

GOLD COUNTRY RECREATIONAL TRAILS AND ABANDONED MINES ASSESSMENT



*A Pilot Study to Assess Exposure Potential to Toxins from Mine Waste
and Naturally Occurring Hazardous Substances*

June 2010





ABOUT THE SIERRA FUND

The Sierra Fund is the only nonprofit community foundation dedicated to the Sierra Nevada. Our mission is to increase and organize public and private investment to protect and restore the region's natural resources and communities. We pursue this mission three ways: through *Advocacy* to bring public funding to the region, *Philanthropy* to provide a vehicle for private funding, and *Strategic Campaigns* that pursue critically needed programs in the Sierra.

Since 2006, the **Mining's Toxic Legacy Initiative** has been our primary strategic campaign. The goal of this Initiative is to assess and address the ongoing impacts of toxins left over from the Gold Rush and subsequent mining in the Sierra Nevada.

In 2009, The Sierra Fund initiated two pilot studies to learn whether people who live, work, or recreate in the Sierra Nevada are being exposed to legacy mining toxins including mercury, arsenic, lead, asbestos and chromium. Results of the study of *Gold Country Recreational Trails and Abandoned Mines Assessment* are presented here. The *2009 Gold Country Angler Mercury Exposure Survey*, which looks at exposure to mercury from eating fish caught in Sierra lakes and rivers, will be released in July 2010. Copies of these documents as well as more information about our work may be obtained online at www.sierrafund.org or by contacting The Sierra Fund directly.

The Sierra Fund
432 Broad Street - Nevada City, CA 95959
(530) 265-8454 - info@sierrafund.org
www.sierrafund.org

ACKNOWLEDGEMENTS

*This study, the Gold Country Recreational Trails and Abandoned Mines Assessment, was funded in part by the Richard and Rhoda Goldman Fund; True North Foundation; The California Endowment; and The California Wellness Foundation.**

Principal Author: Carrie Monohan, Ph.D., The Sierra Fund

Contributors: Kyle Leach, Consulting Scientist, Friends of Deer Creek
Madeline Flandreau, Graduate Student, CSU, Chico
Matt Freitas, AmeriCorps Service Member, Friends of Deer Creek

Reviewers: Wesley Nicks, Nevada County Department of Environmental Health
Jill Pahl, Placer County Dept. of Environmental Health
Tom Quinn, Forest Supervisor, Tahoe National Forest
Randy Adams, CA Department of Toxic Substances Control
John Hillenbrand, US Environmental Protection Agency

Mining Initiative Staff: Elizabeth “Izzy” Martin, The Sierra Fund
Mike Thornton, The Sierra Fund

Editor: Kerry Morse, The Sierra Fund



*Created in 1992 as a private, independent foundation, TCWF's mission is to improve the health of the people of California by making grants for health promotion, wellness education, and disease prevention.

TABLE OF CONTENTS

ABOUT THE SIERRA FUND	1
ACKNOWLEDGEMENTS.....	2
TABLE OF CONTENTS.....	3
ABSTRACT.....	4
INTRODUCTION	5
Abandoned Mines in California.....	5
Chemical Hazards of AML Sites	6
PURPOSE AND SCOPE	9
METHODOLOGY	10
Site Selection	10
Field Methods.....	11
Soil Sampling	12
Laboratory Sample Analysis.....	12
Selection of Laboratory	13
Evaluation of Sample Results and Constituents of Concern.....	14
SAMPLE RESULTS AND DISCUSSION	17
Downieville Area.....	17
Nevada City Area.....	23
Foresthill Area	25
SUMMARY AND RECOMENDATIONS	27
Summary of Results.....	27
Recommendations.....	28
<i>Posted Warnings.....</i>	<i>28</i>
<i>Additional Sampling.....</i>	<i>289</i>
<i>Dust Exposure Study.....</i>	<i>30</i>
<i>Survey of Recreationists.....</i>	<i>31</i>
REFERENCES	32
TABLES AND FIGURES.....	33
APPENDICES	
ALS-Chemex Quality Assurance Overview.....	Appendix A
ALS-Chemex Geochemical Procedure ME-ICP 41	Appendix B
Chain of Custody and Laboratory Reports	Appendix C
Correlations and Summary Statistics between ALS and EPA Data.....	Appendix D
Peer Review Process.....	Appendix E

Gold Country Recreational Trails and Abandoned Mines Assessment

A pilot study to assess potential exposure to toxins from mine waste and naturally occurring hazardous substances by recreationists including off-highway vehicle (OHV) riders, mountain bikers, horseback riders, runners and hikers

ABSTRACT

The physical dangers to recreationists at abandoned mine sites are well known, but the hazards associated with exposure to heavy metals in dust at abandon mine sites are not well understood. This pilot study identified contaminants of concern (COC) at popular recreation areas around Downieville, Nevada City, and Foresthill, CA.

Methods: COCs were defined by the concentration of heavy metals in surface soils samples at levels exceeding secondary screening levels. Secondary screening levels were established in accordance with commonly used environmental exposure thresholds set by State and Federal Agencies. The secondary screening level for arsenic was selected as 270 mg/kg in accordance with the California Department of Toxic Substances Control (DTSC) Empire Mine assessment for a recreational runner. The secondary screening level for lead was selected as 1,000 mg/kg according to the Bureau of Land Management (BLM) camper or ATV driver criteria. The screening levels used in this study were meant to be used in the site assessment process to help identify areas that require further evaluation, and were not meant to be used as cleanup goals or regulatory standards without consideration of site-specific factors and exposure scenarios.

Results: In the Downieville area, Saddleback Road had elevated levels of lead (max. 1,570 mg/kg), the Columbo Mine area had elevated levels of arsenic (max. 442 mg/kg), and Slug Canyon on the North Yuba Trail Extension also had elevated levels of arsenic (max. 439 mg/kg). In the Nevada City area, Banner Mountain Trail and mine waste above Little Deer Creek had elevated levels of arsenic (max. 4,050 mg/kg). In the Foresthill off-highway vehicle (OHV) designated recreation area, lead was at elevated levels in the Marall Chrome Mine (max. 4,790 mg/kg).

In addition to heavy metal contamination, numerous abandoned mine land sites in recreation areas also had asbestos. Asbestos was detected along Saddleback Road adjacent to serpentine rock outcrops, in the Goodyears Bar assessment area, along the Newtown Ditch Trail and in the Foresthill OHV Area including the Marall Chrome Mine pit and on the Loop 4 Trail (max. 40% chrysotile).

Recommended Actions:

1. Post warnings in areas with known contamination,
2. Further assess areas where elevated levels of contaminants were found,
3. Conduct a dust exposure study to determine exposure scenarios of different recreational activities, and
4. Conduct a user survey to inform education of populations at risk of being exposed to contaminated dust during recreational activities in the Gold Country.

INTRODUCTION

A trail assessment was conducted in the Sierra Nevada to provide preliminary information on the potential for human exposure to mining toxins from recreational activities such as off-highway vehicle (OHV) riding, mountain biking, horseback riding, running and hiking. The field investigation was performