05 to 1.587E-04 structures cc^{-1}. The sample from Station 3 for Period 3 was overloaded and required an indirect preparation that resulted in a slightly higher total PCMe concentration due to analytical uncertainty. Periods 4 and 5 also had four detected total PCMe structures at Station 3; these two periods had the two highest average wind speeds of 6.7 and 6.1 mph and no precipitation.

Station 4 ambient air typically had the highest total PCMe structures and resulting asbestos concentrations (3.9715E-05 to 1.415E-03 structures cc^{-1}) of the four Phase I stations. The highest recorded total PCMe concentration of 1.41E-03 structures cc^{-1} was recorded at Station 4 from June 10 – 15, 2014. The location of this station and the land uses in the immediately surrounding area appear to have an impact on ambient air results, causing a higher level of total PCMe asbestos in this area compared to the other areas. The predominant winds from the southwest and south directions during the 3-month sampling period may have caused dust, with asbestos, to be transported from potential asbestos source areas (such as the playa) onto the south end of the site.

Wind and precipitation patterns are certain to have an effect on the PCMe concentrations in the ambient air results. Wind direction and speeds tend to vary in a diurnal pattern and likely impact PCMe concentrations. No precipitation fell during Periods 1 through 5, but it did rain (from 0.02 to 0.45 inch) during five events during Periods 6, 7, and 8 (Figure 5-3). Many other variables likely have an effect on asbestos concentrations in ambient air over a 5 day long sampling, but the 0.5 inch of rain during Period 8 appears to have resulted in lower asbestos levels in ambient air.

The short duration (3 months) of Phase I ambient air sampling limits the representativeness of the results for an annual average ambient exposure and may reduce the accuracy for risk calculations. The scheduled continuation of ambient air sampling for an additional period up to 1 year will help assure the effects of the seasonal wind patterns and precipitation are accounted for in estimates of asbestos concentrations in ambient air and will improve the validity and accuracy of risk calculations.

5.2 SURFACE SOIL/SUBSURFACE SOIL AND BEDROCK

Analytical results indicate low concentrations of NOA, in the form of actinolite, are present in some surface and subsurface soils, alluvium materials, and bedrock within the Phase I project area. The source of the actinolite is likely derived from the parent materials and bedrock in and adjacent to the Phase 1 alignment. A summary of all solid media sampling results for the site characterization is in Table 5-2. Figure 5-3 presents the results in graphical view for all surface soil, subsurface soil, and bedrock samples.

Of the 66 composite surface soil samples submitted for analysis, asbestos structures were detected in 10 samples using a polarized light microscopy (PLM) method and counting 400 points (EPA Method 600, EPA 1993). After evaluating the PLM results, 12 of the 66 surface soil samples were selected, from across the Phase I project area and from the range of PLM results, and submitted for additional TEM analysis. All 66 surface soil PLM results were below 0.25% (the lowest reporting level above non-detection for Method EPA 600). None of the 12 surface soil samples analyzed by TEM had detectable total PCMe asbestos concentrations above the analytical sensitivity (ranged from 0.0162% to 0.0175%). The distribution and concentrations of NOA from PLM and TEM results indicate that low levels of NOA were found in the upper 6 inches of the Phase I surface soils and low NOA appears to be more prevalent in the central and southern portions of the project area. Only one location in the northern portion of the project had NOA in the surface soil.

Twenty composite samples were collected from the subsurface, alluvial soil materials using backhoe test pits. Two subsurface soil samples had a PLM concentration of less than or equal to (≤) 0.25% and 18 were non-detect. Four of the 20 samples were submitted for additional TEM analysis; 3 had reported concentrations less than the analytical sensitivity and one sample (SB-17) had an anomalous detection of 1 large chrysotile structure that yielded a result of 6.83% by weight. The SB-17 test pit was in an area underlain by older alluvium, however it was adjacent and down gradient of the US 93/95, east of the Railroad Pass Casino. Other surficial debris was noted in this area and was likely the source of the chrysotile asbestos.

Six composite samples were submitted from the hollow-stem auger borings for asbestos determinations. NOA was detected in HS-6 with a PLM concentration of less than 0.25% and a TEM concentration less than the analytical detection limit (<0.0172%). The HS-6 sample was composited from the 0 to 25 foot depth from the boring in the central portion of the alluvial wash (mapped as older alluvium).

Composite samples were also collected from 14 outcrop locations in the Phase I project area. NOA was detected by PLM method in 5 of the 14 locations. There were no PLM detections in the three outcrop samples obtained from the hill between Frontage Road (Station 56 + 00 to 64 + 00). Fresh unweathered quartz monzonite was the primary unit mapped in this area. Evidence of faulting and or shearing was observed in the drainage immediately south of the hill, near the location of the rock core boring RC-2. The 5 outcrop samples (BR-5, BR-7, BR-8, BR-9 and BR-14) with NOA detections had concentrations <0.25%. Three of the 14 outcrop samples were submitted for TEM analysis and two had concentrations below the analytical sensitivity (0.016%). One sample (BR-5) had a total PCMe structure concentration of 0.20%. BR-5 was collected from an area underlain by quartz monzonite; however dacite dikes were also mapped nearby.

As noted in Section 3.2, the rock core sampling methodology yielded limited results due to the poor core recovery. Rock coring was only conducted at three locations with a maximum depth of 35 feet at the RC-1, 16 feet at RC-2, and 4.5 feet at RC-4. Ten composite rock core samples were submitted for NOA and none of the samples had detectable asbestos by PLM analysis. Two of the 10 rock core samples were submitted for TEM analysis and both samples had total PCMe concentrations below the analytical sensitivity of 0.016%.

Nine discrete bedrock samples were collected and submitted for NOA analysis. Only four samples had detections of <0.25% by PLM with five samples having non-detect results. Four samples were submitted for the additional TEM analysis and three of the four had total PCMe concentrations below the analytical sensitivity (ranged from 0.0161% to 0.0178). One sample (G48QM11) did have a total PCMe concentration of 0.025%.

Outcrop and discrete bedrock displayed fine elongated hornblende crystals and appeared to have been derived from the hillside area west of the Phase I alignment. Geologic mapping of this area identified that significant faulting and/or shearing of the quarts monzonite bedrock has occurred. Evidence of weak hydrothermal alteration was also noted in the area along the western Phase 1 boundary and in the hillside west of the project.

5.3 OPPORTUNITY-BASED SAMPLING FINDINGS

Tetra Tech completed opportunity-based sampling during sampling of solid media (surface soil, sub-surface soil, and rock) and driving activities throughout the Phase I project area. The opportunity-based samples are not intended to directly mimic anticipated construction activities, but may provide insight into expected exposures and potential risk to workers during future construction. Opportunity-based samples were collected during activities by the soil and rock sampling personnel, the backhoe and drill rig operators, and a lone driver travelling on project area dirt or gravel roads during mainly dry conditions (no precipitation fell immediately before, or during sampling). Some water was applied to surface soil by the backhoe operator during test pit sampling to simulate dust suppression measures likely to be used during the use of heavy equipment.

Tasks completed by each participant during opportunity-based sampling included a full range of activities from sample location setup, to sample mixing and collection in sample containers, to driving and sitting in a truck. A summary of representative activities and locations for opportunity-based sampling is provided in Table 3-1. Opportunity-based sampling locations and roads driven are shown on Figure 3-4.

The analytical results of the opportunity-based sampling are provided in Table 5-3 and show total PCMe concentrations (structures cc^{-1}) by opportunity-based sampling event. Twenty-four actinolite structures and two non-regulated amphibole structures were identified. The highest concentration of total PCMe was 6.86E-03 structures cc^{-1} and was recorded during surface soil sampling in the south-central portion of the Phase I project area. Seven other opportunity-based samples had detectable, but low concentrations of total PCMe, and nine samples had no asbestos detections. Summaries of the results, by activity type, from opportunity-based sampling are presented below.

5.3.1 Surface Soil Sampling (Activity 1)

Opportunity-based sampling during surface soil sampling was completed in five areas (Table 3-2 and Figure 3-4). Each opportunity-based sample was collected during visits to multiple surface soil locations. The highest concentration of asbestos (6.86E-03 structures cc^{-1}) was detected during surface soil sampling in the south-central portion of the project area. Three other samples showed detectable asbestos (1.96E-03 to 4.90E-03 structures cc^{-1}) in the south-central and southern project areas. The only area with no detection of NOA (during opportunity-based sampling) was the northernmost portion (both east and west of the highway). Total PCMe analytical results for this Activity appear to correlate with NOA detections in surface soil samples. The main areas with low NOA concentrations are in the central and southern portions of the project area.

5.3.2 Hollow-Stem Auger and Test Pit Backhoe Sampling (Activity 2)

Opportunity-based sampling during hollow-stem auger sampling of sub-surface soil was done in two areas (Table 3-2 and Figure 3-4). Each opportunity-based sample was collected during visits to two borehole locations. The first two samples (BC-ABS-00013 and BC-ABS-00014) were collected during visits to two boreholes generally in the north-central portions of the project area. Samples were collected from both the drill rig operator and the soil sampler. Analytical results from these sample locations showed non-detect levels of asbestos for the drill rig operator and for the sampler. Non-detect results for both are consistent with non-detect levels of asbestos in the areas where opportunity-based sampling was done.

The second two samples (BC-ABS-00018 and BC-ABS-00019) were collected during visits to two borehole locations, generally in the south-central/southeastern portions of the project area. Samples were collected from the drill rig operator and the soil sampler. Analytical results from these sample locations showed non-detect levels of asbestos associated with the soil sampler and an asbestos total PCMe analytical result of 2.98E-03 structures cc^{-1} for the drill rig operator. One nearby location (TP-13) contained detectable levels of asbestos. Opportunity-based samples for the drill rig operator appear to correlate with these findings. Non-detect results for the soil sampler may be explained by the distance from the main area of soil disturbance maintained by the sampler during drilling.

Opportunity-based sampling during test pit backhoe sampling of sub-surface soil was done in two areas (Table 3-2 and Figure 3-4). Each opportunity-based sample was collected during visits to multiple test pit locations. The first two samples (BC-ABS-00009 and BC-ABS-00010) were collected during visits to seven test pit locations and one surface soil sampling location, generally in the southern and eastern portions of the project area. Samples were collected from both the backhoe operator and the soil sampler. Analytical results from these sample locations showed non-detect levels of NOA associated with the backhoe operator and a total PCMe concentration of 1.96E-03 structures cc^{-1} for the sampler. Several sample locations (TP-12, TP-13, and SS-66) in this opportunity-based sampling area contained detectable levels of asbestos. Opportunity-based samples for the sampler appear to correlate with these findings. Non-detect results for the backhoe operator may be explained by the distance of the operator from the area of soil disturbance.

The second two samples (BC-ABS-00028 and BC-ABS-00029) were collected during visits to six test pit locations, widely distributed across the north central, central, southern, and eastern portions of the project area. Samples were collected from the backhoe operator and the soil sampler. Analytical results from these sample locations showed non-detect levels of NOA associated with the backhoe operator and a total

PCMe concentration of 9.74E-04 structures cc^{-1} for the sampler. One location (TP-5) contained detectable levels of asbestos. Opportunity-based samples for the sampler appear to correlate with these findings. Non-detect results for the backhoe operator may be explained by the distance of the operator from the area of soil disturbance or by the application of water for dust control.

5.3.3 Rock Core Drilling (Activity 3)

Opportunity-based sampling during core sampling of bedrock soil was done in one location (surface soil sampling grid #16) (Table 3-2 and Figure 3-4). Two opportunity-based samples were collected at that location. The two samples (BC-ABS-00031 and BC-ABS-00032) were collected from the coring location generally in the northwestern portion of the project area. Samples were collected from the drill rig operator and the soil sampler. Analytical results from these samples showed non-detect levels of asbestos for both the drill rig operator and for the sampler. Non-detect results for both the drill rig operator and the sampler are consistent with non-detect levels of asbestos in the area where opportunity-based sampling was done.

5.3.4 Driving (Activity 4)

Opportunity-based sampling during driving was done throughout a majority of the project area south and west of Highway 93/95 (Figure 3-4). Only areas east and north of the highway were not driven because accessibility was poor. All reasonably accessible Phase I area roads (gravel/dirt) west and south of the highway were driven for each of the five sampling rounds. Figure 3-4 provides a diagram of the roads driven during this scenario. Driving was done concurrently with other solid media and ambient air sampling. There were five rounds of driving for opportunity-based sampling, but three of the five samples were not suitable for analysis because of filter damage (opaque filters received at laboratory). A discussion of these samples is in Section 4.3. Of the remaining two samples, one was found to be non-detect for asbestos and the other contained a total PCMe concentration of 4.85E-03 structures cc^{-1}. Detection of asbestos in the driving scenario sample is consistent with the documented presence of asbestos in the central, southern and eastern areas of the project area.

6.0 PRELIMINARY WORKER HUMAN HEALTH RISK ESTIMATES

This section presents preliminary estimates of risk to construction workers from exposure to NOA during construction. This risk estimate provides:

- Preliminary estimates of the approximate magnitude of potential human health risks associated with inhalation of ambient outdoor air and outdoor air containing dust disturbed by construction.

- Identification of the environmental media posing the primary health concerns for NOA, and those posing little or no threat to human health for NOA.
- Recommendations for further evaluation of activities that potentially pose risk to construction workers and other receptors.

The risk estimate incorporates guidance issued by the EPA. Risks were estimated for construction worker receptors only due to the contract-defined tasks, and because construction workers have the greatest potential risk of exposure during road construction. Risks estimates were based on ambient and opportunity-based sampling results from samples collected from late May to early August of 2014. There are limitations on the data that should be considered when reviewing the risk estimate:

- Limited data for ambient results have been collected over approximately 3 months during the summer. This limitation means that the average is for the summer months only, and may not be representative of an annual average ambient exposure.
- Limited, opportunistic, personal samples were collected during investigation sampling and were not collected during actual or simulated construction activities. These samples will be referred to as opportunity-based samples. Many activities that have not been tested may have risk higher or lower than the potential risks estimated in this report.
- The ambient and opportunity-based sampling results are representative only of the Phase I portion of the project and may or may not be applicable to Phase II, or to activities associated with future operations and maintenance of the highway.
- The preliminary risk estimates in this section should not be considered to be a risk assessment for the project.

6.1 RISK ESTIMATE APPROACH

This preliminary risk estimate was developed following risk assessment guidance developed by EPA—the EPA Framework for Investigating Asbestos-Contaminated Superfund Sites (EPA 2008). It is understood that the project is not under the jurisdiction of Superfund; however, the Superfund framework provides a useful approach for asbestos that is not currently available for NOA projects.

The structure of this section follows the overall framework documented in "Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual (Part A)" (also known as "RAGS") (EPA 1989). The EPA RAGS framework consists of six basic steps:

- **CSM:** This step involves evaluating potential exposure pathways of the contaminants of potential concern (COPC) and human populations that might be exposed to them under current or future site conditions.

- **Data Evaluation and Selection of COPCs:** This step consists of evaluating the analytical data for usability in the risk estimate, grouping analytical data by site and by medium, and selecting COPCs in site media.

- **Exposure Assessment:** This step quantifies exposure to the identified COPCs for potentially complete exposure pathways. Exposure point concentrations (EPC) are estimated from measured or modeled concentrations, and pathway-specific intakes (doses) are estimated using hypothetical human receptors for evaluation in the subsequent risk calculations.

- **Toxicity Assessment:** This step consists of compiling toxicity values that characterize potential adverse health effects from exposure to COPCs.

- **Risk Characterization:** This step combines the results of the previous steps to quantitatively characterize potential risks to human health associated with exposure to COPCs at the area evaluated. Both potential cancer risks and non-cancer hazard quotient (HQ), a measure of the potential for adverse health effects other than cancer, are normally evaluated. However, because asbestos has no published non-cancer toxicity value, only cancer risk is evaluated in this risk estimate.

- **Uncertainty Analysis:** This step analyzes the major uncertainties associated with the risks estimated.

Although the RAGS framework was used, RAGS tables were not prepared for two reasons. First, the project is not under the jurisdiction of Superfund, and therefore not every requirement of the Superfund program is necessary. Second, the RAGS tables are primarily intended for Superfund sites with multiple chemicals of potential concern. For this project NOA is the only substance to be evaluated and the RAGS tables would add unneeded complexity to the discussion. The remainder of this section has the methods for and results of each of the six steps.

6.2 CONCEPTUAL SITE MODEL

The CSM summarizes information on sources of NOA, affected environmental media, NOA release and transport mechanisms that may occur, potentially exposed human receptors, and potential exposure pathways for each receptor. Figure 2-3 provides the CSM. The components of the CSM are:

6.2.1 Sources of Naturally-Occurring Asbestos

The COPC considered in this risk estimate is asbestos. Although there may be risk from other substances such as metals in airborne dust, only asbestos is considered in this preliminary risk estimate.

The asbestos of concern occurs naturally in surface and subsurface geologic materials in the planned construction area, as discussed in Section 2.2.

6.2.2 Affected Environmental Media

Because of the nature of the construction project and the nature of NOA, outdoor air is the primary media of concern.

6.2.3 NOA Release and Transport Mechanisms

NOA release and transport mechanisms for the NOA are shown in the CSM (Figure 2-3). Based on these transport mechanisms, NOA in soil may migrate to ambient (outdoor) air and this is considered to be the primary source of exposure. Wind erosion and construction activities are the mechanisms for release of NOA from soil to outdoor air. Asbestos in outdoor air may be directly inhaled, deposited onto surface soil or other surfaces, or transported off-site on worker clothing or vehicles. Water runoff from mitigation activities may transport NOA to other surface soil locations.

6.2.4 Potentially Exposed Human Receptors

The preliminary risk estimate is intended to address ambient risk and risk to construction workers, so only a future construction worker receptor was evaluated in the preliminary risk estimate. Future road maintenance workers may need to be monitored to evaluate whether they may be exposed to unacceptable concentrations of NOA, but this cannot be evaluated until after the road has been built.

6.2.5 Potentially Complete Exposure Pathways

According to EPA guidance (EPA 1989), a complete exposure pathway consists of four elements:

- A source and mechanism of chemical release
- A retention or transport medium (or media in cases involving transfer of chemicals)
- A point of potential human contact with the contaminated medium (referred to as the exposure point)
- An exposure route (such as ingestion) at the contact point

If any of these elements is missing (except in a case where the source itself is the point of exposure), then the exposure pathway is considered incomplete. For example, if human contact with the source or transport medium does not occur, then the exposure pathway is incomplete and is not quantitatively evaluated for risk. Similarly, if human contact with an exposure medium is not possible, the exposure pathway is considered incomplete and is not evaluated.

The CSM summarizes the information on sources of NOA, affected environmental media, possible NOA release and transport mechanisms, potentially exposed receptors, and potential exposure pathways for each receptor (see Figure 2-3). Potentially complete exposure pathways are designated by a filled circle in the CSM. Potentially complete but insignificant exposure pathways are designated by an empty circle. Quantitative risk evaluation (that is, calculation of numerical cancer risk estimates) was done for exposure pathways identified in the CSM as potentially complete.

The exposure pathways for the future exposure scenarios are based on an assumed future exposure. Inhalation of NOA released to outdoor air was identified as the only potentially complete exposure pathway. Additional data will be required to evaluate non-construction exposure scenarios. Exposure to outdoor air was evaluated only for the construction worker due to the contract-defined tasks and because these activities have the greatest potential risk of exposure during road construction.

6.3 DATA EVALUATION AND IDENTIFICATION OF CHEMICALS OF POTENTIAL CONCERN

Because of the current scope of work for the Boulder City Bypass project, only asbestos from naturally-occurring surface and subsurface geologic materials was evaluated as a COPC in outdoor air.

All analytical data for ambient air and opportunity-based samples collected during initial investigations of the project area were included for evaluation in the risk estimate. Data associated with the investigation are further described in Sections 5.1 through 5.3.

In accordance with Section 14 of the SAP (Tetra Tech 2014), the analytical data underwent verification equivalent to Stage 1 verification as described in EPA's Guidance for Labeling Externally Validated Laboratory Analytical Data for Superfund Use (EPA 2009) to identify and correct data reporting errors. This process included checking that results were correctly transferred from the original hand-written, hard-copy field documentation and analytical laboratory documentation into the project database. In accordance with Section 14 of the SAP (Tetra Tech 2014), data validation was to be done on an as needed basis only. Data validation was not done. A list of the analytical results for the ambient air data used in the risk estimate is in Table 6-1. A list of the analytical results for the opportunity-based samples used in the risk estimate is in Table 6-2.

Overall estimates of risk were made for all ambient air data and opportunity-based sampling data as a whole. Ambient air data were grouped by location, and opportunity-based samples were grouped by activity for more specific risk estimates.

6.4 EXPOSURE ASSESSMENT

This exposure assessment identifies potential human receptors that could be exposed to project-related NOA, and the routes, magnitude, frequency, and duration of the potential exposures. The principal objective of this evaluation is to identify reasonable maximum exposures (RME), defined by EPA (1989), as the maximum exposure reasonably expected to occur at a site. For an RME scenario, EPA specifies that some exposure parameters are to be selected as upper-bound estimates, while others may be estimates of centrally tendency as long as the combination of all variables results in an estimate of the reasonable maximum exposure for that pathway.

The potential human receptors and complete exposure pathways for the identified receptors are in Section 6.2, Conceptual Site Model. The remainder of this section describes the process used to estimate EPCs and quantify NOA intake for pathway-specific exposures for each receptor.

6.4.1 Exposure Points and Exposure Point Concentrations

Potential exposure points are identified on the basis of present and anticipated future population activity patterns and the relationship of the activities to the presence of contaminated media. A location is identified as an exposure point if a human might contact (for example, inhale) a contaminated medium (for example, outdoor air) at that location. Potential exposure to COPCs is assumed to occur uniformly throughout project area (exposure point), although specific sample locations for ambient air and specific opportunity-based sampling scenarios were also assessed individually. Because it is not reasonable to assume that long-term contact with a specific maximum concentration will occur for a specific receptor, average concentrations rather than maximum concentrations are used in the preliminary risk estimate.

The concentration in a medium (for example, outdoor air) that a receptor may be exposed to is called the EPC. In accordance with the EPA Framework for Investigating Asbestos-Contaminated Superfund Sites (EPA 2008), the EPCs were calculated as simple means of the measured air concentrations, with non-detected results treated as values of zero. TEM results for total asbestos structures of all types reported as PCMe were used to develop the EPCs. PCMe structures have an aspect ratio ≥ 3:1, are longer than 5 µm, and have a width that is ≥ to 0.25 µm.

EPCs were developed for each of the four Phase I locations where ambient air samples were collected. Figure 3-1 shows the Phase I ambient air stations. These EPCs are reported in Table 6-3.

In addition to the location-specific EPCs, an overall ambient air EPC was developed using all four Phase I locations. This EPC was calculated by averaging the average concentrations for all four locations, and is also reported in Table 6-3.

Limited data for ambient results were collected over approximately 3 months between late May and early August. The limited period of ambient air sample collection means that the average is for late spring through mid-summer only, and may not be representative of an annual average ambient exposure.

Limited opportunity-based sampling data were collected, for only a few scenarios. Sections 3.3 and 5.3 discuss the opportunity-based scenarios investigated. Figure 3-4 shows the driving routes for the driving scenario and the sampling locations for the other scenarios. Not all of the scenarios are likely to be applicable to construction work (for example, the sampling activities), and not all construction activities that will occur on the project have been evaluated.

EPCs were developed for each of the four opportunity-based scenarios. Two of the scenarios have separate sub-scenarios for different worker activities with separate EPCs for each of these sub-scenarios. These scenarios and sub-scenarios were not combined to develop an overall time-weighted EPC because it is unlikely that construction workers will have a balanced set of activities that match such an average. Overall risk estimates for construction workers may be developed using a time-weighted approach, but the current opportunity-based sampling data set is not robust enough to justify such an approach.

Although the opportunity-based sampling data set is limited, it was collected as an initial estimate of likely construction worker exposure. The full range of construction activities may include higher and lower exposures, and each individual construction activity should be assessed as it is begun during project construction.

6.4.2 Time Weighting Factors

Estimates of exposure risks are based on the EPCs (as described in Section 6.4.1) and scenario-specific assumptions. Consistent with EPA (2008) guidance, time weighting factors were calculated for an RME scenario. The RME scenario represents the highest exposure reasonably expected to occur and risk for this scenario is estimated using the EPC and the RME exposure parameters.

EPA-derived exposure algorithms were used to estimate the time weighting factors for inhalation. The generic equation for calculating time weighting factors for inhalation is (EPA 2008):

$$TWF = \frac{ET \times EF}{24 hours / day \times 365 days / year} \qquad \textit{(6-1)}$$

where:

TWF = Time weighting factor: the proportion of time over which specific activities may occur (unitless). TWFs are combined with EPCs for each activity and an appropriate inhalation unit risk (IUR) value to estimate excess lifetime cancer risks associated with activity-based exposure to asbestos.

ET = Exposure time: number of hours the exposure occurs (hours per day); the exposure time is applicable only for inhalation exposures.

EF = Exposure frequency: how often the exposure occurs (days per year)

The exposure time is the number of hours per day (or hours per event) when a receptor is present at a specific exposure point; it is used only to describe the inhalation pathway. An exposure time of 8 hours per day was assumed for the construction worker (EPA 2014b) for evaluation of exposure to asbestos in outdoor air for both ambient and opportunity-based sampling scenarios. Although it is not expected that the opportunity-based activities investigated will be performed by construction workers for 8 hours, for this preliminary risk estimate it is assumed that each activity is performed for 8 hours.

The exposure frequency is the number of days per year (or events per year) when exposure occurs. An exposure frequency of 250 days per year was assumed for construction workers (EPA 2014b), corresponding to the number workdays in a year.

Based on these assumptions, the proportion of time over which specific activities may occur (TWF) for the construction worker is estimated to be 0.23 (see Table 6-3).

In addition to the exposure factors used to estimate the TWF, two additional exposure factors (exposure duration and age at the start of exposure) are used in the Framework to estimate the IUR. The exposure duration is the total number of years when exposure occurs. The exposure duration is not used to calculate the TWF, but is used to select an IUR value that is adjusted for non-lifetime exposure (see Section 6.5.1 of EPA 2008). The exposure duration was assumed to be 1 year for the Phase I construction worker (EPA 2014b), although it is likely that few construction workers on the project will have a full year of exposure. For selecting the IUR to use in the risk estimate, it was assumed that exposure begins at age 18. This age was selected using professional judgment as the likely age that most road construction workers begin working in this field, and is likely to be conservative since most working on the project are expected to be older than 18 at the start of the project.

6.5 TOXICITY ASSESSMENT

The toxicity assessment identifies the reference concentration (RfC) and IUR used to evaluate adverse non-cancer health effects and cancer risks.

6.5.1 Inhalation Unit Risk

Asbestos is classified as a Group A substance for classifying carcinogenicity, meaning that it is a known human carcinogen. The toxicity information considered in the assessment of potential cancer risks includes an IUR for evaluation of inhalation exposures and a weight-of-evidence classification. The IUR for asbestos is 0.23 fibers cc^{-1} and is based on the central-tendency estimate of potency factors, approximating the mean of the increased cancer risk from lifetime exposure to asbestos (EPA 2014a). Section 6.5.1 of the EPA Framework for Investigating Asbestos-Contaminated Superfund Sites recommends an approach of adjusting this IUR to account for less than lifetime exposures (EPA 2008). This approach, with the assumed exposure duration of 1 year and the starting exposure age of 18, provides a derived age- and duration-dependent $IUR_{a,d}$ of 0.0052 fibers cc^{-1}. The IUR and $IUR_{a,d}$ values were developed based on PCM concentration in units of fibers/cubic centimeter.

6.5.2 Reference Concentration

The potential for adverse non-cancer health effects to result from exposure to NOA is typically characterized by comparing an exposure estimate (intake) with an RfC for inhalation exposures. Because no RfC is currently published for non-cancer effects from inhalation of asbestos, the preliminary risk estimate does not account for non-cancer hazards. The uncertainty associated with the possible adoption of a newly-developed draft RfC for amphibole is discussed in Section 6.8.3.

6.6 RISK CHARACTERIZATION

The final step in the risk estimate is the characterization of the potential risks associated with exposure to NOA. The methodology for estimating cancer risk is discussed in Section 6.6.1. Non-cancer hazard was not estimated; this is discussed in Section 6.6.2.

6.6.1 Characterization of Cancer Risks

Risks associated with exposure to NOA are estimated as the incremental probability that an individual will develop cancer over a lifetime as a direct result of an exposure (EPA 1989). The estimated risk is expressed as a unitless probability.

To estimate inhalation cancer risks for asbestos, the EPC is multiplied by the TWF for the receptor and the $IUR_{a,d}$ (EPA 2008):

$$Cancer\ Risk\ (inhalation) = EPC \times TWF \times IUR_{a,d} \qquad (6\text{-}2)$$

where:

EPC = Exposure Point Concentration (structures per cubic centimeter) for TEM results for all abestos structures reported as PCMe

TWF = Time Weighting Factor (unitless)

$IUR_{a,d}$ = Age-and Duration-Dependent Inhalation Unit Risk (fibers/cubic centimeter^{-1})

6.6.2 Characterization of Non-cancer Hazards

The potential for exposure that may result in adverse health effects other than cancer would be evaluated by comparing the intake with an RfC (inhalation exposure). At this time, the Framework for Investigating Asbestos-Contaminated Superfund Sites does not include a proposed method for estimating non-cancer hazards from exposure to asbestos. Because no RfC is currently published for non-cancer effects from inhalation of asbestos (Section 6.5.2), the preliminary risk estimate does not account for non-cancer hazards. The uncertainty associated with the possible future adoption of an RfC is discussed in Section 6.8.3.

6.7 RESULTS OF THE HUMAN HEALTH RISK ESTIMATE

This preliminary risk estimate section included a statistical analysis of data for outdoor air, an exposure assessment, a toxicity assessment, and a risk characterization. As discussed in Section 6.2, only future construction workers were evaluated in the preliminary risk estimate. In accordance with EPA guidance, risk estimates are presented to only one significant figure (EPA 1989).

6.7.1 Ambient Air Risk

Ambient air exposure risk for the future construction worker is based on inhalation of asbestos in ambient outdoor air. Ambient air samples were collected from four locations.

Estimated cancer risks were compared with 1E-06, the point of departure for carcinogens and the risk management range of 1E-06 to 1E-04, as defined by the EPA Office of Solid Waste and Emergency Response (OSWER) Directive 9355.0-30 (EPA 1991). The point of departure and risk management range are intended for use on the Superfund program, and are not directly applicable to this project or location; however, comparison to these values is useful as a comparison to established risk assessment practice.

The cancer risk was estimated separately for each ambient air sample location, reported in Table 6-3. The cancer risk was also estimated for the average of all four Phase I locations combined, and is in Table 6-3. The cancer risk from exposure to ambient air ranges from 3E-08 to 7E-07 for the four separate ambient stations, and the overall risk from the average concentration for all 4 stations is 2E-07. All of the calculated risks are less than the point of departure of 1E-06 for carcinogens, and are considered to be insignificant.

The total non-cancer HQ from exposure to ambient outdoor air for the future construction worker scenario has not been estimated since there is no established RfC for asbestos inhalation.

6.7.2 Opportunity-Based Air Exposure Risk

Exposure risk for the future construction worker is based on inhalation of asbestos in outdoor air containing dust disturbed by construction activities. Opportunity-based samples were collected for four separate scenarios. Two of those scenarios included two different types of exposures, as described in Section 3.3.

The cancer risk from exposure for each specific activity is listed in Table 6-4, and ranges from 1E-06 to 4E-06 based on the EPC, not including two activities for which no asbestos was detected. The calculated risks are within, and at the low end of, the EPA risk management range of 1E-06 to 1E-04. For the two activities with no detections, it is expected that the collection of additional samples would provide a finite estimate of cancer risk for those activities. The analytical sensitivity of the method (1.0E-03) can be used to estimate an upper bound limit of 1E-06 for the cancer risk for these activities.

Because of the limited number of samples for each opportunity-based scenario, minimum and maximum values were also used to estimate risk. For all scenarios, the minimum estimated risk is based on the minimum concentration of zero structures per cubic centimeter, resulting in an estimate of zero risk. The maximum estimated risk values range from 2E-06 to 8E-06 for the five scenarios.

The non-cancer HQ from incidental inhalation of asbestos in outdoor air containing dust disturbed by construction activities for the future construction worker scenario has not been estimated since there is no established RfC for asbestos inhalation.

6.8 UNCERTAINTY EVALUATION

Varying degrees of uncertainty at each stage of the human health risk estimate arise from the assumptions made in the risk estimate and the limitations of the data used to calculate the estimate. Uncertainty and variability are inherent in the exposure assessment, toxicity values, and risk characterization. EPA guidance (1989) states (emphasis from the original):

> "There are several categories of uncertainties associated with risk assessments. One is the initial selection of substances used to characterize exposures and risk on the basis of the sampling data and available toxicity information. Other sources of uncertainty are inherent in the toxicity values for each substance used to characterize risk. Additional uncertainties are inherent in the exposure assessment for individual substances and individual exposures. These uncertainties are usually driven by uncertainty in the chemical monitoring data and the models used to estimate exposure concentrations in the absence of monitoring data, but can also be driven by population intake parameters. Finally, additional uncertainties are incorporated in the risk characterization when exposures to several substances across multiple pathways are summed."

EPA defines uncertainty as a "lack of knowledge about specific factors, parameters or models," including "parameter uncertainty (measurement errors, sampling errors, and systematic errors), model uncertainty (uncertainty that results from necessary simplification of real-world processes, mis-specification of the model structure, model misuse, or use of inappropriate surrogate variables), and scenario uncertainty (descriptive errors, aggregation errors, errors in professional judgment, or incomplete analysis)." Variability is defined as "observed differences attributable to true heterogeneity or diversity in a population or exposure parameter." Variability is the result of natural random processes, such as variations in body weight, breathing rate, or drinking water consumption. Variability cannot be reduced by further study, but may be better characterized through further measurements. The next sections describe the key sources of uncertainty in this risk estimate.

6.8.1 Sampling Data

Lack of sufficient samples to characterize outdoor air can result in an under- or over-estimate of risk because EPCs for an exposure area may be based on very few samples that may or may not be representative of the area at large. The risk estimate is based on the analytical results for existing samples. The ambient air and the opportunity-based sample sets are limited, which may result in overestimate or underestimate of risk.

Limited data for ambient air were collected over approximately 3 months between mid-May and early August. This limitation means that the average may not be representative of an annual average ambient exposure. As discussed in Section 5.1, it did not rain during the first five periods, but it did rain during Periods 6, 7, and 8.

The opportunity-based sample set is limited in two regards. First, only a few samples were collected for each activity. This limitation could result in an overestimate or an underestimate of rick. Second, many construction activities that will likely be common during the project (for example, road-grading, loading, load travel, dumping, blasting, rock crushing, and ripping), and may potentially release NOA to a greater extent, have not yet been tested. This limitation could result in an underestimate of risk. If and when a more robust opportunity-based sampling dataset is developed, overall estimate of risks for construction workers could be developed based on TWFs for specific activities.

6.8.2 Exposure Assessment

Uncertainties were identified in association with three areas of the exposure assessment process: (1) the selection of exposure scenarios and pathways, (2) the estimation of EPCs, and (3) the selection of exposure variables used to estimate NOA intake. Uncertainties in each of these areas are discussed in the following sections.

6.8.2.1 Exposure Scenarios and Pathways

Exposure scenarios were identified based on assumed project activity that may occur. Uncertainties are introduced to the degree that actual land use and activity patterns are not represented by those assumed.

As discussed in Section 6.4.1, only a few opportunity-based sampling scenarios were investigated. Many activities that have not been tested may have risk higher or lower than the potential risks in this report.

This assumption should be evaluated with activity-based sampling (ABS) as construction begins. Each significant construction activity should be tested using ABS with receptors wearing respiratory protection until the sampling results demonstrate that cancer risk is at an acceptable level, with the use of appropriate engineering controls or personal protective equipment as necessary.

Off-site receptors were not evaluated as part of the preliminary risk estimate. This data gap should be evaluated with a robust perimeter monitoring program as construction begins.

6.8.2.2 Estimating Exposure Point Concentrations

EPA guidance for estimating EPCs for asbestos recommends the use of a simple mean calculated with non-detected values treated as zero. This recommendation is made because methods for estimating upper confidence limits (UCL) for asbestos that incorporate contributions from authentic inter-sample variation and from random Poisson counting variation have not approved by EPA. The use of a simple mean with non-detected values treated as zero is an uncertain estimate of the true mean, and actual risks may be overestimated or underestimated by this approach.

Exposure point concentrations were developed using the sum of regulated and non-regulated structures (all asbestos structures were included in the estimates). If non-regulated amphiboles have lower or higher toxicity than regulated amphiboles, then this approach overestimate or underestimate the risk accordingly.

Minimum and maximum concentrations were also used to assess the opportunity-based sampling data, but because of the limited number of samples collected, even the full range of concentrations may underestimate the risk associated with construction activities.

A few samples required the use of indirect preparation for the asbestos analysis. Three of 56 ambient samples and 1 of 20 opportunity-based samples required indirect preparation. Although indirect preparation may increase the concentration associated with these specific samples, the increase in concentration is likely low for actinolite (Goldade and O'Brien 2014). Because only a few samples in each data set were affected, the overall effect is to slightly increase the EPCs.

6.8.2.3 Selecting Exposure Variables

The exposure variables used to estimate NOA intake are standard upper-bound estimates. In reality, there may be considerable variation in the activity patterns and physiological response of individuals. It is possible that the exposure variables used in this evaluation do not represent actual future exposure conditions.

The exposure assumptions used in the risk estimate were standard default assumptions for workers. It is likely that many exposure assumptions are conservative. For example, most construction workers are unlikely to begin work on the project at age 18, or to have a full year of exposure as part of Phase I of the project, or an exposure frequency as high as 250 days per year engaging in activities that disturb soil or rock. All defaults are intended to provide a conservative estimate of risks, rather than to underestimate risks.

6.8.3 Toxicity Assessment

The primary uncertainties associated with the toxicity assessment are related to derivation of toxicity values for COPCs, and the mineralogy of asbestos. IURs developed by EPA were used to estimate potential cancer health effects from exposure to asbestos. These values are derived by applying conservative (health-protective) assumptions and are intended to protect the most sensitive potentially exposed individuals.

Because asbestos is a general term for a number of mineralogical varieties of silicate minerals containing thin fibrous crystals, the established Integrated Risk Information System (IRIS) IUR may not be accurate for every variety. The IRIS IUR was established based on weighted averages of several different asbestos fiber types, and focused on common types of asbestos including chrysotile, tremolite, amosite, and crocidolite (EPA 2014a). In contrast, most NOA found in the project area is of the actinolite type, as discussed in Section 5.2. As a result, the published IUR may be biased either high or low relative to the NOA in the project area.

At present, no RfC for inhalation of asbestos is established (EPA is in the process of establishing an RfC for inhalation of amphibole derived from the Libby Asbestos Superfund Site), and non-cancer effects are not accounted for in the preliminary risk estimate, so the non-cancer hazards are underestimated. The magnitude of the underestimation is unknown until the RfC is established. However, EPA’s proposed draft Libby-specific RfC indicates that non-cancer endpoints may be the toxicity driver in determining risk thresholds.

6.8.4 Risk Characterization

Because only inhalation exposure to asbestos was evaluated, there is no uncertainty associated with summing exposures to several substances across multiple pathways. However, there is some uncertainty associated with not summing risks for different exposure types (for example, ambient risk plus risk associated with construction activities) or different receptor types (for example, construction workers who are also residents of Boulder City and may be exposed to NOA at work and at home). These types of uncertainties are expected to result in potential underestimation of risk.

Uncertainties in risk characterization also include the sum of all uncertainties from the initial steps leading up to the calculations of risk.

6.9 CONCLUSIONS AND RECOMMENDATIONS

This preliminary risk estimate was developed to assess potential risk to construction workers from inhalation of ambient outdoor air and outdoor air containing dust disturbed by construction activities. The preliminary risk estimate should not be considered to be a risk assessment for the project. Several uncertainties associated with the data used to develop the preliminary risk estimate are discussed below.

The cancer risk from exposure to ambient air ranges from 3E-08 to 7E-07 for the four separate ambient stations, and the overall average for all four stations is 2E-07. All of the calculated risks are less than the point of departure of 1E-06 for carcinogens.

Limited data for ambient air were collected over approximately 3 months between mid-May and early August. This limitation means that the average may not be representative of an annual average ambient exposure. As discussed in Section 5.1, it did not rain during first five periods, but it did rain during Periods 6, 7, and 8. It is recommended that the ambient air sampling program be continued for 1 year to assure that the effects of seasonal wind patterns and precipitation are accounted for in estimates of ambient air concentrations. This will improve the accuracy of risk calculations based on these estimated concentrations. The perimeter monitoring program should be reevaluated based on ambient air results on an ongoing basis.

The cancer risk from exposure for each specific opportunity-based sampling scenario ranges from 2E-06 to 8E-06. The calculated risks are within, and at the low end of, the EPA risk management range of 1E-06 to 1E-04.

The opportunity-based sample set is limited in two regards. First, only a few samples have been collected for each activity. Second, many construction activities which will likely be common during the project for example, road-grading, loading, load travel, dumping, blasting, and ripping) have not yet been tested. Therefore, it is recommended that opportunity-based sampling be done for the scenarios investigated in this preliminary risk estimate, and additional scenarios that are likely to occur during the project. ABS should be used to demonstrate that new construction activities do not cause risk in excess of the target risk level selected for the project. In addition to monitoring new activities for excess risk, the development of a robust opportunity-based sampling dataset will allow for the development of a more accurate overall estimate of risk for construction workers based on the expected frequency and time spent on specific activities by typical construction worker scenarios.

The non-cancer HQ from exposure to outdoor air for the future construction worker scenario has not been estimated since there is no established RfC for asbestos inhalation.

7.0 CONSTRUCTION MITIGATION MEASURES AND MONITORING

This section presents the general guidelines for mitigation and monitoring measures outlined to reduce the risk associated with NOA during road construction at the BCB Phase I construction site. No areas within the Phase I project right-of-way contained NOA at ≥ 0.25% concentrations. Mitigation measures for the BCB Phase I project are modeled after the ≥ 0.25% California regulatory threshold (California Air Resources Board) for asbestos concentrations in solid materials analyzed by PLM. Solid media asbestos concentrations for the Phase I portion of the project are shown on Figure 5-3. Mitigation measures specifically for NOA are not expected to be required for Phase I. The dust control measures required for all construction projects by Clark County are relatively comprehensive and should minimize the risk due to any lower levels of NOA by controlling dust. Because of the limited number of samples analyzed during the investigation, additional monitoring to verify NOA exposure levels to on-site workers and the surrounding community is recommended during the initial periods (first weeks) of the Phase I construction activities.

This section has the following information:

- Minimum required mitigation Best Management Practices (BMP) for the entire project consistent with the Clark County Air Quality Regulations, Section 94 and Clark County Dust Control Handbook.
- Recommended air monitoring for the area surrounding the work site (perimeter) and active construction area air monitoring.
- Recommendations for on-site use or reuse of soil and rock containing NOA

- Recommendations for equipment decontamination engineering controls
- Recommended health and safety measures for contractors who may disturb NOA during construction.

Table 7-1 summarizes construction mitigation measures and monitoring recommendations for the Phase I BCB construction project. The BMPs were obtained from the Construction Activities Dust Control Handbook which are considered part of the Clark County Air Quality Regulations. BMPs applicable to the project were placed in the table for ease of reference and to aid in the decision process. Additional details and BMPs are available in the handbook.

7.1 MITIGATION GUIDELINES

The following guidelines outline mitigation measures to be used during Phase I of the BCB construction project.

7.1.1 Dust Mitigation Guidelines

Dust mitigation measures must be in place throughout construction to prevent excessive dust. The minimum dust control measures must remain in compliance with the Clark County Air Quality Regulations, Section 94 and Clark County Dust Control Handbook (Portions summarized in Table 7-1). The previous investigation found there are no areas where asbestos exceeds 0.25% in the Phase I project area. However, the contractor may be required to take more conservative precautions when performing more aggressive construction activities that disturb soils or when disturbing soils with NOA that exceeds 0.25% asbestos, if they are discovered during construction.

Dust generating activities anticipated during construction include but are not limited to:

- General soil and land disturbance,
- Clearing and grubbing,
- Cutting and filling.
- Backfilling,
- Blasting,
- Crushing,
- Importing and exporting soil and rock,
- Paving and subgrade preparation,
- Screening,
- Stockpiling,
- General truck and vehicle operations, and
- Truck loading and transport.

Dust mitigation involves the use of various measures depending on the activity. Table 7-1 provides potential mitigation measures for expected activities and BMPs to meet the minimum requirements.

7.1.2 Mitigation Guidelines for Managing Contamination Run-off and Off-Site Migration

Mitigation measures must be in place during and after construction to manage contaminated run off and off site migration of contaminated soils. The minimum control measures must be to remain in compliance with the Clark County Air Quality Regulations, Section 94 and Clark County Dust Control Handbook (Portions summarized in Table 7-1). Although previous investigation found there are no Phase I areas where asbestos exceeds 0.25%, construction operations may excavate soils and rock exceeding this level. Control measures must be employed to mitigate contaminant run off and off site migration.

Contaminant run off and off site migration control will involve the use of various measures. Examples include:

- Develop a comprehensive erosion and sediment control (ESC) plan prior to earth-moving activities. Four key factors affect the potential for contaminated soil erosion from a site: soil characteristics, vegetative cover, topography, and climate. Take all of these factors into consideration to develop an ESC plan that will minimize soil loss, limit the area exposed to construction, maximize the vegetative cover, use natural topographic features to the best advantage, and include BMPs suitable to the Clark County regional climate. Apply ESC practices to prevent excessive onsite damage. Use ESC BMPs to control the flow of runoff water and thereby prevent or lessen soil erosion. Limiting land disturbance and preserving natural vegetation.
- Apply perimeter control practices to protect the disturbed area from offsite runoff and to prevent sedimentation damage to areas below the construction site. A sediment and runoff barrier surrounding the disturbed area prevents construction site runoff from moving offsite and fouling surface waters downstream.
- Keep runoff velocities low and retain runoff on the site. The erosive power of runoff increases dramatically as distance and slope increase. BMPs can be used to effectively control runoff velocity and detain it to remove 80 to 90% of the sediment from runoff.
- Stabilize disturbed areas immediately after final grade has been attained. Any exposed soil is subject to erosion from rainfall, wind, and vehicles. BMPs to stabilize soil should be applied as quickly as possible after the land is disturbed. Temporary stabilization practices include seeding, mulching, and erosion control blankets or mats.
- Construction Site BMPs may include the use of straw bale barriers, filter fabrics, silt fences, sediment basins, and measures to stabilize site entrances where vehicles enter or leave the site.
- Permanent control BMPs may include grassed swales, filter strips, terracing, check dams, detention ponds or basins, infiltration trenches and basins.

7.2 DUST MITIGATION WHEN BLASTING OF SOIL AND ROCK

These control measures are specific to areas where NOA has been identified and the applicant will be required to comply with these work practices for minimizing or preventing the release of dust.

The application for a dust control permit will include a dust mitigation plan that describes in detail the control measures that will be implemented for the control and prevention of dust emissions associated with blasting of soil and rock. This plan will be incorporated into and become part of the dust control permit and enforceable by the Department of Air Quality.

The plan must contain information explaining how the applicant will comply with following requirements:

- Describe the dust control practices to minimize dust emissions during blasting when blasting occurs within 1,500 feet of a residential area, occupied building, or major roadway, and the wind direction is toward these structures.
- Provide a general schedule as to the hours of the day blasting will occur.
- Describe methods to be used to monitor weather and wind conditions prior to blasting when the forecast is for wind gusts of 25 mph or greater.
- Describe procedures for pre-watering and maintaining surface soils in a stabilized condition where drills, support equipment and vehicles will operate.
- Describe what materials will be utilized for stemming. NOA containing soils are prohibited to use as stemming materials.
- Describe which system the applicant will use to minimize dust emissions during blasting. The applicant must employ blasting mats or utilize a DustBoss water spray system.
- Describe methods for mitigating fly-rock from blasting operations.
- Describe procedures for pre-watering the area around the blast zone floor.
- Describe methods for stabilizing soils directly after each blast.
- Provide notification to Air Quality at least 4 hours prior to each blast.

The Control Officer for Air Quality will review each requirement and approve the dust mitigation plan as proposed or may add additional requirements based on the work practices proposed by the applicant. Air Quality will not impose an opacity limit on blasting activities for this project.

7.3 AIR MONITORING PLANS

This section provides various air monitoring recommendations. Air quality and dust levels within the demarcated construction areas are generally required to be at or below 20% opacity when measured by a qualified Visible Emissions Evaluator using the Opacity Standard (Section 91, Clark County Air Quality Regulations). Lower dust levels should generally correlate with lower asbestos levels in air. However, airborne asbestos levels can only be determined by on-site testing. In consideration that NOA is present at this project site, Clark County (through its Dust Control Permit for the BCB construction project) will require no visible emissions be released to the atmosphere outside the construction area perimeter during construction activities with the exception of when blasting occurs, which will be subject to more stringent BMPs as a means to reduce the particulate emissions during the blast. The monitoring recommended during the construction process is in the following sections.

7.3.1 Perimeter Ambient Air Monitoring

Perimeter air monitoring is recommended at various locations around and along the construction site to document the contractor's engineering and administration controls and to ensure dust and potential asbestos air concentrations at perimeter monitoring locations do not exceed the risk-based thresholds. Perimeter air concentration thresholds have been established for Phase II of the BCB project and will be adopted for Phase I. These thresholds may be based on a risk-based approach that uses background levels established before construction. The contractor should develop engineering and administration controls based on these established threshold levels, including stop work levels, to ensure that asbestos air concentrations at the perimeter monitors do not exceed these threshold criteria. It is important to note that this threshold is not to be interpreted as a "not to exceed" limit in all cases; occasional exceedances of the threshold are not expected to result in cancer risks above the specified excess cancer risk limit, provided that the long-term (3-year) average air concentration is below the threshold. While there may be individual air samples above the threshold criteria, the average concentration should remain below the threshold. However, to ensure protection of the residential community, for the BCB, if ongoing perimeter air data monitoring results indicate that NOA concentrations for individual air samples exceed the threshold, appropriate engineering and administrative controls will be revised to prevent further offsite migration of asbestos.

Perimeter monitoring would involve collecting both upwind and downwind perimeter air samples during each day of construction. Samples would be collected 24-hours per day and analyzed by PCM and TEM methods. These sample results could be compared to the background ambient air samples currently being collected to ensure that construction has not caused any additional risk to the surrounding areas.

7.3.2 Perimeter Monitoring of Construction Zones

Perimeter construction zone monitoring (in addition to the standard 20% opacity monitoring in designated construction areas and no visible dust at fence lines) is recommended throughout the project for all construction activities in areas where NOA has been detected. Perimeter zone monitoring will be done near various construction processes to closely scrutinize variances in work practices and engineering controls. Some perimeter air monitoring stations should be semi-permanent and others moved frequently depending on construction activities, locations and wind patterns each day.

Perimeter air concentration thresholds have not yet been established but should be developed using a risk-based approach coordinated and in general agreement with the BCB Phase II project thresholds. The Phase II project proposed using a 0.002 structures cc-1 (PCMe) threshold level that may be adjusted using attenuation factors specific for Phase II. Phase I will develop the thresholds based on risk, background criteria, and specific Phase I attenuation factors. The contractor should develop engineering and administration controls based on these established threshold levels, including stop work levels, to ensure that asbestos air concentrations at the perimeter zone monitoring do not exceed these threshold criteria.

Perimeter air monitoring should be completed along the entire BCB Phase I project boundary during all construction activities. Monitoring stations will be approximately ½ mile apart along the north, south, east, and west sides of the project area to ensure some stations are upwind and downwind of all activities. Air samples will be collected during each day of construction and analyzed by PCM and TEM. Real time, direct read monitoring could be included, along with the fixed perimeter air sampling, using particulate reading meters. The direct particulate readings would only document dust levels, not airborne NOA, but would provide additional information to assist with changing construction activities. BMPs and guidelines, in addition to those required by Clark County, have been prepared by other agencies and could be implemented. For example, the Bay Area Air Quality Management District in California prepared guidelines for minimizing off-site migration of asbestos for construction, grading, quarrying, and surface mining operations (Bay Area Air Quality Management District Section 93105 (d)(1)(B)(4).

7.3.3 Personnel Monitoring

The employees working closest to a source of contamination have the highest likelihood of exposure to airborne asbestos contaminant concentrations that may exceed established exposure limits, so the workers who are closest to a source of contaminant generation should be monitored. The type of construction activity can also significantly affect exposure for the workers near the most aggressive activities that disturb materials containing NOA. Personal monitoring should be completed in the breathing zone and, if a worker is wearing respiratory protective equipment, outside the face piece. Work that results in potential employee exposure to airborne asbestos above the prescribed permissible exposure limit (PEL) or short term exposure limit (STEL) requires an exposure assessment regulated under the Occupational Safety and Health Administration (OSHA) reference method 29 Code of Federal Regulations (CFR) Part1926.1101. The determinations of employee exposure should be made from breathing zone air samples representative of the 8-hour TWA and 30-minute STEL for each employee work category. The PEL for PCM sample analysis is 0.1 fibers per cubic centimeter (f/cc) for the 8-hour TWA, and the STEL is 1.0 f/cc over a 30-minute period per 29 CFR Part 1926.1101(c) and (k).

Many activities anticipated during the BCB project may cause exposure of workers to NOA if it is contained in the material being disturbed. Initial air monitoring should be completed throughout each Phase I geologic unit and represent all construction activities because such activities could constitute asbestos disturbance procedures as defined by 29 CFR Part 1926.1101. Depending on the type of activity, even low asbestos levels can generate personnel exposure concerns. The initial exposure assessments will be representative of each specific work situation and such activity documented. Factors to be weighed include (but are not limited to) type of work, condition of the materials, air monitoring results from similar tasks, and all elements that could make the work more difficult (such as obstructions, high temperature areas, and poor reach areas). Initial exposure assessment samples should be collected for each employee job category or unique activity, prioritizing the highest likely exposure activities first. Exposure assessment samples should also be collected periodically during the course of the project as part of the QA/QC process.

The initial exposure assessments will be designed to provide negative exposure assessments (NEA) to demonstrate that employee exposures will be below the PEL or STEL for each representative construction task. The initial exposure assessment should be completed at the beginning of construction activities or when new construction tasks are initiated. The monitoring and analysis should be completed in compliance with the OSHA asbestos standard in effect. Successful NEAs can be used in the initial exposure assessment to reduce or eliminate the need for respiratory protection if all applicable criteria are met. NOA levels are likely to vary across the project site. It should not be assumed that initial NEA will be representative of the same task done in different areas, so additional monitoring is recommended when moving from one area to the next, particularly where the geology changes or the previously detected levels of NOA change.

Personnel air monitoring should be completed to calculate the airborne fiber concentration to ensure that employee exposure remains below the PEL and STEL. The worker’s exposures will be measured by first collecting an air sample from the breathing zone (within 12 inches from the nose) throughout an entire work-shift. This measurement usually necessitates that workers wear an air sampling pump near the waist. The personal air monitoring should be evaluated based on the different work activities and the geological zone where work is done. A representative set of air samples should be collected during activities that represent typical construction days.

The sampling pump flow rates should be between 0.5 L/min and 2.5 L/min when using a 25-millimeter cassette. Once this sample is analyzed, the results should be used to calculate the average level of exposure during the complete work shift (the TWA). The TWA results should then be used for comparison to the PEL and to evaluate compliance with OSHA regulations. They will also be used to dictate if respiratory protection is required to ensure that the PEL is not exceeded.

29 CFR Part 1926.1101(d) pertains to multi-employer worksites whereby the contractor controlling the construction site is required to inform other employers on the site of the asbestos regulated area and the presence of NOA and any and all air sampling results. Additionally, these employers must comply with applicable protective provisions to protect their employees.

Personal air samples should also be collected and analyzed in the manner described for comparison to the PEL and STEL. Sample filters should be analyzed using PCM methodology by laboratory personnel (1) trained in National Institute for Occupation Safety and Health (NIOSH) 582 microscopist (or equivalent) courses, and (2) participating in a quality control program meeting the requirements established in 29 CFR 1926.1101. The NIOSH method used for this analysis will be Method 7400. The PCM analytical method is designed to identify all fibers of specific size and shape characteristics but not to distinguish between asbestos and non-asbestos fibers. PCM sample results are reported in f/cc. The contractor should request that all sample filters be returned from the laboratory after analysis to be archived. The laboratories should be accredited though the National Voluntary Laboratory Accreditation Program (NVLAP) and experienced with asbestos analyses.

7.4 ON-SITE REUSE OF SOIL AND ROCK CONTAINING NOA

Areas where NOA does not exceed 0.25% do not require special handling for asbestos. However, the area should generally be made no worse than it was initially, so the human health risks upon completion of the project are not greater than before starting. There are no known Phase I areas where NOA exceeds 0.25%. If any soils or rock materials are discovered with NOA concentrations ≥ 0.25%, these additional measures may be required:

The contractor should stockpile embankment fill and surface rock for sampling. Stockpiles should be sampled to characterize NOA using the same procedures used for surface and subsurface soil sampling (Section 3.2). Stockpiles with NOA concentrations ≥ 0.25% asbestos must:

- apply adequate water during hauling and placement of embankment fill and surface rock
- cap excavation areas (unconsolidated material) with a minimum of 3-inches of soils with < 0.25% NOA such as crushed rock, paving, vegetative cover, or any other measure deemed sufficient to prevent visible dust emission during wind speeds of 10 mph or greater
- stabilize or cover stockpiles of crushed material if remaining long term
- The contractor should collect samples for NOA analysis for exposed rock surfaces slated for blasting. Rock surfaces with NOA ≥ 0.25% must apply an appropriate encapsulant suitable for capping the exposed NOA

NOA containing soil and rock must typically be covered with materials that contain lower levels of asbestos. For example if any soils in the Phase I area are found to contain NOA concentrations ≥ 0.25%, they should be covered with soils or other capping materials with NOA < 0.25%. The intent is to leave a stable surface that is cleaner, or at least no worse than what previously existed. Embankments should be covered with aggregate or shotcrete, and flat shoulders and medians can have gravel or clean compacted soil with hydro-seed and plants.

Remaining areas with capped NOA, or surface NOA <0.25%, should be mapped to convey the location of these materials for any future disturbances during maintenance efforts.

7.5 EQUIPMENT DECONTAMINATION ENGINEERING CONTROLS

The primary intent of equipment decontamination is to reduce tracking of material off-site thereby reducing the risk of exposure to NOA. The normal procedures required by Clark County are sufficient for Phase I construction because levels of NOA in soils and rock materials are < 0.25%. However, additional BMPs may be necessary if any areas are found to contain NOA levels ≥ 0.25%, or if air monitoring determines an increase in airborne NOA. These include:

- Establish decontamination stations at the perimeter of areas with levels of NOA ≥ 0.25%. The intent is to stop the potential tracking of NOA off-site and from areas with higher NOA concentrations to areas of lower concentrations.
- Inspect equipment prior to de-mobilizing from site or areas of elevated NOA concentration
- HEPA vacuum and wet wipe cab interiors
- Minimize track-out of project area soil and wash pavement as necessary or use HEPA equipped street sweepers to remove track-out on pavement.

- Route all exiting traffic over selected track-out control devices and provide wheel washers to remove contamination from vehicles prior to leaving the project site.
- Stabilize all haul routes and all off-road and parking areas.

7.6 NOA Related Health and Safety Measures for Contractors

The health and safety topics in this section are not intended to meet all the requirements of the contractor's HASP but instead to outline health and safety issues that pertain to NOA that should be considered during construction. Physical and other hazards at the site, such as heavy equipment excavation measures and equipment operation, are not addressed in this section.

7.6.1 Health and Safety Plan Enforcement

The contractor's HASP must apply to all site activities and all personnel working on the project and must be enforceable. Personnel should be encouraged to report, orally or in writing, to the site safety coordinator any conditions or practices they consider detrimental to their health or safety or that they believe violate applicable health and safety standards. Personnel who believe that conditions or procedures threaten human health or the environment should be encouraged to remove themselves from the area or the hazardous condition and warn all other personnel of the source of the danger. The hazardous condition or matter should be brought to the immediate attention of the site safety coordinator for resolution.

7.6.2 Chemical Hazards

Actinolite asbestos is a potentially hazardous substance anticipated to be encountered. The major potential route of exposure for asbestos is inhalation; however, secondary potential routes include dermal (skin) contact and ingestion. Asbestos may contaminate equipment, vehicles, instruments, and personnel. Specific information on potential chemical hazards is in Table 7-2. The overall health threat to construction employees from exposure to asbestos is uncertain because: (1) actual concentrations of exposure cannot be predicted until assessments and sampling begins, (2) the actual duration of exposure is unknown, and (3) the effects of low-level exposure to asbestos cannot be predicted. To reduce the potential for inhaling asbestos, workers should adhere to soil dust mitigation procedures and decontamination methods that reduce the creation of airborne dust that may contain NOA.

7.6.3 Training Requirements

All on-site personnel who may be exposed to asbestos hazardous conditions should be required to meet training requirements specified in 29 CFR 1926.1101 (Construction Industry Standard for Asbestos).

General asbestos awareness training (minimum 2-hour course) must be given for all site workers prior to commencing work on the BCB jobsite and must be given annually while they are on the project. The training must cover these topics:

a. The health hazards of asbestos, including the nature of various asbestos-related diseases, routes of exposure, known dose-response relationships, the synergistic relationship between asbestos exposure and cigarette smoking, latency periods for disease, and health basis for standards.

b. The physical characteristics of asbestos, including fiber size, aerodynamic properties, physical appearance, and where NOA is located at the site.

c. Work practices for NOA related site work; transportation and handling of NOA containing soil and rock; worker and equipment decontamination systems; posting of warning signs; engineering controls; dust mitigation; proper working techniques; cleanup and housekeeping protocol; waste handling, storage, and disposal procedures.

d. Personal hygiene including entry and exit procedures for the regulated work areas; use of showers or other decontamination systems; prohibition of eating, drinking, smoking, and chewing in the regulated work areas; and entry and exit of regulated areas). If contractor establishes a regulated area, he must properly erect signage to warn employees of the area and that proper personal protective equipment (PPE) must be used when entering this area. It is suggested language be added to incorporate 29 CR 1926.1101(k)(7)

e. Air monitoring procedures and requirements for workers including description of equipment and procedures, reasons for monitoring, types of samples, and current standards with recommended changes.

Additional training may be required for any workers who may likely be exposed to airborne NOA exceeding the OSHA PEL:

f. Employee PPE including the types and characteristics of respirator classes; limitations of respirators; proper selection, inspection, donning, use, maintenance and storage of respirators; field testing the face piece-to-face seal (positive and negative pressure fitting tests); qualitative and quantitative fit-testing procedures; variations between laboratory and field fit factors; factors that affect respirator fit (e.g., facial hair); selection and use of disposable clothing; non-skid shoes; gloves; eye protection; and hard hats.

g. Medical monitoring requirements for workers including required and recommended tests, reasons for medical monitoring, and employee access to records.

Clark County DAQ also requires for certain job functions that construction workers attend a Dust Class. The DAQ dust class is generally 2 hours long and focuses on Section 94 requirements of the air quality regulations. All construction workers working on the project should attend the dust class. The DAQ will modify the class to incorporate NOA into the curriculum.

Excavation, road construction and grading that disturbs materials with >1% NOA are considered "unclassified work" by OSHA for which there is no specified durations for training referenced in the regulations. However, staffing should be sufficient to assure that at least one supervisor overseeing activities in NOA containing areas should be on site at all times and should be trained as an Asbestos Hazard Emergency Response Act (AHERA) contractor/supervisor meeting the requirements of 29 CFR 1926.32 (f) and the EPA's Model Accreditation Plan (40 CFR 763). The on-site asbestos supervisor should be capable of identifying existing asbestos hazards associated with road construction in areas with NOA and with selecting the appropriate engineering and personal control strategies for asbestos exposure. The on-site asbestos supervisor should be given the authority to take prompt corrective measures to eliminate identified hazards and to do periodic site inspections and carry out other duties related to NOA hazards on the job site.

All personnel entering the site will be required to review the contractor's HASP and participate in daily tailgate safety meetings.

Training Documentation: The Contractor should document training by providing date of training, training entity, and names and qualifications of trainers.

On-Site Training: The Contractor should conduct and document, as required, special on-site training on equipment and procedures unique to this job site.

Emergency Response and Evacuation: The Contractor shall provide and document training in emergency response and evacuation procedures.

7.6.4 Personal Protection Equipment

Each contractor with workers that may be exposed to NOA should have a respiratory protection program and a site-specific plan in place outlining procedures related to NOA work. A copy of the plan should be provided to NDOT before the project begins. The contractor's HASP should address personnel working in areas of the site that contain NOA at levels that could cause airborne exposures exceeding the PEL and the level of PPE that would be donned in various conditions. For example, for activities that will likely exceed the PEL the contractor should notify NDOT and adhere to 29 CFR Part 134, Table 1 and 29 CFR 1926.1101(h), that require correct respirator protection prior to achieving a negative exposure assessment. The site safety coordinator will need authority to upgrade PPE levels at any time site conditions or procedures warrant a change.

7.6.5 Worker Exposure Monitoring

See Section 7.2.3 – Personnel Monitoring

7.6.6 Medical Surveillance

Contractor workers who may encounter an airborne concentration of 0.1 f/cc or greater for an 8 hour TWA must provide up-to-date proof of participation in a medical surveillance program. The medical surveillance program must, at a minimum, meet OSHA requirements in 29 CFR 1926. In addition, the contractor must provide a physician's evaluation of the individual's ability to work in environments capable of producing heat stress.

7.6.7 Personnel and Equipment Decontamination

Prior to leaving areas containing NOA, personnel and equipment that may be contaminated must be decontaminated. The contractor's HASP must address decontamination methods and inspection procedures. Other HASP topics include water availability, "clean" and "dirty" staging areas, decontamination methods and equipment, periodic cleaning of decontamination areas, and site coordination of decontamination issues.

8.0 PROJECT SUMMARY

Tetra Tech completed all contracted tasks for the NDOT BCB Phase I site characterization project, with the exception of the ambient air monitoring task that will continue through March 2015. The objective of the site characterization project was to define the concentrations of NOA in soils and bedrock materials identified for disturbance and determine potential NOA levels in dust during the construction to support an initial estimate of the human health risks from potential exposures to NOA, specifically for the construction workers and community residents. This objective was met as described in this report.

The technical tasks to complete site characterization began on April 11, 2014 and involved:

5. Preparing draft and final versions of the SAP, QAPP, and HASP,
6. Completing the site characterization field work with a team of 10 field scientists over a 3.5 week period in May and June, 2014,
7. Submitting more than 150 solid media samples, 50 ambient air samples, and 20 opportunity-based samples for analysis at two certified asbestos laboratories,
8. Completing this Site Characterization Report to document the findings, provide risk estimates, and present construction mitigation and monitoring measures.

Tetra Tech worked directly under contract and at the direction of NDOT, and in cooperation and with input from other government and private entities, including the RTC, FHWA, Volpe, Kleinfelder, and the Clark County Air Quality Department. Key Tetra Tech personnel responsible for the site characterization, risk estimations, and mitigation and monitoring activities are listed in Section 1 and were involved from the beginning of the work plans through the drafting of this Site Characterization Report.

Ambient Air Results: Three months of ambient air results are presented in graphical form (Figure 5-2) and in Table 5-1. The highest total PCMe asbestos concentration of 1.41E-03 structures cc^{-1} was recorded at Station 4 from June 10 – 15, 2014. Of the 36 samples collected over the 3 months of sampling, actinolite was detected 26 times, non-regulated amphiboles were detected 4 times, and chrysotile, tremolite, and anathophyllite were each detected once. Seven of 36 ambient air samples exhibited no detectable asbestos. Each of the four stations exhibited at least one sample with no asbestos.

Station 1 generally had the lowest concentrations of PCMe asbestos during the three months of air monitoring. Less asbestos was found in the surface and subsurface soils on the northern end of the project area which may have an effect on the results at Station 1. Station 2 consistently recorded between zero and three total PCMe structures for each 5 days of sampling. Station 3 had somewhat variable results: two events with no detectable PCMe structures and the other events with one to four PCMe structures. Station 4 ambient air typically had the highest number of PCMe structures and resulting asbestos concentrations of the four Phase I stations. The land uses and large playa in the area surrounding Station 4 may have an impact on ambient air results.

Ambient air PCMe results were compared to wind and precipitation data for each of the 5 day sampling Periods. The predominant winds were from the southwest and south during the May through July period and may have transported dust with asbestos from potential source areas onto the south end of the site. Precipitation appears to have an effect on the PCMe concentrations in the ambient air as shown by the low PCMe concentrations at all 4 stations during Period 8 when there was 0.5 inch of rain.

Solid Media Results: More than 150 solid media samples were collected from the BCB Phase I project area. Samples of surface soil, subsurface soil, alluvium materials, and bedrock were collected and analyzed for asbestos concentrations. Results for all solid media samples are in Table 5-2. Analytical results indicate low concentrations of NOA, in the form of actinolite, are present in some surface and subsurface soils, alluvium materials, and bedrock in the Phase I project area. The source of the actinolite is likely derived from the parent materials and bedrock in and adjacent to the Phase 1 alignment.

Sixty-six samples were collected across the Phase I project area to characterize the surface soils. Ten of the 66 samples had detectable PLM concentrations of <0.25% (the lowest reporting level above non-detection) while 56 samples were non-detect. Twelve surface soil samples were then analyzed by TEM method and all 12 had total PCMe concentrations below the analytical detection limit (ranged from <0.0162% to <0.0175%). The distribution and concentrations of the PLM and TEM PCMe total results indicate only low levels of NOA are found in the upper 6 inches of the Phase I surface soils. NOA concentrations may be more prevalent in the soils in the central and southern portions of the project area. Only one location in the northern portion of the project had NOA in the surface soil.

Subsurface alluvium materials exhibited similar NOA results compared to surface soils. Of the 20 subsurface samples analyzed, only two had PLM concentrations of <0.25% while 18 were non-detect. Three of the four samples analyzed by TEM had concentrations less than the analytical detection limit. One sample (SB-17) had one large chrysotile structure that yielded a result of 6.83% by weight. The SB-17 asbestos result is likely from a manmade chrysotile material associated with cultural debris or from the numerous utility pipelines in the project area.

Five outcrop samples had NOA detections of <0.25%. One of the outcrop samples had a total PCMe structure concentration of 0.20% which was the highest actinolite asbestos concentration for all Phase I solid media. That outcrop sample (BR-5) was collected from an area underlain by quartz monzonite, however dacite dikes were also mapped nearby.

A total of 25 hollow-stem, rock core, and discrete bedrock samples were also collected from across the project area. The highest PLM concentrations were <0.25% and over 50% of the samples were non-detect. The TEM result for one sample (G48QM11) was a PCMe total concentration of 0.025%, slightly above the detection limit.

Opportunity-Based Sampling Results: Tetra Tech completed opportunity-based sampling during sampling of solid media (surface soil, sub-surface soil, and rock) and driving activities throughout the project area. The opportunity-based samples were collected to provide some initial estimates of potential exposures and risks to workers' health during construction. Opportunity-based samples were collected from the soil and rock sampling personnel, the backhoe and drill rig operators, and a lone driver travelling on project area roads. Samples were collected during a period with no rainfall (end of May through mid-June). Water was used to suppress dust during the subsurface sampling with a backhoe and during the drilling operations.

Tasks of each participant during the opportunity-based sampling included a full range of activities from sample location setup—to sample mixing and collection in sample containers—to driving and sitting in a truck. The analytical results of the opportunity-based sampling are provided in Table 5-3 and show the concentrations of total PCMe asbestos. The highest concentration of PCMe asbestos was 6.86E-03 structures cc^{-1}, found during surface soil sampling in the south-central portion of the project area. Seven other opportunity-based samples had detectable levels of PCMe asbestos at lower concentrations and nine samples had no detectable asbestos. Overall, cancer risk-based on opportunity-based sampling was within (and at the low range) of the EPA risk management range of 1E-06 to 1E-04 (Section 6.0).

Risk Estimates for the BCB Phase I Project: Preliminary risk estimates were developed to assess potential risk to construction workers from inhalation of ambient outdoor air and outdoor air containing dust disturbed by construction activities (Section 6.0). The cancer risk from exposure to ambient air ranged from 2E-08 to 6E-07 and the overall average from 3 months of sampling was 1E-07. The calculated risks from ambient air are less than the point of departure of 1E-06 for carcinogens. The cancer risk from exposure for specific opportunity-based sampling scenarios ranged from 2E-06 to 8E-06 and is within, and at the low end of, the EPA risk management range of 1E-06 to 1E-04.

The BCB Phase I site characterization found non-detectable to very low concentrations of NOA in the soils, alluvium and subsurface materials, and bedrock that are planned to be disturbed during road construction activities. Opportunity-based sampling results indicate that future potential risks for construction workers from exposures to airborne NOA in dust from construction may be within, and at the low end of the risk management range of 1E-06 to 1E-04. Dust from the road construction can be adequately mitigated and monitored if contractors comply with existing and project-specific regulations. Early efforts to establish a risk-based perimeter air monitoring program, complete additional construction-specific activity- and opportunity-based sampling, and develop and specify mitigation measures will help ensure the BCB Phase I road construction project is completed safely.

9.0 REFERENCES

American Conference of Industrial Hygienists (ACGIH). "Threshold Limit Values and Biological Exposure Indices for 1998." Latest edition.

Anderson, R.E. 1977. Geologic Map of the Boulder City 15-Minute Quadrangle, Clark County, Nevada. USGS GQ-1395, published scale 1:62,500.

Bay Area Air Quality Management District, Section 93105 (d)(1)(B)(4). Asbestos Airborne Toxic Control Measure for Construction, Grading, Quarrying, and Surface Mining Operations, Inspection Guidelines. 25p.

Buck, B.J. and Gossen, D. 2013. Naturally Occurring Asbestos: Potential for Human Exposure, Southern Nevada, USA. Soil Sci. Soc. Am. J. 77:2192-2204, May.

Felger, Tracy J., L. Sue Bear, Zachary W. Anderson, Robert J. Fleck, Joseph L. Wooden, and Gustav B. Seixas. 2013. Preliminary Geologic Map of Black Canyon and Surrounding Region, Nevada and Arizona: U.S. Geological Survey Open-File Report 2013-1267-A, scale 1:48,000.

Goldade, M.P., and W.P. O'Brien. "Use of direct versus indirect preparation data for assessing risk associated with airborne exposures at asbestos-contaminated sites." Journal of Occupational Environmental Hygiene. Volume 11, Number 2. Pages 67-76.

Kleinfelder. 2014. Interstate 11 – Boulder City By Pass, Phase II Design Build Project, Geotechnical Data Report, Boulder City, Clark County, Nevada, Project No.: 137120, April 9.

Longwell, C.R., Pampeyan, E.H., Bowyer, B., and Roberts, R.J., 1965. Geology and mineral deposits of Clark County, Nevada; Nevada Bureau of Mines and Geology Bulletin 62, 218p.

National Institute for Occupational Safety and Health. 2004. "Pocket Guide to Chemical Hazards." U.S. Department of Health and Human Services. U.S. Government Printing Office. Washington, DC. June.

Peterson, F.F. 1981. Landforms of the Basin and Range province defined for soil survey. Nevada Agricultural Experiment Station Technical Bulletin 28.

Tetra Tech. 2014. Final Sampling and Analysis Plan and Quality Assurance Project Plan for Boulder City Bypass Naturally Occurring Asbestos (NOA) Project. 78p. May 23.

U.S. Department of Agriculture (USDA), Natural Resources Conservation Service (NRCS). 2006. Soil Survey of Clark County Area, Nevada. In cooperation with the USDA Forest Service; U.S. Department of Interior, Bureau of Land Management, Bureau of Indian Affairs, and National Park Service; and University of Nevada Agricultural Experiment Station and the University of Nevada Las Vegas. 1802 p.

U.S. Environmental Protection Agency (EPA). 1989. "Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual (Part A), Interim Final." Office of Emergency and Remedial Response (OERR). EPA/540/1-89/002. December. Available on-line at: <http://www.epa.gov/oswer/riskassessment/ragsa/>.

EPA. 1991. Memorandum Regarding the "Human Health Evaluation Manual, Supplemental Guidance: Standard Default Exposure Factors." From Timothy Fields, Jr. Acting Director Office of Solid Waste and Emergency Response (OSWER). To Distribution. March 25.

EPA. 1993. Test Method 600/R-93/116– Method for the Determination of Asbestos in Bulk Building Materials. Office of Research and Development, July.

EPA. 2002. "Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites, Interim Guidance." OSWER 9355.4-24. December. Available on-line at: <http://www.epa.gov/superfund/health/conmedia/soil/pdfs/ssg_main.pdf>.

EPA. 2008. "Framework for Investigating Asbestos-Contaminated Superfund Sites." Office of Solid Waste and Emergency Response, Asbestos Committee of the Technical Review Workgroup. OSWER DIRECTIVE #9200.0-68. September. Available on-line at: <http://www.epa.gov/superfund/health/contaminants/asbestos/pdfs/framework_asbestos_guidance.pdf>

EPA. 2009. "Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part F, Supplemental Guidance for Inhalation Risk Assessment)." Final. Office of Solid Waste and Emergency Response. 9285.7-82. January. On-line address: <http://www.epa.gov/oswer/riskassessment/ragsf/pdf/partf_200901_final.pdf>.

EPA. 2014a. Integrated Risk Information System (IRIS). On-line Database. Office of Research and Development, National Center for Environmental Assessment. Accessed July 29. Available on-line at: <http://www.epa.gov/iris>.

EPA. 2014b. Libby: Frequently Asked Questions. EPA Region 8 Accessed July 29. Available on-line at: < http://www2.epa.gov/region8/libby-frequently-asked-questions#moreinfo33>.

TABLES

TABLE 3-1
SUMMARY OF SOLID MEDIA SAMPLES
BCB PHASE I PROJECT AREA

Sampling Method	**Sample Analysis**	**Number of Samples**	**Material Sampled**
Surface Soil (0-0.5 ft.)	PLM	66	Soil
Subsurface Test Pits (0-10 ft.)	PLM	20	Alluvium
Hollow-Stem Auger (0-45 ft.)	PLM	9	Alluvium
Outcrop Grid	PLM	10	Quartz Monzonite
Rock Core	PLM	10	Quartz Monzonite/Volcanic Breccia
Discrete "Targeted" Samples	PLM	9	Quartz Monzonite or Volcanic Breccia
TEM Comparative Analysis (20%)	TEM	26	Various
	Total	**150**	

Notes: PLM – Polarized light microscopy
TEM – Transmission electron microscopy

TABLE 3-2
OPPORTUNITY-BASED SAMPLING SUMMARY
BCB PHASE I PROJECT AREA

Opportunity-Based Sample Number	Activity/Activities	Locations
BC-ABS-00001	Surface Soil Sampling	SS-1, SS-4, SS-6, SS-7, SS-8, SS-11
BC-ABS-00004	Surface Soil Sampling	SS-37, SS-38, SS-39, SS-40, SS-41
BC-ABS-00005	Surface Soil Sampling	SS-27, SS-32, SS-33, SS-56, SS-57, SS-58
BC-ABS-00007	Surface Soil Sampling	SS-41, SS-42, SS-43, SS-44, SS-45, SS-46
BC-ABS-00009	Test Pit Sampling	TP-12, TP-13, TP-14, TP-15, TP-17, TP-19, TP-20, SS-66
BC-ABS-00010	Test Pit Sampling	TP-12, TP-13, TP-14, TP-15, TP-17, TP-19, TP-20, SS-66,
BC-ABS-00012	Surface Soil Sampling	SS-48, SS-49, SS-50, SS-51, SS-52, SS-53
BC-ABS-00013	Hollow Stem Auger Drilling	HSA-3, HSA-4
BC-ABS-00014	Hollow Stem Auger Drilling	HSA-3, HSA-4
BC-ABS-00016	Driving	Site-wide
BC-ABS-00017	Driving	Site-wide
BC-ABS-00018	Hollow Stem Auger Drilling	HSA-5, HAS-6
BC-ABS-00019	Hollow Stem Auger Drilling	HSA -5, HSA -6
BC-ABS-00023	Driving	Site-wide
BC-ABS-00024	Driving	Site-wide
BC-ABS-00025	Driving	Site-wide
BC-ABS-00028	Test Pit Sampling	TP-4, TP-5, TP-6, TP-8, TP-16, TP-18
BC-ABS-00029	Test Pit Sampling	TP-4, TP-5, TP-6, TP-8, TP-16, TP-18
BC-ABS-00031	Rock Core Drilling	RC-1
BC-ABS-00032	Rock Core Drilling	RC-1

Notes:
SS Surface Soil
TP Test Pit
HSA Hollow Stem Auger
RC Rock Core

TABLE 4-1
SAMPLING DEVIATIONS FROM SAP AND QAPP
BCB PHASE I PROJECT AREA

Sample Type	Deviations From SAP and QAPP
Ambient Air Sampling	Sample collection flow rates reduced from 2.0 to 1.5 liters per minute after Sampling Event 4.
Surface Soil Sampling	65 of 65 proposed samples were collected. One additional surface soil sample was collected.
Backhoe Subsurface Soil Sampling	20 of 20 proposed samples collected; some test pits moved to avoid utilities.
Hollow Stem Auger Subsurface Soil Sampling	6 of 9 proposed samples collected from deeper alluvium; some borehole locations moved to avoid utilities.
Rock Outcrop Sampling	None - 10 proposed samples collected
Rock Core Sampling	10 of 21 proposed samples collected from 3 of 5 proposed rock core locations.
Discrete Rock "Targeted" Samples	9 of 15 proposed "targeted" samples were analyzed; some samples collected outside of right-of-way.
Opportunity-Based Sampling	Activity 1: Surface Soil Sampling – 4 samples proposed, 5 collected. Activity 2: Subsurface Soil Sampler and Backhoe Operator – 3 sampler and 3 operator samples proposed, 2 sampler and 2 operator samples collected. Activity 3: Rock Sampler and Drill Rig Operator – 6 sampler/operator samples proposed, 2 collected. Activity 4: Truck Driver – 4 driver samples proposed, 5 collected (only 2 results reported because 3 filters were opaque and could not be analyzed). Overall: 20 opportunity-based samples proposed, 20 were collected (17 analyzed).

Notes:
SAP Sampling and Analysis Plan
QAPP Quality Assurance Project Plan

TABLE 5-1
SUMMARY OF AMBIENT AIR RESULTS
BCB PHASE I PROJECT AREA

Event #	Station #	Sample Number	Start Date	Finish Date	Quant. (liters)	Sample Prep	PCMe Total Structures (# of structures)	PCMe Total Concentration (structures/cc)	Event Weather Data		
									Avg. Wind Speed (mph)	Max. Wind Speed (mph)	Precipitation (in)
1	1	BC-AA-01-00001	5/8/2014	5/13/2014	14422	Direct	0	0.0	5.0	28	0.00
	2	BC-AA-02-00001	5/8/2014	5/13/2014	14422	Direct	0	0.0			
	3	BC-AA-03-00001	5/8/2014	5/13/2014	14422	Direct	0	0.0			
	4	BC-AA-04-00001	5/8/2014	5/13/2014	14422	Direct	13	5.16E-04			
2	1	BC-AA-01-00002	5/19/2014	5/24/2014	14400	Direct	1	3.97E-05	5.5	29.5	0.00
	2	BC-AA-02-00002	5/19/2014	5/24/2014	14400	Direct	1	3.97E-05			
	3	BC-AA-03-00002	5/19/2014	5/24/2014	14400	Direct	2	7.94E-05			
	4	BC-AA-04-00002	5/19/2014	5/24/2014	14400	Direct	17	6.75E-04			
3	1	BC-AA-01-00003	5/30/2014	6/4/2014	14400	Indirect	1	7.77E-05	5.1	31.1	0.00
	2	BC-AA-02-00003	5/30/2014	6/4/2014	9156	Direct	2	7.98E-05			
	3	BC-AA-03-00003	5/30/2014	6/4/2014	14400	Indirect	4	8.08E-04			
	4	BC-AA-04-00003	5/30/2014	6/4/2014	8726	Direct	33	1.20E-03			
4	1	BC-AA-01-00004	6/10/2014	6/15/2014	14400	Direct	1	3.97E-05	6.7	33.8	0.00
	2	BC-AA-02-00004	6/10/2014	6/15/2014	14400	Direct	3	1.19E-04			
	3	BC-AA-03-00004	6/10/2014	6/15/2014	14400	Direct	4	1.59E-04			
	4	BC-AA-04-00004	6/10/2014	6/15/2014	14400	Indirect	7	1.41E-03			
5	1	BC-AA-01-00005	6/21/2014	6/26/2014	10800	Direct	0	0.0	6.1	29.2	0.00
	2	BC-AA-02-00005	6/21/2014	6/26/2014	10800	Direct	1	3.97E-05			
	3	BC-AA-03-00005	6/21/2014	6/26/2014	10800	Direct	4	1.59E-04			
	4	BC-AA-04-00005	6/21/2014	6/26/2014	10800	Direct	10	3.97E-04			
6	1	BC-AA-01-00006	7/3/2014	7/8/2014	10800	Direct	3	1.19E-04	4.7	41.4	0.32
	2	BC-AA-02-00006	7/3/2014	7/8/2014	10800	Direct	2	7.94E-05			
	3	BC-AA-03-00006	7/3/2014	7/8/2014	10800	Direct	1	3.97E-05			
	4	BC-AA-04-00006	7/3/2014	7/8/2014	10800	Direct	1	3.97E-05			

TABLE 5-1 (Cont.)
PHASE I AMBIENT AIR RESULTS WITH WEATHER
BCB PHASE I PROJECT AREA

Event #	Station #	Sample Number	Start Date	Finish Date	Quant. (liters)	Sample Prep	PCMe Total Structures (# of structures)	PCMe Total Concentration (structures/cc)	Event Weather Data		
									Avg. Wind Speed (mph)	Max. Wind Speed (mph)	Precipitation (in)
7	1	BC-AA-01-00007	7/14/2014	7/19/2014	10800	Direct	0	0.0	4.8	21	0.02
	2	BC-AA-02-00007	7/14/2014	7/19/2014	10800	Direct	1	3.97E-05			
	3	BC-AA-03-00007	7/14/2014	7/19/2014	10800	Direct	0	0.			
	4	BC-AA-04-00007	7/14/2014	7/19/2014	10800	Direct	8	3.18E-04			
8	1	BC-AA-01-00008	7/25/2014	7/30/2014	10800	Direct	1	3.97E-05	4.0	31.5	0.50
	2	BC-AA-02-00008	7/25/2014	7/30/2014	10800	Direct	2	7.94E-05			
	3	BC-AA-03-00008	7/25/2014	7/30/2014	10800	Direct	1	3.97E-05			
	4	BC-AA-04-00008	7/25/2014	7/30/2014	10800	Direct	0	0.0			

Notes:

#	Number
cc	Cubic centimeter
mph	Miles per hour
in	Inches

TABLE 5-2
SOLID MEDIA SAMPLE PLM AND TEM RESULTS
BCB PHASE I PROJECT AREA

Sample Location	Sample Type	PLM Result 400 Point Count (% Detected)	TEM Result Total PCMe Structures (Weight %)	Sample Description
SS-1	Surface Soil	ND	NA	30-Point Composite Sample From 0-6 Inches (bgs)
SS-2	Surface Soil	ND	NA	30-Point Composite Sample From 0-6 Inches (bgs)
SS-3	Surface Soil	<0.25%	<0.0160%	30-Point Composite Sample From 0-6 Inches (bgs)
SS-4	Surface Soil	ND	NA	30-Point Composite Sample From 0-6 Inches (bgs)
SS-5	Surface Soil	ND	NA	30-Point Composite Sample From 0-6 Inches (bgs)
SS-6	Surface Soil	ND	NA	30-Point Composite Sample From 0-6 Inches (bgs)
SS-7	Surface Soil	ND	NA	30-Point Composite Sample From 0-6 Inches (bgs)
SS-8	Surface Soil	ND	NA	30-Point Composite Sample From 0-6 Inches (bgs)
SS-9	Surface Soil	ND	NA	30-Point Composite Sample From 0-6 Inches (bgs)
SS-10	Surface Soil	ND	NA	30-Point Composite Sample From 0-6 Inches (bgs)
SS-11	Surface Soil	ND	<0.0169%	30-Point Composite Sample From 0-6 Inches (bgs)
SS-12	Surface Soil	ND	NA	30-Point Composite Sample From 0-6 Inches (bgs)
SS-13	Surface Soil	ND	NA	30-Point Composite Sample From 0-6 Inches (bgs)
SS-14	Surface Soil	ND	NA	30-Point Composite Sample From 0-6 Inches (bgs)
SS-15	Surface Soil	ND	NA	30-Point Composite Sample From 0-6 Inches (bgs)
SS-16	Surface Soil	ND	NA	30-Point Composite Sample From 0-6 Inches (bgs)
SS-17	Surface Soil	ND	NA	30-Point Composite Sample From 0-6 Inches (bgs)
SS-18	Surface Soil	ND	<0.0165%	30-Point Composite Sample From 0-6 Inches (bgs)
SS-19	Surface Soil	ND	NA	30-Point Composite Sample From 0-6 Inches (bgs)
SS-20	Surface Soil	ND	NA	30-Point Composite Sample From 0-6 Inches (bgs)
SS-21	Surface Soil	ND	NA	30-Point Composite Sample From 0-6 Inches (bgs)
SS-22	Surface Soil	ND	NA	30-Point Composite Sample From 0-6 Inches (bgs)
SS-23	Surface Soil	<0.25%	<0.0175%	30-Point Composite Sample From 0-6 Inches (bgs)
SS-24	Surface Soil	<0.25%	NA	30-Point Composite Sample From 0-6 Inches (bgs)
SS-25	Surface Soil	ND	NA	30-Point Composite Sample From 0-6 Inches (bgs)
SS-26	Surface Soil	ND	NA	30-Point Composite Sample From 0-6 Inches (bgs)
SS-27	Surface Soil	ND	NA	30-Point Composite Sample From 0-6 Inches (bgs)
SS-28	Surface Soil	ND	NA	30-Point Composite Sample From 0-6 Inches (bgs)
SS-29	Surface Soil	<0.25%	<0.0173%	30-Point Composite Sample From 0-6 Inches (bgs)
SS-30	Surface Soil	ND	NA	30-Point Composite Sample From 0-6 Inches (bgs)
SS-31	Surface Soil	ND	NA	30-Point Composite Sample From 0-6 Inches (bgs)
SS-32	Surface Soil	ND	NA	30-Point Composite Sample From 0-6 Inches (bgs)
SS-33	Surface Soil	ND	NA	30-Point Composite Sample From 0-6 Inches (bgs)
SS-34	Surface Soil	ND	NA	30-Point Composite Sample From 0-6 Inches (bgs)
SS-35	Surface Soil	ND	<0.0171%	30-Point Composite Sample From 0-6 Inches (bgs)
SS-36	Surface Soil	ND	NA	30-Point Composite Sample From 0-6 Inches (bgs)
SS-37	Surface Soil	ND	NA	30-Point Composite Sample From 0-6 Inches (bgs)
SS-38	Surface Soil	<0.25%	NA	30-Point Composite Sample From 0-6 Inches (bgs)
SS-39	Surface Soil	ND	NA	30-Point Composite Sample From 0-6 Inches (bgs)

TABLE 5-2 (Cont.)
SOLID MEDIA SAMPLE PLM AND TEM RESULTS
BCB PHASE I PROJECT AREA

Sample Location	Sample Type	PLM Result 400 Point Count (% Detected)	TEM Result Total PCMe Structures (Weight %)	Sample Description
SS-40	Surface Soil	<0.25%	<0.0163%	30-Point Composite Sample From 0-6 Inches (bgs)
SS-41	Surface Soil	ND	NA	30-Point Composite Sample From 0-6 Inches (bgs)
SS-42	Surface Soil	<0.25%	<0.0164%	30-Point Composite Sample From 0-6 Inches (bgs)
SS-43	Surface Soil	ND	NA	30-Point Composite Sample From 0-6 Inches (bgs)
SS-44	Surface Soil	ND	NA	30-Point Composite Sample From 0-6 Inches (bgs)
SS-45	Surface Soil	ND	NA	30-Point Composite Sample From 0-6 Inches (bgs)
SS-46	Surface Soil	ND	NA	30-Point Composite Sample From 0-6 Inches (bgs)
SS-47	Surface Soil	ND	<0.0168%	30-Point Composite Sample From 0-6 Inches (bgs)
SS-48	Surface Soil	ND	NA	30-Point Composite Sample From 0-6 Inches (bgs)
SS-49	Surface Soil	ND	NA	30-Point Composite Sample From 0-6 Inches (bgs)
SS-50	Surface Soil	ND	NA	30-Point Composite Sample From 0-6 Inches (bgs)
SS-51	Surface Soil	ND	NA	30-Point Composite Sample From 0-6 Inches (bgs)
SS-52	Surface Soil	ND	<0.0162%	30-Point Composite Sample From 0-6 Inches (bgs)
SS-53	Surface Soil	ND	NA	30-Point Composite Sample From 0-6 Inches (bgs)
SS-54	Surface Soil	ND	NA	30-Point Composite Sample From 0-6 Inches (bgs)
SS-55	Surface Soil	ND	NA	30-Point Composite Sample From 0-6 Inches (bgs)
SS-56	Surface Soil	ND	NA	30-Point Composite Sample From 0-6 Inches (bgs)
SS-57	Surface Soil	ND	NA	30-Point Composite Sample From 0-6 Inches (bgs)
SS-58	Surface Soil	<0.25%	<0.0168%	30-Point Composite Sample From 0-6 Inches (bgs)
SS-59	Surface Soil	ND	NA	30-Point Composite Sample From 0-6 Inches (bgs)
SS-60	Surface Soil	ND	NA	30-Point Composite Sample From 0-6 Inches (bgs)
SS-61	Surface Soil	ND	NA	30-Point Composite Sample From 0-6 Inches (bgs)
SS-62	Surface Soil	ND	NA	30-Point Composite Sample From 0-6 Inches (bgs)
SS-63	Surface Soil	ND	NA	30-Point Composite Sample From 0-6 Inches (bgs)
SS-64	Surface Soil	ND	NA	30-Point Composite Sample From 0-6 Inches (bgs)
SS-65	Surface Soil	<0.25%	NA	30-Point Composite Sample From 0-6 Inches (bgs)
SS-66	Surface Soil	<0.25%	<0.0168%	30-Point Composite Sample From 0-6 Inches (bgs)
BR-1	Bedrock Outcrop	ND	NA	30-Point Bedrock Outcrop Composite Sample
BR-2	Bedrock Outcrop	ND	NA	30-Point Bedrock Outcrop Composite Sample
BR-3	Bedrock Outcrop	ND	NA	30-Point Bedrock Outcrop Composite Sample
BR-4	Bedrock Outcrop	ND	NA	30-Point Bedrock Outcrop Composite Sample
BR-5	Bedrock Outcrop	<0.25%	0.20%	30-Point Bedrock Outcrop Composite Sample
BR-6	Bedrock Outcrop	ND	NA	30-Point Bedrock Outcrop Composite Sample
BR-7	Bedrock Outcrop	<0.25%	NA	30-Point Bedrock Outcrop Composite Sample
BR-8	Bedrock Outcrop	<0.25%	<0.0165%	30-Point Bedrock Outcrop Composite Sample
BR-9	Bedrock Outcrop	<0.25%	NA	30-Point Bedrock Outcrop Composite Sample
BR-10	Bedrock Outcrop	ND	NA	30-Point Bedrock Outcrop Composite Sample
BR-11	Bedrock Outcrop	ND	NA	30-Point Bedrock Outcrop Composite Sample
BR-12	Bedrock Outcrop	ND	NA	30-Point Bedrock Outcrop Composite Sample

TABLE 5-2 (Cont.)
SOLID MEDIA SAMPLE PLM AND TEM RESULTS
BCB PHASE I PROJECT AREA

Sample Location	Sample Type	PLM Result 400 Point Count (% Detected)	TEM Result Total PCMe Structures (Weight %)	Sample Description
BR-13	Bedrock Outcrop	ND	NA	30-Point Bedrock Outcrop Composite Sample
BR-14	Bedrock Outcrop	<0.25%	<0.0164%	30-Point Bedrock Outcrop Composite Sample
G44-Aditwall1	Discrete Bedrock	<0.25%	NA	Discrete Bedrock Sample From Adit Wall
G16RC1	Discrete Bedrock	ND	NA	Discrete Bedrock Sample From Polygon 16
G25F1	Discrete Bedrock	<0.25%	<0.0161%	Discrete Bedrock Sample From Polygon 16
G30SS-3OF	Discrete Bedrock	<0.25%	<0.0178%	Discrete Bedrock Sample From Polygon 30
G38RC2-QM	Discrete Bedrock	ND	NA	Discrete Bedrock Sample From Polygon 38
G48QM11	Discrete Bedrock	<0.25%	0.025%	Discrete Bedrock Sample From Polygon 48
G61QM12	Discrete Bedrock	ND	NA	Discrete Bedrock Sample From Polygon 61
G64TV1	Discrete Bedrock	ND	NA	Discrete Bedrock Sample From Polygon 64
G64TV1-Altered	Discrete Bedrock	ND	<0.0169%	Discrete Bedrock Sample From Polygon 64
HS-1	Subsurface Soil - From HSA	ND	NA	Composite Soil Sample (0-25 feet bgs)
HS-2	Subsurface Soil - From HSA	ND	NA	Composite Soil Sample (0-45 feet bgs)
HS-3	Subsurface Soil - From HSA	ND	NA	Composite Soil Sample (0-35 feet bgs)
HS-4	Subsurface Soil - From HSA	ND	NA	Composite Soil Sample (0-35 feet bgs)
HS-5	Subsurface Soil - From HSA	ND	NA	Composite Soil Sample (0-25 feet bgs)
HS-6	Subsurface Soil - From HSA	<0.25%	<0.0172%	Composite Soil Sample (0-25 feet bgs)
RC-1	Bedrock Core	ND	NA	Composite Bedrock Core RC-1 (0-9.5 feet bgs)
RC-2	Bedrock Core	ND	NA	Composite Bedrock Core RC-1 (9.5-11 feet bgs)
RC-3	Bedrock Core	ND	<0.0163%	Composite Bedrock Core RC-1 (11-14 feet bgs)
RC-4	Bedrock Core	ND	NA	Composite Bedrock Core RC-1 (18.5-29.5 bgs - sand)
RC-5	Bedrock Core	ND	NA	Composite Bedrock Core RC-1 (29.5-35 feet bgs)
RC-6	Bedrock Core	ND	NA	Composite Bedrock Core RC-1 (34.5-35 feet bgs)
RC-7	Bedrock Core	ND	NA	Composite Bedrock Core RC-2 (10-14 feet bgs)
RC-8	Bedrock Core	ND	<0.0165%	Composite Bedrock Core RC-2 (11-16 feet bgs)
RC-9	Bedrock Core	ND	NA	Composite Bedrock Core RC-4 (1.5-4 feet bgs)
RC-10	Bedrock Core	ND	NA	Composite Bedrock Core RC-4 (4-4.5 feet bgs)
SB-1	Subsurface Soil - Test Pit	ND	NA	Composite Subsurface Soil Sample (0-5 feet bgs)
SB-2	Subsurface Soil - Test Pit	ND	NA	Composite Subsurface Soil Sample (0-6 feet bgs)
SB-3	Subsurface Soil - Test Pit	ND	NA	Composite Subsurface Soil Sample (0-2 feet bgs)
SB-4	Subsurface Soil - Test Pit	ND	NA	Composite Subsurface Soil Sample (0-5.5 feet bgs)

TABLE 5-2 (Cont.)
SOLID MEDIA SAMPLE PLM AND TEM RESULTS
BCB PHASE I PROJECT AREA

Sample Location	Sample Type	PLM Result 400 Point Count (% Detected)	TEM Result Total PCMe Structures (Weight %)	Sample Description
SB-5	Subsurface Soil - Test Pit	ND	NA	Composite Subsurface Soil Sample (0-5 feet bgs)
SB-6	Subsurface Soil - Test Pit	ND	<0.0172%	Composite Subsurface Soil Sample (0-5.75 feet bgs)
SB-7	Subsurface Soil - Test Pit	ND	NA	Composite Subsurface Soil Sample (0-4 feet bgs)
SB-8	Subsurface Soil - Test Pit	ND	NA	Composite Subsurface Soil Sample (0-5 feet bgs)
SB-9	Subsurface Soil - Test Pit	ND	NA	Composite Subsurface Soil Sample (0-5 feet bgs)
SB-10	Subsurface Soil - Test Pit	ND	NA	Composite Subsurface Soil Sample (0-5 feet bgs)
SB-11	Subsurface Soil - Test Pit	ND	NA	Composite Subsurface Soil Sample (0-5 feet bgs)
SB-12	Subsurface Soil - Test Pit	<0.25%	<0.0165%	Composite Subsurface Soil Sample (0-5 feet bgs)
SB-13	Subsurface Soil - Test Pit	<0.25%	<0.0170%	Composite Subsurface Soil Sample (0-5 feet bgs)
SB-14	Subsurface Soil - Test Pit	ND	NA	Composite Subsurface Soil Sample (0-5 feet bgs)
SB-15	Subsurface Soil - Test Pit	ND	NA	Composite Subsurface Soil Sample (0-5.5 feet bgs)
SB-16	Subsurface Soil - Test Pit	ND	NA	Composite Subsurface Soil Sample (0-5.5 feet bgs)
SB-17	Subsurface Soil - Test Pit	ND	6.83%	Composite Subsurface Soil Sample (0-5 feet bgs) One large Chrysotile Asbestos Structure Detected.
SB-18	Subsurface Soil - Test Pit	ND	NA	Composite Subsurface Soil Sample (0-5 feet bgs)
SB-19	Subsurface Soil - Test Pit	ND	NA	Composite Subsurface Soil Sample (0-5 feet bgs)
SB-20	Subsurface Soil - Test Pit	ND	NA	Composite Subsurface Soil Sample (0-4 feet bgs)

Notes:
% Percent
bgs below ground surface
HSA Hollow Stem Auger
NDOT Nevada Department of Transportation
NA Not analyzed
ND Not detected
< Less than the analytical detection limit
PCMe Phase Contrast Microscopy Equivalent
PLM Polarized Light Microscopy
PLM Results: Equals percent detected using a 400 point count method (1 structure counted = 0.25%)
TEM Transmission Electron Microscopy
TEM Results: Equals the weight percent of Total PCMe structures (Regulated + Nonregulated).

TABLE 5-3
OPPORTUITY-BASED AIR SAMPLE RESULTS
BCB PHASE I PROJECT AREA

Sample Number	Scenario	Activity	Receptor	Concentration of PCMe Regulated and Non-Regulated Primary Structures (s/cc)
BC-ABS-00001	Surface Soil Sampling	Sample Collection/ Mixing/Storing	Sampler	0
BC-ABS-00004	Surface Soil Sampling	Sample Collection/ Mixing/Storing	Sampler	4.90E-03
BC-ABS-00005	Surface Soil Sampling	Sample Collection/ Mixing/Storing	Sampler	1.96E-03
BC-ABS-00007	Surface Soil Sampling	Sample Collection/ Mixing/Storing	Sampler	6.86E-03
BC-ABS-00009	Shallow Subsurface Soil Sampling	Pit Excavation/Filling	Backhoe Operator	0
BC-ABS-00010	Shallow Subsurface Soil Sampling	Sample Collection/ Mixing/Storing	Sampler	1.96E-03
BC-ABS-00012	Surface Soil Sampling	Sample Collection/ Mixing/Storing	Sampler	4.90E-03
BC-ABS-00013	Subsurface Soil Sampling	Hollow Stem Auger Drilling	Drill Rig Operator	0
BC-ABS-00014	Subsurface Soil Sampling	Sample Collection/ Mixing/Storing	Sampler	0
BC-ABS-00016	Driving Work Vehicle	Driving	Driver/ Passenger	NA
BC-ABS-00017	Driving Work Vehicle	Driving	Driver /Passenger	0
BC-ABS-00018	Subsurface Soil Sampling	Hollow Stem Auger Drilling	Drill Rig Operator	2.98E-03
BC-ABS-00019	Subsurface Soil Sampling	Sample Collection/ Mixing/Storing	Sampler	0
BC-ABS-00023	Driving Work Vehicle	Driving	Driver/ Passenger	NA
BC-ABS-00024	Driving Work Vehicle	Driving	Driver/ Passenger	NA
BC-ABS-00025	Driving Work Vehicle	Driving	Driver/ Passenger	4.85E-03
BC-ABS-00028	Shallow Subsurface Soil Sampling	Pit Excavation/Filling	Backhoe Operator	0
BC-ABS-00029	Shallow Subsurface Soil Sampling	Sample Collection/ Mixing/Storing	Sampler	9.74E-04
BC-ABS-00031	Subsurface Rock Sampling	Core Drilling	Drill Rig Operator	0
BC-ABS-00032	Subsurface Rock Sampling	Core Sampling	Sampler	0

Notes:
NA Not analyzed
PCMe Phase contrast microscopy equivalent
s/cc Structures per cubic centimeter

TABLE 6-1
AMBIENT SAMPLING DATA FOR PHASE I
Boulder City Bypass Project, Nevada

Sample Number	Ambient Station	Date collected	Concentration [a] (PCMe, all structures fibers/cubic centimeter)
BC-AA-01-00001	1	05/13/2014	0.00E+00
BC-AA-01-00002	1	05/24/2014	3.97E-05
BC-AA-01-00003	1	06/04/2014	7.77E-05
BC-AA-01-00004	1	06/15/2014	3.97E-05
BC-AA-01-00005	1	06/26/2014	0.00E+00
BC-AA-01-00006	1	07/08/2014	1.19E-04
BC-AA-01-00007	1	07/19/2014	0.00E+00
BC-AA-01-00008	1	07/30/2014	3.97E-05
BC-AA-01-00009	1	08/10/2014	3.97E-05
BC-AA-02-00001	2	05/13/2014	0.00E+00
BC-AA-02-00002	2	05/24/2014	3.97E-05
BC-AA-02-00003	2	06/02/2014	4.72E-05
BC-AA-02-00004	2	06/15/2014	1.19E-04
BC-AA-02-00005	2	06/26/2014	3.97E-05
BC-AA-02-00006	2	07/08/2014	7.94E-05
BC-AA-02-00007	2	07/19/2014	3.97E-05
BC-AA-02-00008	2	07/30/2014	7.94E-05
BC-AA-02-00009	2	08/10/2014	7.94E-05
BC-AA-03-00001	3	05/13/2014	0.00E+00
BC-AA-03-00002	3	05/24/2014	7.94E-05
BC-AA-03-00003	3	06/04/2014	8.08E-04
BC-AA-03-00004	3	06/15/2014	1.59E-04
BC-AA-03-00005	3	06/26/2014	1.59E-04
BC-AA-03-00006	3	07/08/2014	3.97E-05
BC-AA-03-00007	3	07/19/2014	0.00E+00
BC-AA-03-00008	3	07/30/2014	3.97E-05
BC-AA-03-00009	3	08/10/2014	0.00E+00
BC-AA-04-00001	4	05/13/2014	5.16E-04
BC-AA-04-00002	4	05/24/2014	6.75E-04
BC-AA-04-00003	4	06/02/2014	1.20E-03
BC-AA-04-00004	4	06/15/2014	1.41E-03
BC-AA-04-00005	4	06/26/2014	3.97E-04
BC-AA-04-00006	4	07/08/2014	3.97E-05
BC-AA-04-00007	4	07/19/2014	3.18E-04
BC-AA-04-00008	4	07/30/2014	0.00E+00
BC-AA-04-00009	4	08/10/2014	7.15E-04

Notes:
a Concentrations of zero indicate that no fibers were detected in the sample.
PCMe Phase-contract microscopy equivalents

TABLE 6-2
OPPORTUNITY-BASED SAMPLING DATA USED IN THE PRELIMINARY RISK ESTIMATE
Boulder City Bypass Project, Nevada

Sampling Scenario	Sampling Activity	Receptor	Sample Number	Date Collected	Concentration (PCMe, all structures fibers/cubic centimeter)
Surface soil sampling	Collection and mixing of samples	Sampler	BC-ABS-00001	05/30/2014	0.00E+00
			BC-ABS-00004	05/31/2014	4.90E-03
			BC-ABS-00005	05/31/2014	9.80E-04
			BC-ABS-00007	06/02/2014	6.86E-03
			BC-ABS-00012	06/04/2014	3.92E-03
Subsurface soil sampling	Excavation and filling of sampling pit	Backhoe Operator	BC-ABS-00009	06/03/2014	0.00E+00
			BC-ABS-00028	06/06/2014	0.00E+00
	Collection and mixing of samples	Sampler	BC-ABS-00010	06/03/2014	1.96E-03
			BC-ABS-00019	06/05/2014	0.00E+00
			BC-ABS-00029	06/06/2014	9.74E-04
Subsurface Rock/Geological Materials Sampling	Core Drilling	Drill Rig Operator	BC-ABS-00013	06/04/2014	0.00E+00
			BC-ABS-00018	06/05/2014	2.98E-03
			BC-ABS-00031	06/09/2014	0.00E+00
	Core Sampling	Sampler	BC-ABS-00014	06/04/2014	0.00E+00
			BC-ABS-00032	06/09/2014	0.00E+00
Driving Work Vehicle	Driving	Driver/Passenger	BC-ABS-00016	06/05/2014	NA
			BC-ABS-00017	06/05/2014	0.00E+00
			BC-ABS-00023	06/06/2014	NA
			BC-ABS-00024	06/06/2014	NA
			BC-ABS-00025	06/06/2014	4.85E-03
			BC-ABS-DRV-1001	08/22/2014	9.92E-04
			BC-ABS-DRV-2002	08/22/2014	0.00E+00

Notes:
Concentrations of zero indicate that no fibers were detected in the sample.
NA Not applicable - sample was overloaded and concentration could not be accurately measured
PCMe Phase-contract microscopy equivalents

TABLE 6-3
EXPOSURE POINT CONCENTRATIONS, TIME WEIGHTING FACTORS, AND RISK ESTIMATES FOR AMBIENT AIR
Boulder City Bypass Project, Nevada

Representative Receptor	Sample ID	Exposure Scenario	Location	Number of Samples	EPC (PCMe structures/ cubic centimeter)	Cancer Risk
Construction Worker	BC-AA-1	Ambient - Phase I	1	9	2.6E-05	3E-08
	BC-AA-2	Ambient - Phase I	2	9	5.8E-05	7E-08
	BC-AA-3	Ambient - Phase I	3	9	1.2E-04	1E-07
	BC-AA-4	Ambient - Phase I	4	9	5.7E-04	7E-07
Construction Worker	Ambient - Average				1.9E-04	2E-07

Notes

The point of departure for cancer risk is 1E-06.

The EPA risk management range is from 1E-06 to 1E-04 excess cancer risk.

The IURa,d value was derived assuming a construction worker with an exposure duration of 1 year and a starting age of 18 years old.

EPC	Exposure point concentration
PCMe	Phase-contract microscopy equivalents

Exposure factor		Value	Source
EF	Exposure frequency (days/year)	250	EPA 2014b
ET	Exposure time (hours/day)	8	EPA 2014b
$IUR_{a,d}$	Inhalation unit risk ([structures/cubic centimeter]$^{-1}$)	5.2E-03	EPA 2008, 2014a
TWF_C	Time weighting factor for cancer exposure	2.3E-01	Calculated

Risk and Hazard Equations

TWF_C = (ET * EF) / (24 hours/day * 365 days/year)

Cancer Risk = EPC * TWF * IUR

References

EPA. 2008. "Framework for Investigating Asbestos-Contaminated Superfund Sites." Office of Solid Waste and Emergency Response, Asbestos Committee of the Technical Review Workgroup. OSWER DIRECTIVE #9200.0-68. September. Available on-line at: <http://www.epa.gov/superfund/health/contaminants/asbestos/pdfs/framework_asbestos_guidance.pdf>

EPA. 2014a. Integrated Risk Information System (IRIS). On-line Database. Office of Research and Development, National Center for Environmental Assessment. Accessed July 31. Available on-line at: <http://www.epa.gov/iris>.

EPA. 2014b. Regional Screening Level Tables. May. Available on-line at: <http://www.epa.gov/region9/superfund/prg/index.html>.

TABLE 6-4
EXPOSURE POINT CONCENTRATIONS, TIME WEIGHTING FACTORS, AND RISK ESTIMATES FOR OPPORTUNITY-BASED SAMPLE RESULTS

Boulder City Bypass Project, Nevada

Receptor	Sampler Type	Exposure Scenario	Number of Samples	Concentration (PCMe structures/cubic centimeter)			Cancer Risk		
				Minimum	EPC	Maximum	Minimum	EPC	Maximum
Construction Worker	Sampler	Surface soil sampling	5	0.0E+00	3.7E-03	6.9E-03	--	4E-06	8E-06
	Backhoe operator	Shallow subsurface soil sampling	2	0.0E+00	0.0E+00	0.0E+00	--	--	--
	Sampler	Shallow subsurface soil sampling	3	0.0E+00	9.8E-04	2.0E-03	--	1E-06	2E-06
	Drill rig operator	Subsurface rock geologic sampling	3	0.0E+00	9.9E-04	3.0E-03	--	1E-06	4E-06
	Sampler	Subsurface rock geologic sampling	2	0.0E+00	0.0E+00	0.0E+00	--	--	--
	Driver/ Passenger	Driving work vehicle	4	0.0E+00	1.5E-03	4.8E-03	--	2E-06	6E-06

Notes

The point of departure for cancer risk is 1E-06.

The EPA risk management range is from 1E-06 to 1E-04 excess cancer risk.

The IURa,d value was derived assuming a construction worker with an exposure duration of 1 year and a starting age of 18 years old.

EPC Exposure point concentration

PCMe Phase-contract microscopy equivalents

Exposure factor		Value	Source
EF	Exposure frequency (days/year)	250	EPA 2014b
ET	Exposure time (hours/day)	8	EPA 2014b
IURa,d	Inhalation unit risk ([structures/ cubic centimeter]-1)	5.2E-03	EPA 2008, 2014a
TWF_C	Time weighting factor for cancer exposure	2.3E-01	Calculated

Risk and Hazard Equations

TWF_C = (ET * EF) / (24 hours/day * 365 days/year)

Cancer Risk = EPC * TWF_C * IUR

References

EPA. 2008. "Framework for Investigating Asbestos-Contaminated Superfund Sites." Office of Solid Waste and Emergency Response, Asbestos Committee of the Technical Review Workgroup. OSWER DIRECTIVE #9200.0-68. September. Available on-line at: <http://www.epa.gov/superfund/health/contaminants/asbestos/pdfs/framework_asbestos_guidance.pdf>

EPA. 2014a. Integrated Risk Information System (IRIS). On-line Database. Office of Research and Development, National Center for Environmental Assessment. Accessed July 31. Available on-line at: <http://www.epa.gov/iris>.

EPA. 2014b. Regional Screening Level Tables. May. Available on-line at: <http://www.epa.gov/region9/superfund/prg/index.html>.

TABLE 7-1
OVERVIEW OF DESIGN-BUILDING CONTRACTOR MITIGATION MEASURES AND MONITORING
BCB PHASE I PROJECT AREA

Item	Reference	Threshold /Action Level	Recommended Approach	Data Input	Soil Category	Associated Tasks	Potential Mitigation Measures or BMP	Additional NOA Mitigation Measures
Minimum (Non-Asbestos Related) Dust Control Procedures For All Areas (When sampling results indicate no unacceptable asbestos risk, such as in Phase I)								
Clearing and Grubbing (BMP-04)	Clark County Air Quality Regulations, Section 94 and Clark County Dust Control Handbook	<0.25%	Follow Clark County Air Quality regulations and BMPs in Clark County Dust Control Handbook	Percent passing #200 sieve, optimum moisture content	All	Preparation and Post Activity	Pre-water and maintain surface soils in a stabilized condition where support equipment and vehicles will operate. OR Apply and maintain a dust palliative on surface soils where support equipment and vehicles will operate. AND Water disturbed soils to form crust immediately following clearing and grubbing activities. OR Apply and maintain a dust palliative on disturbed soils to form crust immediately following clearing and grubbing activities.	Apply the minimum method that will achieve the necessary dust control. Also, it is recommended to maintain live perennial vegetation and desert pavement where possible.
					ML	Actively Working	Apply water during clearing and grubbing activities.	Conduct perimeter air monitoring to determine need for additional BMPs.
					MH	Actively Working	Apply water and tackifier mixture during clearing and grubbing activities.	Conduct perimeter air monitoring to determine need for additional BMPs.
					H	Actively Working	Apply water and surfactant mixture during clearing and grubbing activities.	Conduct perimeter air monitoring to determine need for additional BMPs. Surfactant should be mixed with appropriate dust palliative to increase penetration into soil. Surfactant alone should not be used.

Item	Reference	Threshold /Action Level	Recommended Approach	Data Input	Soil Category	Associated Tasks	Potential Mitigation Measures or BMP	Additional NOA Mitigation Measures
Minimum (Non-Asbestos Related) Dust Control Procedures For All Areas (When sampling results indicate no unacceptable asbestos risk, such as in Phase I)								
Blasting - Soil and Rock (Explosive) (BMP-03)	Clark County Air Quality Regulations, Section 94 and Clark County Dust Control Handbook	<0.25%	Follow Clark County Air Quality regulations and BMPs in Clark County Dust Control Handbook	Percent passing #200 sieve, optimum moisture content	All	General Requirements	No blasting within 1,500 feet of a residential area, occupied building or major roadway, when wind direction is toward these structures. AND Blasting shall be between the hours of 8:00 a.m. and 4:30 p.m.,excluding Saturdays, Sundays and holidays unless prior permission is obtained from the County. AND No blasting allowed when the National Weather Service forecasts wind gusts above 25 miles per hour (mph). Prior to setting explosive charges in holes, document current and predicted weather conditions as provided by the National Weather Service. If the current forecast is for wind gusts of 25 mph or greater or they are forecasted to be 25 mph or greater within the next 24 hours, do not charge any blast holes. When setting explosive charges, monitor weather reports for wind gusts of 25 mph or greater on the National Weather Service Radio and/or Internet sites. If wind gusts above 25 mph are stated, discontinue charging additional blast holes. Limit the blast to holes charged at time the wind report is made.	
					All	Actively preparing or blasting	Pre-water and maintain surface soils in a stabilized condition where drills, support equipment and vehicles will operate. OR Apply and maintain a dust palliative on surface soils where drills, support equipment and vehicles will operate. AND Limit the blast footprint area to no larger than what can be practically stabilized immediately following the blast. AND Maintain surface rock and vegetation where possible to reduce exposure of disturbed soil to wind. AND Water disturbed soils to form crust immediately following blast and safety clearance. OR Apply and maintain a dust palliative to form crust immediately following blast and safety clearance.	Apply the method that will achieve the necessary dust control.
					ML	Actively preparing or blasting	Presoak surface soils to depth of the caliche or bedrock with water using water trucks, water pulls, sprinklers or wobblers.	Additional requirement depending on soil type
					MH	Actively preparing or blasting	Presoak surface soils to depth of the caliche or bedrock with water and tackifier mixture using water trucks, water pulls, sprinklers or wobblers.	Additional requirement depending on soil type
					H	Actively preparing or blasting	Presoak surface soils to depth of the caliche or bedrock with water and surfactant mixture using water trucks, water pulls, sprinklers or wobblers.	Additional requirement depending on soil type

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Item	Reference	Threshold /Action Level	Recommended Approach	Data Input	Soil Category	Associated Tasks	Potential Mitigation Measures or BMP	Additional NOA Mitigation Measures
Minimum (Non-Asbestos Related) Dust Control Procedures For All Areas (When sampling results indicate no unacceptable asbestos risk, such as in Phase I)								
Cut and Fill (BMP-07)	Clark County Air Quality Regulations, Section 94 and Clark County Dust Control Handbook	<0.25%	Follow Clark County Air Quality regulations and BMPs in Clark County Dust Control Handbook	Percent passing #200 sieve, optimum moisture content	All	Preparation and Post Activity	Pre-water and maintain surface soils in a stabilized condition where support equipment and vehicles will operate. OR Apply and maintain a dust palliative on surface soils where support equipment and vehicles will operate. AND Dig a test hold to depth of cut or equipment penetration to determine if soils are moist at depth. AND Apply water, using water truck or water pull, to depth of cut propr to subsquent cuts. OR No cut activities fill only. AND Water disturbed soils to form crust following fill and compaction. OR Apply and maintain a dust pallative on disturbed soils to form crust following fill and compaction.	
					ML	Actively Working	Pre-water with sprinklers or wobblers to allow time for penetration. OR Pre-water with water trucks or water pulls to allow time for penetration.	
					MH	Actively Working	Pre-water with a water and tackifier mixture using sprinklers or wobblers to allow time for penetration. OR Pre-water with a water and tackifier mixture using water trucks or water pulls to allow time for penetration.	
					H	Actively Working	Pre-water with a water and surfactant mixture using sprinklers or wobblers to allow time for penetration. OR Pre-water with a water and surfactant mixture using water trucks or water pulls to allow time for penetration.	

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Item	Reference	Threshold /Action Level	Recommended Approach	Data Input	Soil Category	Associated Tasks	Potential Mitigation Measures or BMP	Additional NOA Mitigation Measures
Minimum (Non-Asbestos Related) Dust Control Procedures For All Areas (When sampling results indicate no unacceptable asbestos risk, such as in Phase I)								
Backfilling (BMP-01)	Clark County Air Quality Regulations, Section 94 and Clark County Dust Control Handbook	<0.25%	Follow Clark County Air Quality regulations and BMPs in Clark County Dust Control Handbook	Percent passing #200 sieve, optimum moisture content	All	Not actively handling	Water backfill material to maintain moisture or to form crust when not actively handling. OR Apply and maintain a dust palliative to backfill material to form crust when not actively handling. OR Cover or enclose backfill material when not actively handling.	Apply the minimum method that will achieve the necessary dust control.
					All	Actively Handlling	Empty loader bucket slowly and minimize drop height from loader bucket. OR Dedicate water truck or large hose to backfilling equipment and apply AND Apply water and maintain disturbed soils in a stable condition until permanent stabilization is complete. AND Apply and maintain a dust palliative on disturbed soils to form a crust following backfilling activity.	Apply the minimum method that will achieve the necessary dust control.
					ML	Actively handling	Apply and mix water into the backfill material until optimum moisture is reached.	Additional requirement depending on soil type
					MH	Actively handling	Apply and mix water and tackifier solution into the backfill material until optimum moisture is reached.	
					H	Actively handling	Apply and mix water and surfactant solution into the backfill material until optimum moisture is reached.	Surfactant should be mixed with appropriate dust palliative to increase penetration into soil. Surfactant alone should not be used.
Screening (BMP-17)	Clark County Air Quality Regulations, Section 94 and Clark County Dust Control Handbook	<0.25%	Follow Clark County Air Quality regulations and BMPs in Clark County Dust Control Handbook	Percent passing #200 sieve, optimum moisture content	All	General Requirements	If using a powered screen, obtain the appropriate Operating Permit for powered screens prior to engaging in screening activity. Comply with permit conditions.	
					All	Preparation and Post Activity	Pre-water and maintain surface soils in a stabilized condition where support equipment and vehicles will operate. OR Apply and maintain a dust palliative on surface soils where support equipment and vehicles will operate AND Apply water to stabilize screened material and surrounding area after screening. OR Apply and maintain a dust palliative to stabilize screened material and surrounding area after screening.	
					All	Actively Working	Apply sufficient water to obtain at least 70% optimum moisture in material prior to screening. OR Apply a dust suppressant to material prior to screening. AND Dedicate water truck or large hose to screening operation and apply water as needed to prevent dust. OR Apply water to material as it is being dropped through the screen. OR Install wind barrier upwind of screen as high as the screen drop point and made of material with a porosity of 50% or less.	

Item	Reference	Threshold /Action Level	Recommended Approach	Data Input	Soil Category	Associated Tasks	Potential Mitigation Measures or BMP	Additional NOA Mitigation Measures
Minimum (Non-Asbestos Related) Dust Control Procedures For All Areas (When sampling results indicate no unacceptable asbestos risk, such as in Phase I)								
Crushing (BMP-	Clark County Air Quality Regulations, Section 94 and Clark County Dust Control Handbook	<0.25%	Follow Clark County Air Quality regulations and BMPs in Clark County Dust Control Handbook	Percent passing #200 sieve, optimum moisture content	All	General Requirements	Obtain the appropriate operating Permit for powered crushers prior to engaging in crushing activity. Comply with permit conditions.	
					All	Preparation and Post Activity	Pre-water and maintain surface soils in a stabilized condition where support equipment and vehicles will operate. OR Apply and maintain a dust palliative on surface soils where support equipment and vehicles will operate. AND Pre-water material prior to loading into crusher. OR Test material to determine moisture content and silt loading, crush only material that is at optimum moisture content. AND Water crushed material to form crust immediately following crushing. OR Apply and maintain a dust palliative to crushed material.	
					All	Actively Working	Apply water to stabilize material so as to remain in compliance with opacity standards and permit conditions, during crushing. OR Monitor emissions opacity. Make adjustments to remain in compliance with opacity standards and permit conditions.	
Paving Subgrade Preperation	Clark County Air Quality Regulations, Section 94 and Clark County Dust Control Handbook	<0.25%	Follow Clark County Air Quality regulations and BMPs in Clark County Dust Control Handboo	Percent passing #200 sieve, optimum moisture content	All	General Requirements	Stablize soils prior to activities. AND Stablize soils during activities. AND Stabliize soils following activites. AND Stabilize adjacent disturbed soils following paving activities.	
					All	Preparation and Post Activity	Pre-water subgrade surface until optimum moisture content is reached and maintained. AND Maintain at least 70% of optimum moisture content for Type II material while aggregate is being applied. AND Place tack coat on Type II aggregate base immediately after it is applied. OR Apply water to Type II aggregate base immediately after it is applied. AND Stabilize adjacent disturbed soils following paving activities by crusting with water. OR Stabilize adjacent disturbed soils following paving activities by applying a dust palliative. OR Stabilize adjacent disturbed soils following paving activities with immediate landscaping activity or installation of vegetative or rock cover. OR There are no soils adjacent to paving activities.	

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Item	Reference	Threshold /Action Level	Recommended Approach	Data Input	Soil Category	Associated Tasks	Potential Mitigation Measures or BMP	Additional NOA Mitigation Measures
Minimum (Non-Asbestos Related) Dust Control Procedures For All Areas (When sampling results indicate no unacceptable asbestos risk, such as in Phase I)								
Disturbed Soil	Clark County Air Quality Regulations, Section 94 and Clark County Dust Control Handbook	<0.25%	Follow Clark County Air Quality regulations and BMPs in Clark County Dust Control Handboo	Percent passing #200 sieve, optimum moisture content	All	Preparation and Post Activity	For each non-linear project to be permitted for 5 acres or less; install perimeter wind barrier 3 feet or more in height made of material with a porosity of 50% or less. AND Limit vehicle traffic and distrubance of soils with the use of fencing, barriers, barricades, and/or wind barriers. AND Record soil conditions and dust control actions in daily project records.	It is recommeded that if interior block walls are planned, install as early in the construction as possible.
						Actively Working	Apply water to stablize disturbed soils. Soils must be kept in a sufficiently damp, crusted or covered condition. OR Apply and maintain a dust palliative based on soil type and future plans.	
Disturbed Land (Long Term)	Clark County Air Quality Regulations, Section 94 and Clark County Dust Control Handbook	<0.25%	Follow Clark County Air Quality regulations and BMPs in Clark County Dust Control Handboo	Percent passing #200 sieve, optimum moisture content	All	General Requirements	Stabilize soil to meet standards required by Air Quality Regulation Section 90. AND Prevent access to limit soil disturbance.	
					All	Preparation and Post Activity	Apply and maintain a dust palliative on disturbed soils for long-term stabilization. OR Stabilize disturbed soil with vegetation for long-term stabilization. OR Pave or apply surface rock for long-term stabilization. OR Use wind breaks in accordance with a site-specific plan approved by the Control Officer and Region IX Administrator of the EPA. OR Apply water and maintain soils in a visible damp or crusted condition for temporary stabilization. AND Prevent access by fencing, ditches, vegetation, berms or other suitable barrier or means approved by the Control Officer.	It is recommened to plant perimeter vegetation early. Use of native and droughttolerant plants with greater than 50 % silhouette area is encouraged.
Dust Palliative - Selection and Use	Clark County Air Quality Regulations, Section 94 and Clark County Dust Control Handbook	<0.25%	Follow Clark County Air Quality regulations and BMPs in Clark County Dust Control Handboo	Percent passing #200 sieve, optimum moisture content	All	General Requirements	Follow AQD "Interim Policy on Dust Palliatives Use In Clark County, Nevada". AND Record use of suppressants and dust palliatives and retain records. AND Follow applicable federal and state regulations.	
					All	Preparation and Post Activity	For traffic area applications use Table 1: Traffic Area Application Requirements, Appropriate Use of Liquid Dust Palliatives and Application Rates, from the Interim Policy on Dust Palliatives Use In Clark County, Nevada. OR For non-traffic area applications use Table 2: Non-Traffic Area Application Requirements, Appropriate Use of Liquid Dust Palliatives and Application Rates, from the Interim Policy on Dust Palliatives Use In Clark County, Nevada.	

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Item	Reference	Threshold /Action Level	Recommended Approach	Data Input	Soil Category	Associated Tasks	Potential Mitigation Measures or BMP	Additional NOA Mitigation Measures
Minimum (Non-Asbestos Related) Dust Control Procedures For All Areas (When sampling results indicate no unacceptable asbestos risk, such as in Phase I)								
Importing Exporting Soil and Rock and Bulk Material	Clark County Air Quality Regulations, Section 94 and Clark County Dust Control Handbook	<0.25%	Follow Clark County Air Quality regulations and BMPs in Clark County Dust Control Handboo	Percent passing #200 sieve, optimum moisture content	All	General Requirements	Limit visible dust opacity from vehicular operations. AND Check belly-dump truck seals regularly and remove any trapped rocks to prevent spillage. AND Maintain 3-6 inched of freeboard to minimize spillage. AND Stabilize materials during transport on site. . AND Clean wheels and undercarriage of haul trucks prior to leaving construction site.	It is recommended to verify State and local laws, concerning the hauling of bulk materials on public roadways.
					All	Preparation and Post Activity	Apply water and limit vehicle speeds to 15 mph on the work site. OR Apply and maintain dust suppressant on haul routes. AND Use tarps or other suitable enclosures on haul trucks. OR Stabilize materials with water.	
Staging Areas	Clark County Air Quality Regulations, Section 94 and Clark County Dust Control Handbook	<0.25%	Follow Clark County Air Quality regulations and BMPs in Clark County Dust Control Handboo	Percent passing #200 sieve, optimum moisture content	All	General Requirements	Limit visible dust opacity from vehicular operations. AND Stabilize stageing area soils during use. AND Stabilize staging are soils at project completion.	It is recommended to limit size of staging areas and limit ingress and egress points.
					All	Preparation and Post Activity	Limit vehicle speeds to 15 mph in the staging area and on all unpaved access routes. OR Apply and maintain dust suppressant on all vehicle traffic areas in the staging areas and unpaved access routes AND Pre-water and maintain surface soils in a stabilized condition where support equipment and vehicles will operate. OR Apply and maintain a dust palliative to surface soils where support equipment and vehicles will be operated. AND Apply a dust palliative. OR Apply screened or washed Type II aggregate. OR Use wind breaks in accordance with a site-specific plan approved by the Control Officer and Region IX Administrator of the EPA. OR Pave with thin paving. OR Completed project will cover staging area with buildings, paving, and/or landscaping. OR Apply water to form adequate crust and prevent access.	

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Item	Reference	Threshold /Action Level	Recommended Approach	Data Input	Soil Category	Associated Tasks	Potential Mitigation Measures or BMP	Additional NOA Mitigation Measures
Minimum (Non-Asbestos Related) Dust Control Procedures For All Areas (When sampling results indicate no unacceptable asbestos risk, such as in Phase I)								
Stockpiling	Clark County Air Quality Regulations, Section 94 and Clark County Dust Control Handbook	<0.25%	Follow Clark County Air Quality regulations and BMPs in Clark County Dust Control Handboo	Percent passing #200 sieve, optimum moisture content	All	General Requirements	To the extent possible, maintain stockpile to avoid steepsides or faces. AND Stockpile location and height must be maintained pursuant to Air Quality Regulations. Stockpiles located within 100 yards of occupied buildings must not be constructed over 8 feet in height. AND Stabilize surface soils where support equipment and vehicles will operate. AND Stabilize stockpile materials during handling. AND Stabilize stockpiles at completion of activity.	
					All	Preparation and Post Activity	Stockpiles will not be constructed over 8 feet in height. OR Stockpiles will be constructed over 8 feet high and must have a road bladed to the top to allow water truck access or must have a sprinkler irrigation system installed, used and maintained. AND Pre-water and maintain surface soils in a stabilized condition where support equipment and vehicles will operate. OR Apply and maintain a dust palliative on surface soils where support equipment and vehicles will operate. AND Water stockpiles to form a crust immediately at the completion of activity. OR Apply and maintain a dust palliative to all outer surfaces of the stockpiles. OR Provide and maintain wind barriers on 3 sides of the pile, whose length is no less than equal to the length of the pile, whose distance from the pile is no more than twice the height of the pile, whose height is equal to the pile height, and made of material with a porosity of 50% or less. AND Apply a cover or screen to stockpiles.	
					All	Actively Working	Pre-water and maintain surface soils in a stabilized condition where support equipment and vehicles will operate. OR Apply and maintain a dust palliative on surface soils where support equipment and vehicles will operate. AND Maintain stockpile materials with at least 70% optimum moisture content. OR Remove material from the downwind side of the stockpile, when safe to do so.	
					All	ML	Apply water during stacking, loading and unloading operations.	
					All	MH	Apply a water and tackifier mixture during stacking, loading and unloading operations.	
					All	H	Apply a water and surfactant mixture during stacking, loading and unloading operations.	

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Item	Reference	Threshold /Action Level	Recommended Approach	Data Input	Soil Category	Associated Tasks	Potential Mitigation Measures or BMP	Additional NOA Mitigation Measures
Minimum (Non-Asbestos Related) Dust Control Procedures For All Areas (When sampling results indicate no unacceptable asbestos risk, such as in Phase I)								
Trackout Prevention and Cleanup	Clark County Air Quality Regulations, Section 94 and Clark County Dust Control Handbook	<0.25%	Follow Clark County Air Quality regulations and BMPs in Clark County Dust Control Handboo	Percent passing #200 sieve, optimum moisture content	All	General Requirements	In soils that have a PEP classification of "High", pave construction activities roadways as early as possible. AND Use of soil to create a ramp for vehicle access over a curb is prohibited. AND Trackout conditions, including preventive and corrective measures, must be recorded daily for every day that the construction project access is used by vehicles. AND Prevent dust from trackout. AND Install and maintain trackout control devices in effective condition at all access points where paved and unpaved access or travel routes intersect. AND All exiting traffic must be routed over selected trackout control device(s).	
					All	Preparation and Post Activity	Record soil conditions and dust control actions in daily project records. AND Immediately clean trackout from paved surfaces to maintain dust control. Trackout must not extend 50 feet or more. OR Maintain dust control during working hours and clean trackout from paved surfaces at the end of the work shift/day. Trackout must not extend 50 feet or more and must be cleaned daily, at minimum. AND Clearly establish and enforce traffic patterns to route traffic over selected trackout control device(s). AND Limit site accessibility to routes with trackout control devices in place by installing effective barriers on unprotected routes.	
					All	Actively Working	Install gravel pad(s) consisting of 1" to 3" rough diameter, clean, wellgraded gravel or crushed rock. Minimum dimensions must be 30 feet wide by 3 inches deep, and, at minimum, 50' or the length of the longest haul truck, whichever is greater. Re-screen, wash or apply additional rock in gravel pad to maintain effectiveness. AND Install wheel shakers. Clean wheel shakers on a regular basis to maintain effectiveness. AND Install wheel washers. Maintain wheel washers on a regular basis to maintain effectiveness. AND Install wheel shakers in the event that trackout cannot be controlled with gravel pads. AND Install wheel washer in the event that trackout cannot be controlled with gravel pads and wheel shakers. AND Motorized vehicles will only operate on paved surfaces.	

Item	Reference	Threshold /Action Level	Recommended Approach	Data Input	Soil Category	Associated Tasks	Potential Mitigation Measures or BMP	Additional NOA Mitigation Measures
Minimum (Non-Asbestos Related) Dust Control Procedures For All Areas (When sampling results indicate no unacceptable asbestos risk, such as in Phase I)								
Traffic (Unpaved)	Clark County Air Quality Regulations, Section 94 and Clark County Dust Control Handbook	<0.25%	Follow Clark County Air Quality regulations and BMPs in Clark County Dust Control Handboo	Percent passing #200 sieve, optimum moisture content	All	General Requirements	Limit visible dust opacity from vehicular operations. AND Stabilize all haul routes. AND Stabilize all off-road and parking areas.	It is recommened to use of bumps or dips for speed control is encouraged.. Apply paving as soon as possible to all future roadway areas for PEP categories other than "High".
					All	Preparation and Post Activity	Limit vehicle speeds to 15 mph on all unpaved routes and parking areas. OR Apply and maintain dust palliative on all vehicle travel areas.	
					All	Activley Working	Apply water to haul routes and maintain in a stabilized condition. OR Apply a dust palliative to haul routes and maintain in a stabilized condition. OR Apply gravel to haul routes and maintain in a stabilized condition. OR Supplement dust palliative or aggregate applications with watering, if necessary. AND Apply water to off-road traffic and parking areas and maintain in a stabilized condition. OR Apply gravel to off-road traffic and parking areas and maintain in a stabilized condition. OR Apply recycled asphalt (or other suitable material) to off-road traffic and parking areas and maintain in a stabilized condition. OR Apply and maintain a dust palliative (designed for vehicle traffic) to offroad traffic and parking areas and maintain in a stabilized condition.	

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Item	Reference	Threshold /Action Level	Recommended Approach	Data Input	Soil Category	Associated Tasks	Potential Mitigation Measures or BMP	Additional NOA Mitigation Measures
Minimum (Non-Asbestos Related) Dust Control Procedures For All Areas (When sampling results indicate no unacceptable asbestos risk, such as in Phase I)								
Truck Loading	Clark County Air Quality Regulations, Section 94 and Clark County Dust Control Handbook	<0.25%	Follow Clark County Air Quality regulations and BMPs in Clark County Dust Control Handboo	Percent passing #200 sieve, optimum moisture content	All	General Requirements	Ensure all loads are covered prior to leaving the construction site and traveling on public roadways.. AND Stabilize surface soils where loaders, support equipment and vehicles will operate. AND Stabilize material during loading.	
					All	Preparation and Post Activity	Pre-water and maintain surface soils in a stabilized condition where loaders, support equipment and vehicles will operate. AND Apply and maintain a dust palliative on surface soils where loaders, support equipment and vehicles will operate.	
					All	Actively Working	Empty loader bucket slowly and keep loader bucket close to the truck to minimize the drop height while dumping.	
					All	ML	Mix material with water prior to loading. OR Spray material with water while loading.	
						MH	Mix material with a water and tackifier mixture prior to loading. OR Spray material with a water and tackifier mixture while loading.	
						H	Mix material with a water and surfactant mixture prior to loading. OR Spray material with a water and surfactant mixture while loading.	

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Item	Reference	Threshold /Action Level	Recommended Approach	Data Input	Soil Category	Associated Tasks	Potential Mitigation Measures or BMP	Additional NOA Mitigation Measures
Minimum (Non-Asbestos Related) Dust Control Procedures For All Areas (When sampling results indicate no unacceptable asbestos risk, such as in Phase I)								
Monitoring to Determine IF Additional NOA Measures Required - Project Specific Requirements								
Perimeter air monitoring of construction zones (Approximately every 1/2 mile on all sides of project)	Not established	Develop a risk-based perimeter air concentration threshold that may include an attenuation factor. Phase II currently proposing a risk-based threshold level of 0.0003 s/cc (PCMe), but does not include any attenuation.	Contractor to develop a specific risk-based perimeter air threshold level for Phase I with an attenuation factor. Set up specific engineering and administration controls, including stop work level, to ensure asbestos air concentrations do not exceed threshold.	Collect perimeter air samples during all construction activities at specified intervals along Phase I project boundary. Analysis samples by PCM and TEM. Initial direct read monitoring, using particulate count meters, may be added.		All	- Adequate watering during all construction activities that disturb rock/soil - Reduce haul traffic speeds as needed - Modify work hours as needed - Employ dust suppression during blasting and crushing - Pre-wet and tarp (cover) loads - Suspend operations during high winds - Stabilize disturbed areas - Employ visible emissions criteria to trigger more intense mitigation measures - Incorporate air monitoring program, results, and data interpretation into the project community communication program.	Work practices as required in Clark County, Air Quality Regulations, Section 94 (and others as appropriate) may be sufficient to keep airborne asbestos levels at or below threshold.
Point of Dust Generation - Zero Dust Emission	Clark County Air Quality Regulations, Section 94 and Clark County Dust Control Handbook	Zero dust emissions will apply to the "point of dust generation" rather than the perimeter of the project.	Project specific requirement to include: 1. Zero dust emissions for all project activities except blasting. 2. Measures to minimize dust such as small blasts at more frequent intervals.	Contractor should submit a blasting plan for approval.		All	- Use of specialized water apparatus (fog cannons, isolating misters) - Utilize small blasts at more frequent intervals. - Alternative blast scheduling (not necessarily between 8:00 am and 4:30 pm) when there is less wind.J59	Collect samples of bedrock during blast hole coring and analyze for NOA. Pre-soak areas, if required. Work with Clark County, Air Quality Department to establish blasting schedule and other mitigation measures.
Worker Exposure								
Personal air monitoring for airborne asbestos (Recommended In areas were asbestos is detected as a minimum)	29 CFR Part 1926.1101	0.1 f/cc TWA-PEL 1.0 f/cc STEL	Contractor adhere to PEL, STEL. Contractor to develop personal air monitoring plan. Contractor to develop engineering, administrative controls, and task-based PPE requirements as needed. Contractor to provide a CIH and an asbestos competent person.	Personal air monitoring (8-hr and 30-min samples, analysis by PCM NIOSH 7400)		All	- Conduct employee training program for asbestos awareness - Maintain site control for areas requiring additional PPE requirements - Notify laboratories that samples may contain NOA - Dust control during work activities (e.g., watering, encapsulant, etc.) - Reduce haul traffic speeds as necessary to reduce dust - Employ dust suppression during drilling, blasting, and crushing - Install HEPA filtration system in trailers for workers working with NOA samples - Don appropriate PPE during work activities as needed - Modify work hours as needed	Work practices as required in Clark County, Air Quality Regulations, Section 94 (and others as appropriate) may be sufficient to keep exposure levels at or below PEL.
Rock Site Use and Disposal (The following section from CDM Smith's spreadsheet and has not been modified. It does not apply to Phase I based on the information we currently have because there are no areas where NOA is >0.25%).								
Embankment fill	CARB Method 435 CARB ATCM Regulatory Text (17 CCR 93105)	0.25%	Develop sampling plan for embankment fill stockpiles to determine capping requirements.	Collect 30-point sample of stockpiled material and analyze by PLM-PC400		Road construction	Stockpile embankment fill for sampling Stockpiles with PLM results ≥ 0.25% asbestos: - apply adequate water during hauling and placement of embankment fill - excavation areas (non-rock) - cap with minimum 3-inches of <0.25% asbestos material - stockpiles of crushed material; stabilize or cover if long term Stockpiles with PLM results < 0.25% asbestos - no additional mitigation measures	No mention of NOA source materials for disposal or use as fill material in Nevada regulations. Concerns: - detection limit for PLM analytical results (ND may not necessarily mean it doesn't contain NOA) - sample representativeness

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Item	Reference	Threshold /Action Level	Recommended Approach	Data Input	Soil Category	Associated Tasks	Potential Mitigation Measures or BMP	Additional NOA Mitigation Measures
Minimum (Non-Asbestos Related) Dust Control Procedures For All Areas (When sampling results indicate no unacceptable asbestos risk, such as in Phase I)								
Surplus rock and excavated or crushed material	CARB Method 435 CARB ATCM Regulatory Text (17 CCR 93105)	0.25%	Develop sampling plan for surplus rock stockpiles to determine capping requirements.	Collect 30-point sample of stockpiled material and analyze by PLM-PC400		Placement of surplus rock		No mention of NOA source materials for disposal or use as fill material in Nevada regulations. Concerns: - detection limit for PLM analytical results (ND may not necessarily mean it doesn't contain NOA) - sample representativeness
Exposed rock surface	Not established	0.25%	Develop sampling plan to characterize newly-blasted rock surface	Collect samples of newly-blasted rock surface for analysis by PLM-PC400		Blasting	Surfaces with PLM results ≥ 0.25% asbestos: - apply appropriate encapsulant suitable for capping exposed asbestos Surfaces with PLM results < 0.25% asbestos - no additional mitigation measures	No mention of newly-blasted exposed rock in Nevada or California regulations.

ATCM	Asbestos Airborne Toxic Control Measure	NIOSH	National Institute for Occupational Safety and Health
CARB	California Air Resources Board	NOA	naturally occurring asbestos
CCR	California Code of Regulations	PCM	phase contrast microscopy
CFR	Code of Federal Regulations	PEL	permissible exposure limit
CIH	Certified Industrial Hygienist	PLM-PC400	polarized light microscopy, point count (400) method
f/cc	fibers per cubic centimeter	PPE	personal protective equipment
HEPA	high-efficiency particulate air	STEL	short-term exposure limit
MPH	miles per hour	TEM-AHERA	transmission electron microscopy, Asbestos Hazard Emergency Response Act counting rules
NA	not applicable	TWA	time-weighted average
ND	nondetect	%	percent
		<	less than
ML	Medium Low soil category	BMP	Best management practice
MH	Medium High soil category		
H	High soil category	(Low and slight soil catergories not listed here, but included in the guide. Slight category only applies to rock outcrops	

Notes:
1. When not actively working soil, it must be maintained with adequate crust to prevent wind erosion as determined by the Drop Ball test (Section 94.12
2. Most of project is in High or Moderate High soil type areas, so those BMPs apply unless soil testing can determine lesser soil classification. (Actual measured soil type takes precedence over mapping
3. Section 91 of the Clark County Air Quality Regulations appies to unpaved roads and the roads must be maintained in a stable condition as defined in that section
4. Cease all construction activites (except water truck pulls) if fugitive dust emisions exceed 20% opacity or visible plume restrictions depite adhering to BPM

TABLE 7-2
POTENTIAL CHEMICAL HAZARDS - PROJECT CONSTRUCTION WORKER
BCB PHASE I PROJECT AREA

Chemical	Exposure Limits and IDLH Level	Exposure Routes	Toxic Characteristics
Asbestos	OSHA PEL: 0.1 fiber/cm^3 (8 hour TWA) OSHA Excursion Limit: 1 fiber/ cm^3 (30 minute exposure) ACGIH TLV: 0.1 fiber/cm^3 NIOSH REL: 0.1 fiber/ cm^3 IDLH: Not Established	Inhalation (primary), ingestion, skin or eye contact	Lung cancer, mesothelioma, asbestosis (chronic exposure): dyspnea (breathing difficulty), interstitial fibrosis, restricted pulmonary function, finger clubbing; eye irritation

Notes:

ACGIH	American Conference of Governmental Industrial Hygienists
IDLH	Immediately dangerous to life or health
cm^3	Cubic centimeter
NIOSH	National Institute for Occupational Safety and Health
OSHA	Occupational Safety and Health Administration
PEL	Permissible exposure limit
ppm	Part per million
REL	Recommended Exposure Level
TLV	Threshold limit value
TWA	Time-weighted average

Sources:

ACGIH. “Threshold Limit Values and Biological Exposure Indices for 1998.” Latest edition.

National Institute for Occupational Safety and Health. 2004. “Pocket Guide to Chemical Hazards.” U.S. Department of Health and Human Services. U.S. Government Printing Office. Washington, DC. June.

FIGURES

SCALE: 1" = 5 miles

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FIGURE 1-1
Project Location Map

TETRA TECH

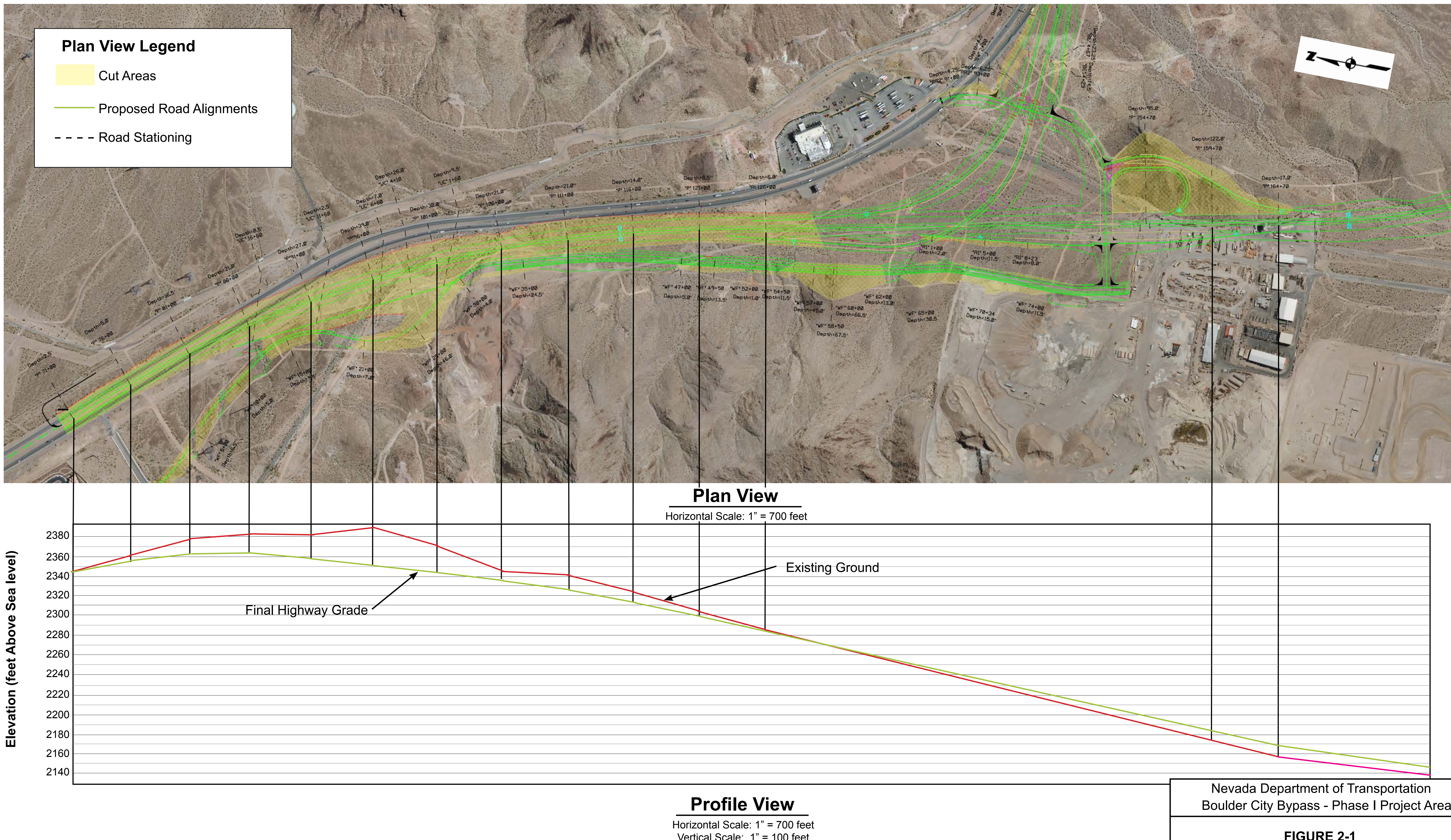

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FIGURE 2-1

Phase I Centerline Plan Map and Profile

TETRA TECH

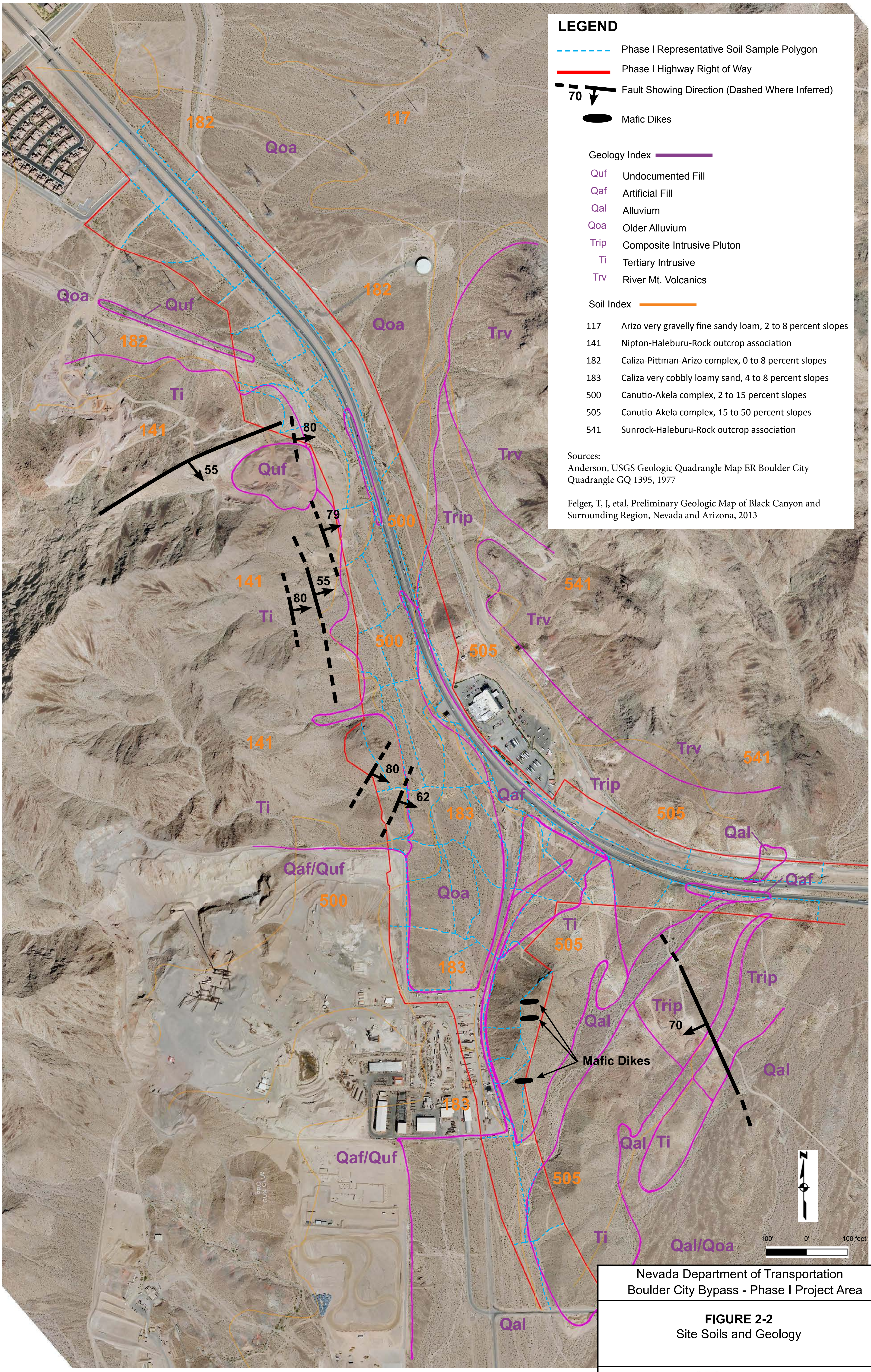

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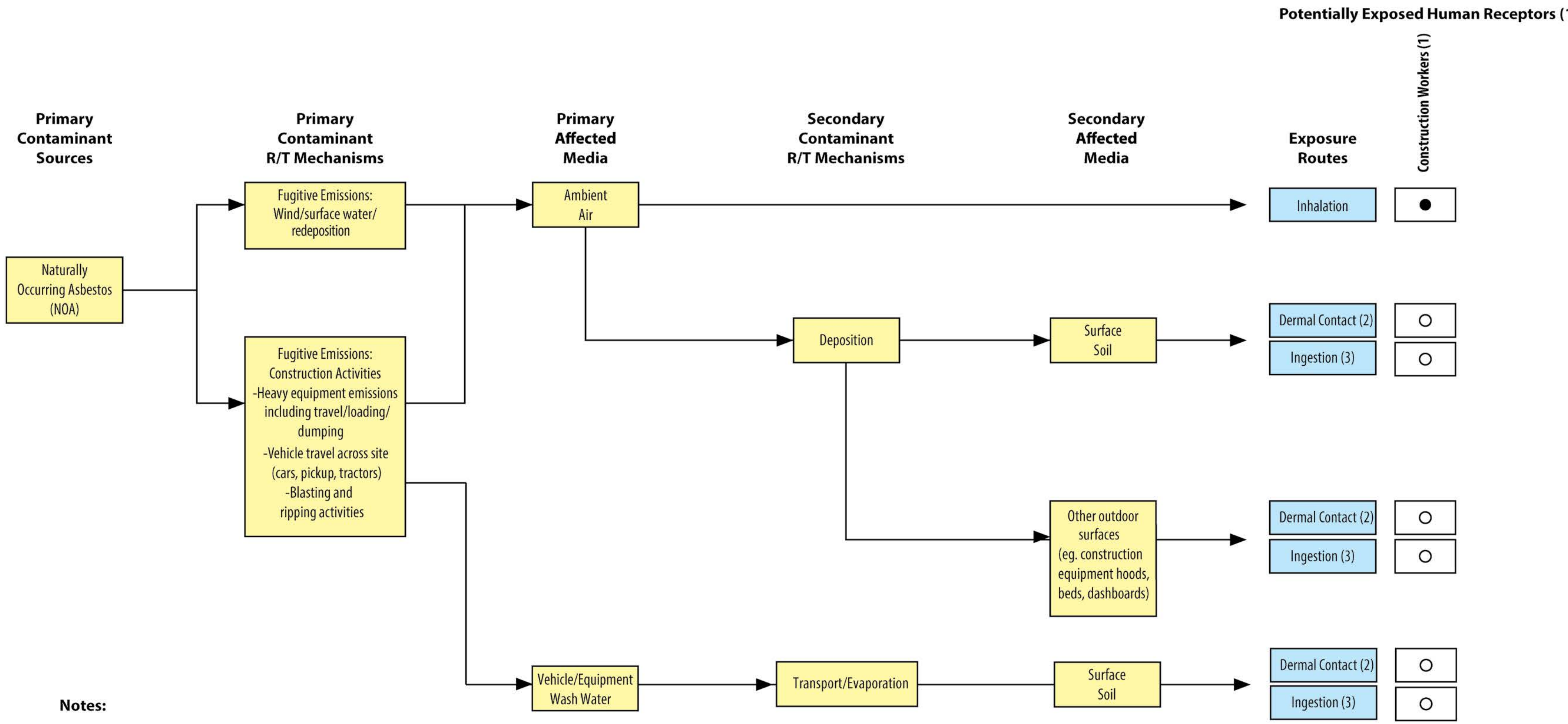
FIGURE 2-2
Site Soils and Geology

TETRA TECH



Notes:

NOA = Naturally occurring asbestos
R/T = Release/transport
● = Potentially complete exposure pathway
○ = Potentially complete but insignificant exposure pathway

1. Construction workers are assumed to be exposed on site.
2. Asbestos fibers are not absorbed through the skin.
3. Potential incidental ingestion of asbestos fibers are expected to result in limited adverse health effects.

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FIGURE 2-3
Conceptual Site Model

TETRA TECH

SCALE: 1" = 3,300 feet

LEGEND

Phase I Ambient Air Sample Station

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FIGURE 3-1
Phase I Ambient Air Sample Locations

TETRA TECH

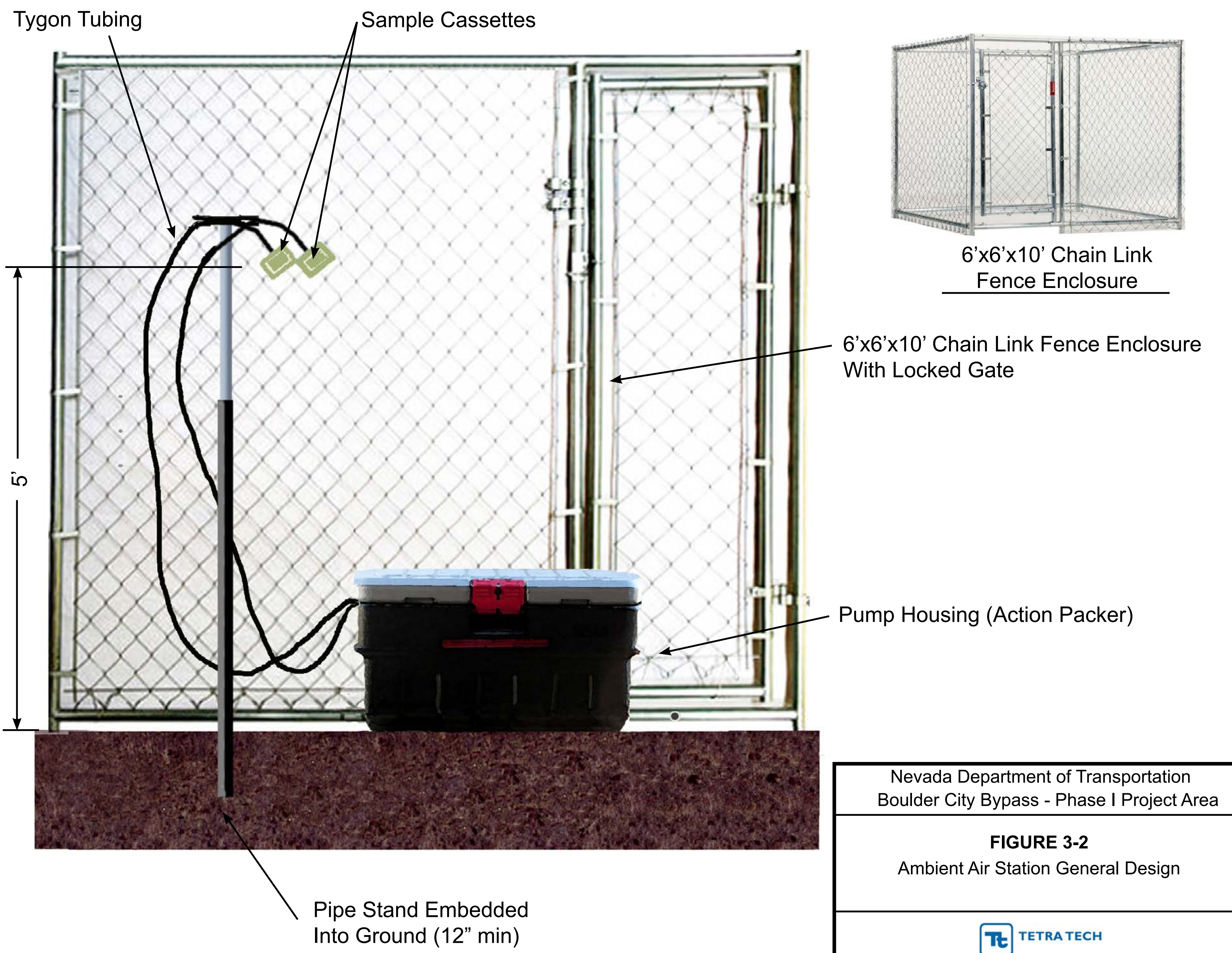

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FIGURE 3-2
Ambient Air Station General Design

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FIGURE 3-3
Phase I Solid Media Sample Locations

TETRA TECH

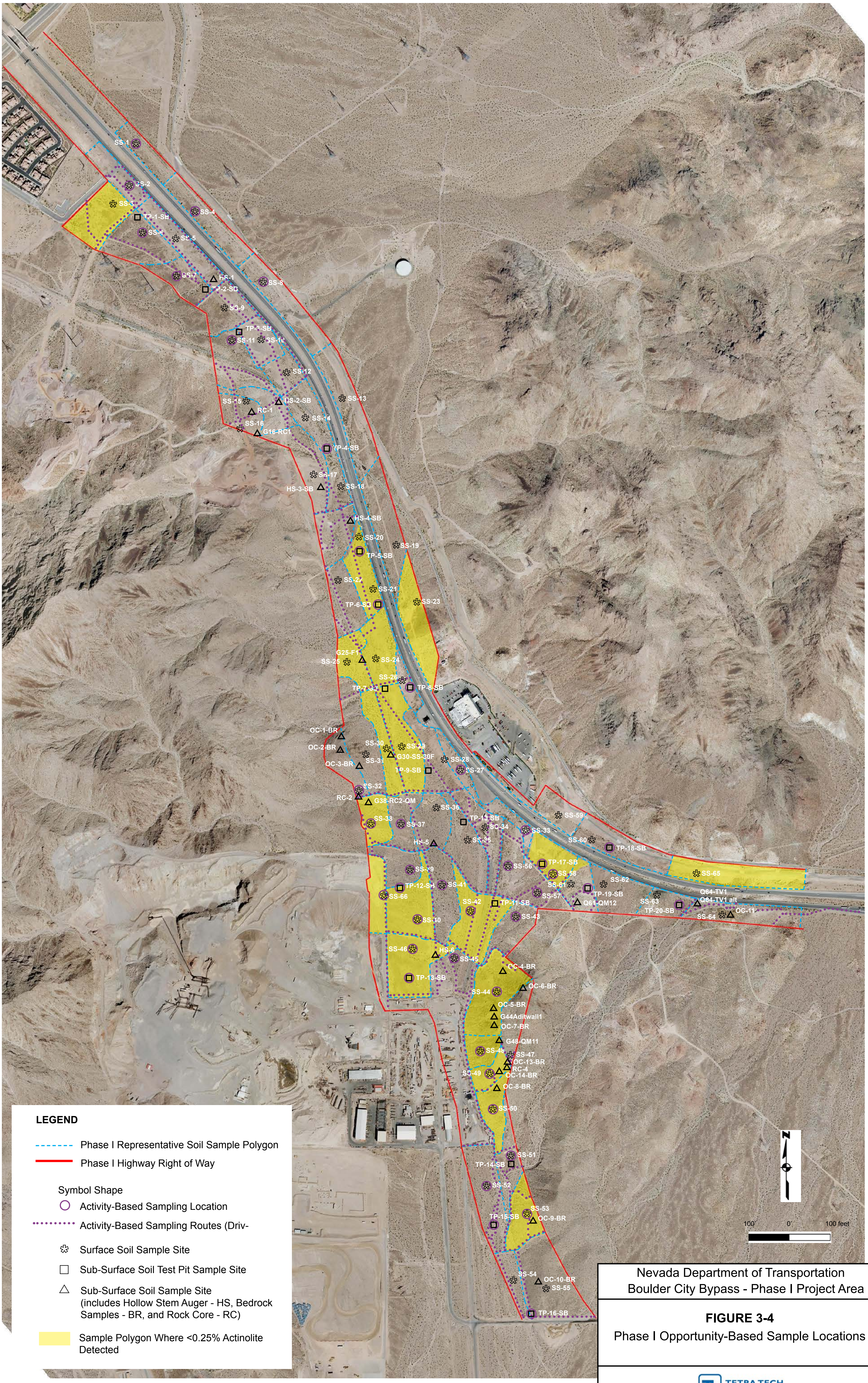

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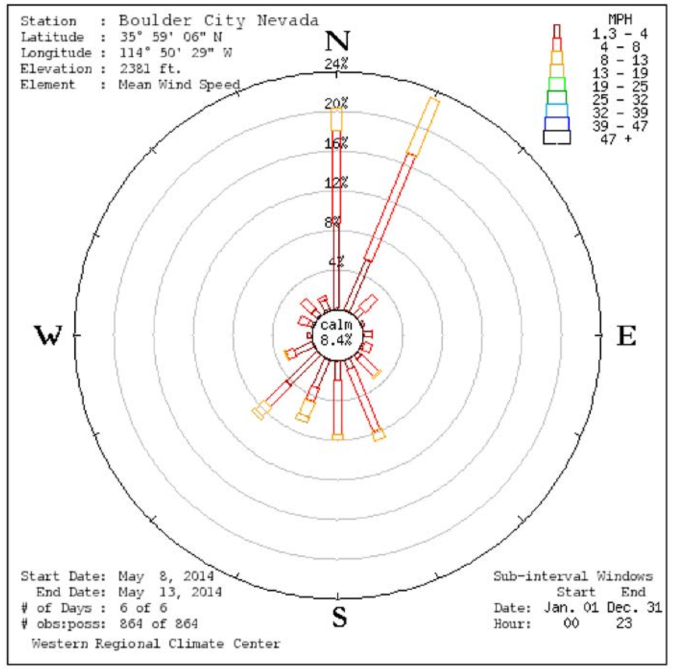
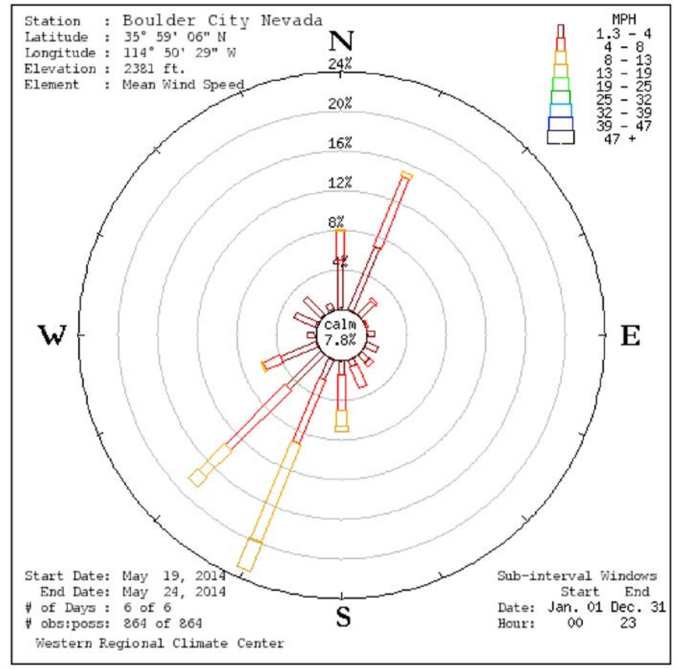
FIGURE 3-4

Phase I Opportunity-Based Sample Locations

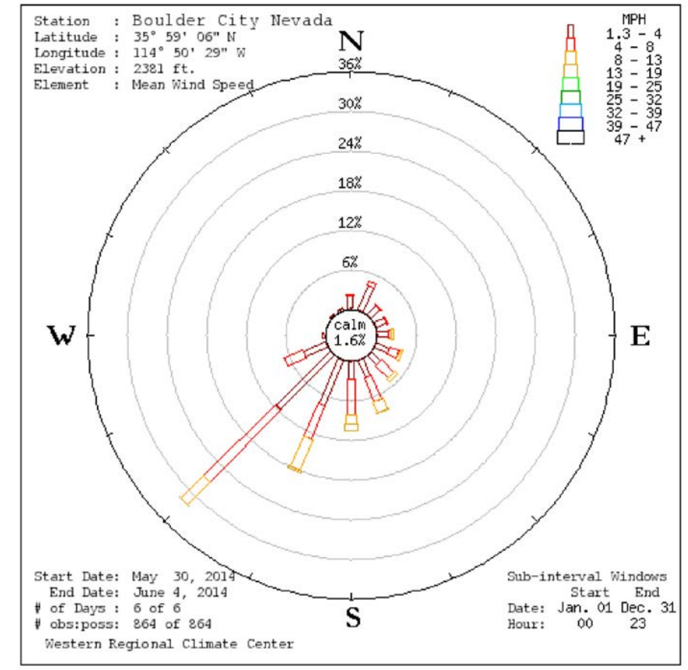
TETRA TECH



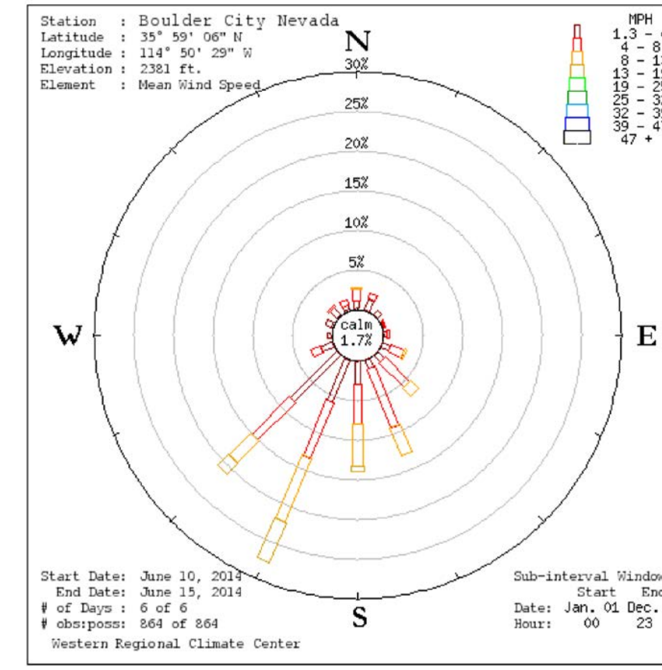
Period 1: May 8 thru 13, 2014



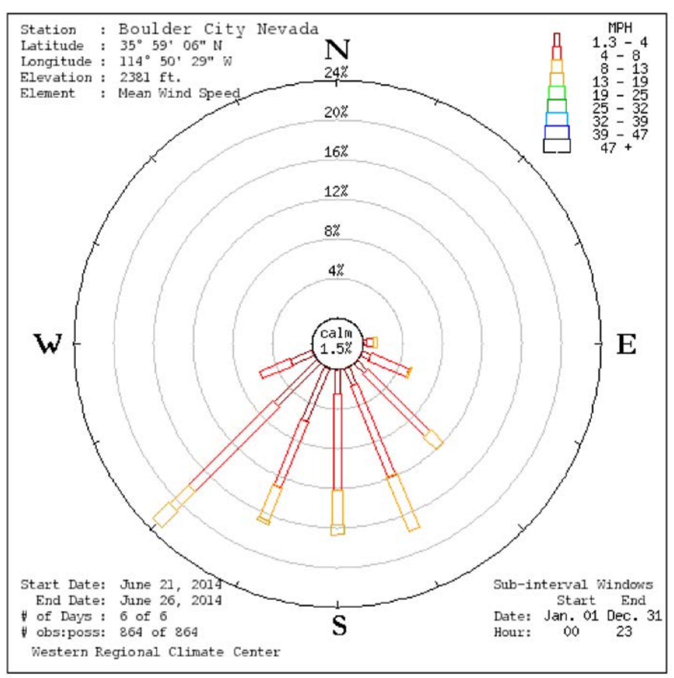
Period 2: May 19 thru 24, 2014



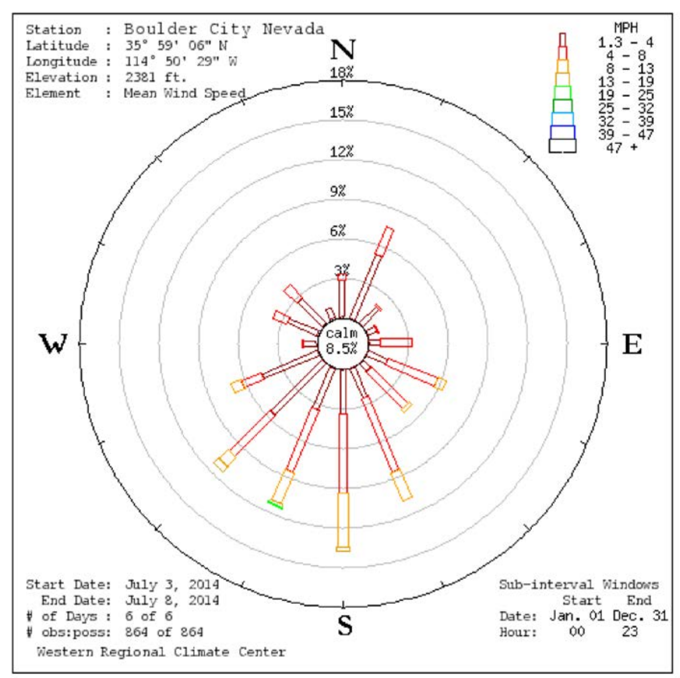
Period 3: May 30 thru June 4, 2014



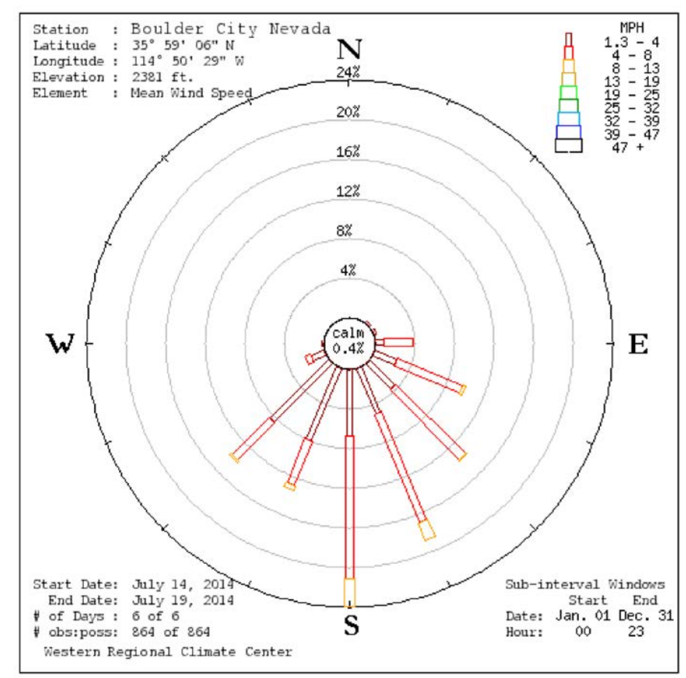
Period 4: June 10 thru 15, 2014



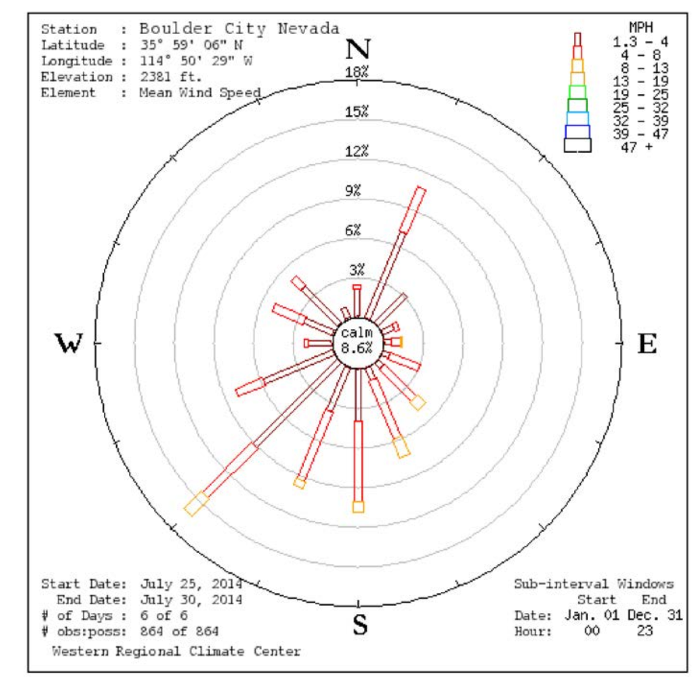
Period 5: June 21 thru 26, 2014



Period 6: July 3 thru 8, 2014



Period 7: July 14 thru 19, 2014



Period 8: July 25 thru 30, 2014

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FIGURE 5-1
Phase I Wind Rose Diagrams For Sampling Periods (May 8 to July 30, 2014)

TETRA TECH

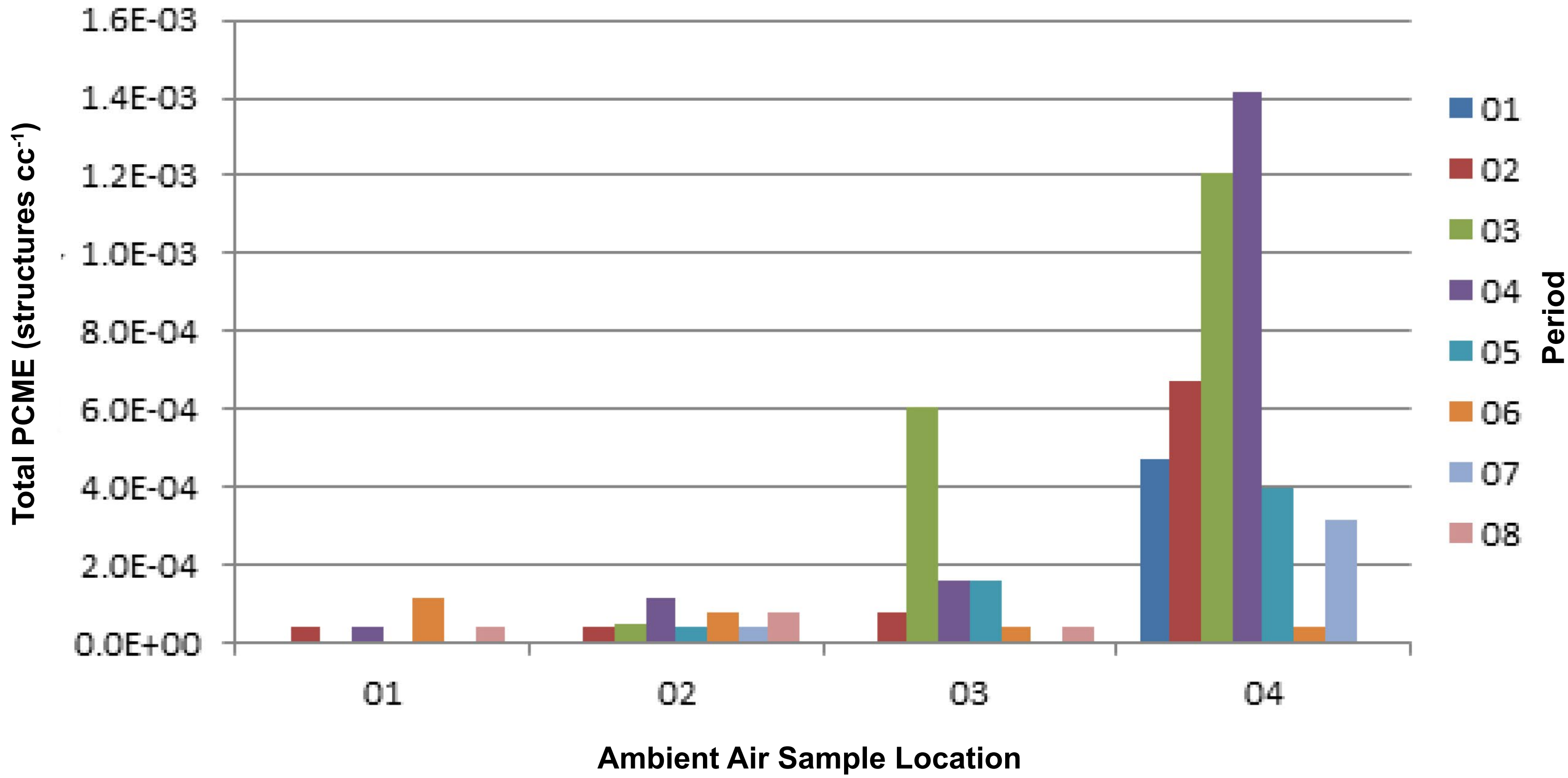

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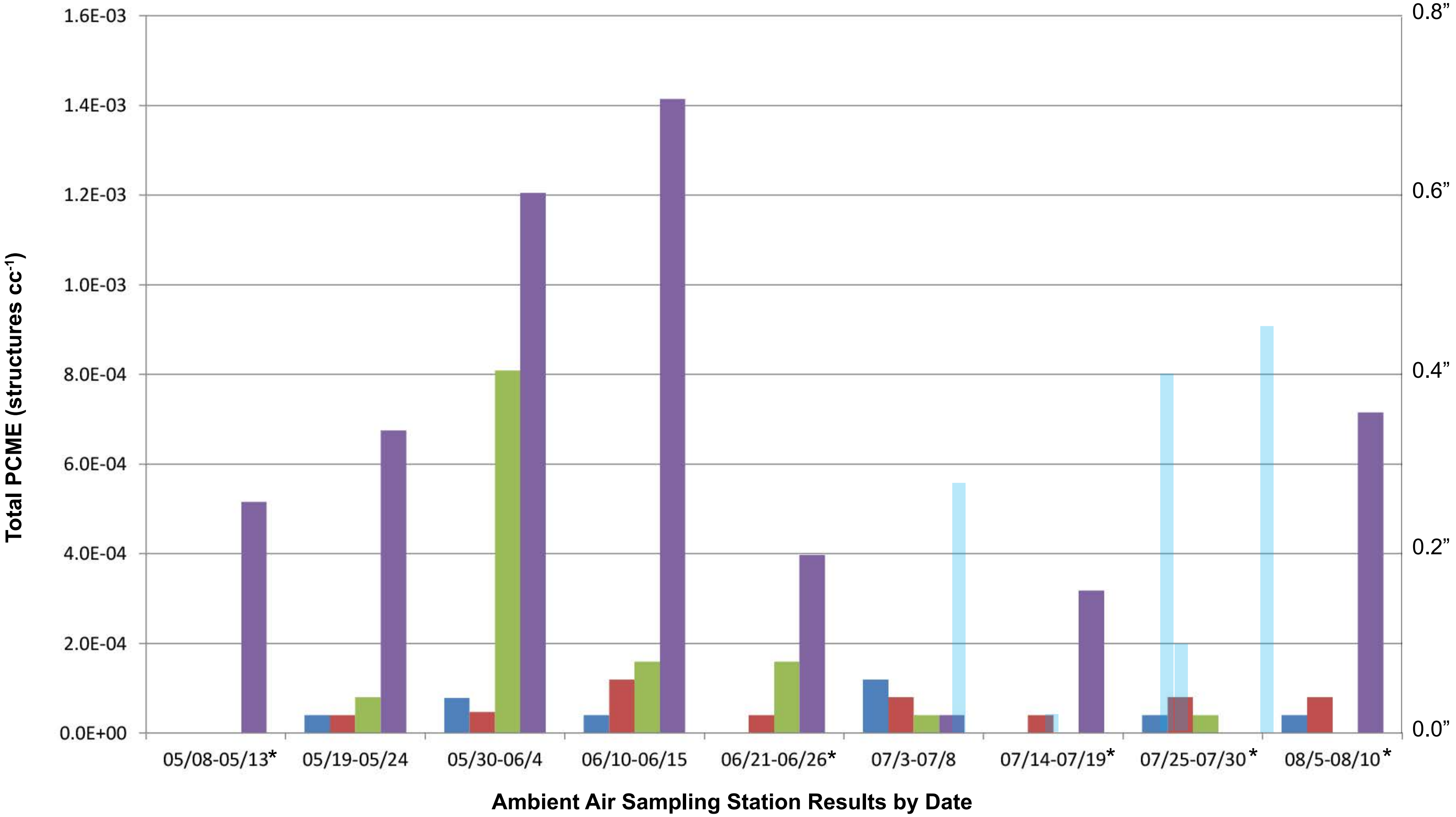
FIGURE 5-2
Ambient Air Total PCME Concentrations
by Station and Period

TETRA TECH



Legend

- Station 1 - PCME Concentration
- Station 2 - PCME Concentration
- Station 3 - PCME Concentration
- Station 4 - PCME Concentration
- Rain Event (no rainfall recorded from 5/8/14 - 7/7/14)

* If station result is not present, no detections were noted for this sampling event

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FIGURE 5-3 Ambient Air - Total PCME Concentrations And Rainfall Events
TETRA TECH

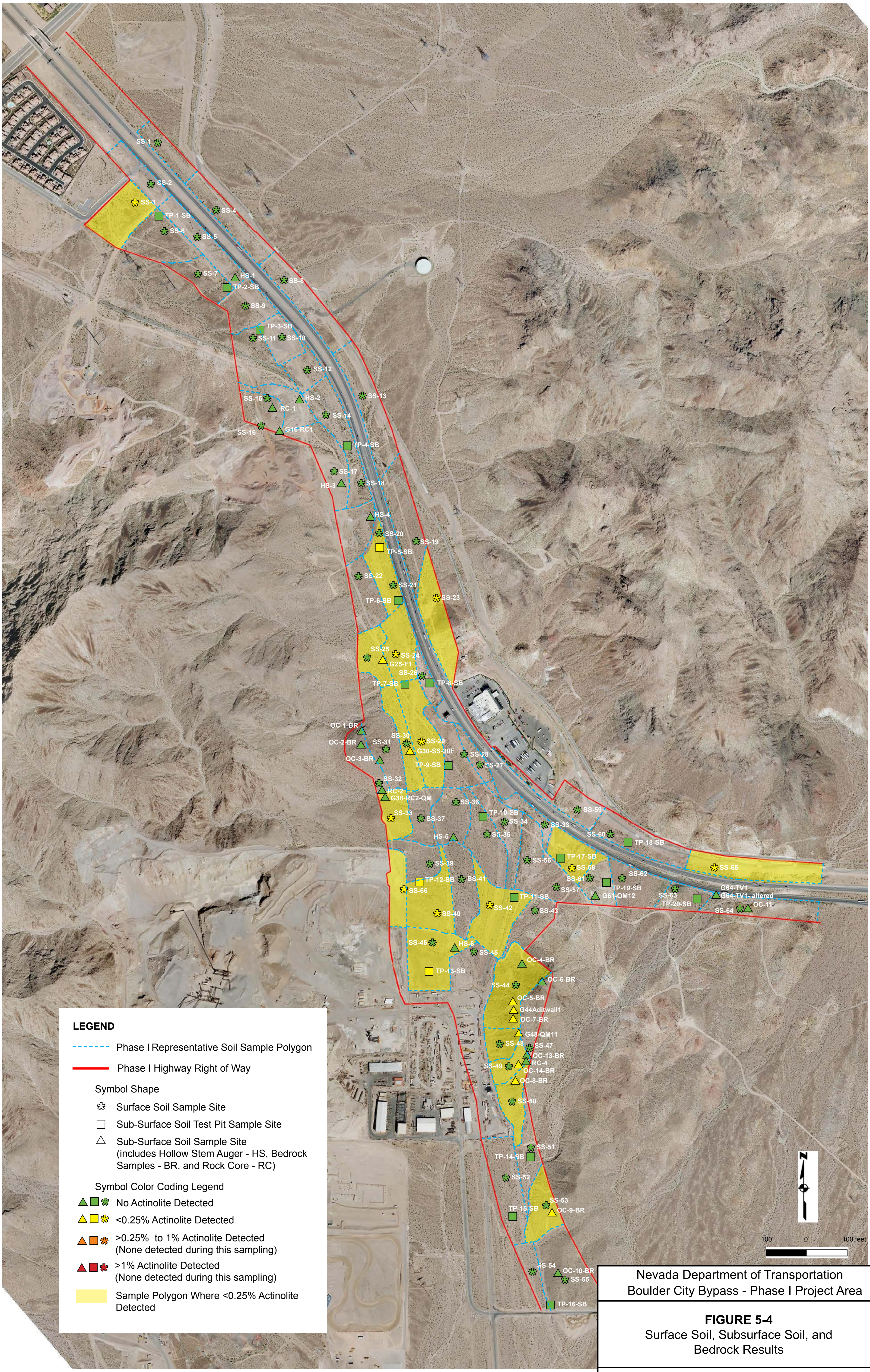

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FIGURE 5-4
Surface Soil, Subsurface Soil, and Bedrock Results

TETRA TECH

APPENDIX A

FIELD FORMS

(CD ONLY)

APPENDIX B

LABORATORY ELECTRONIC DATA DELIVERABLES

(CD ONLY)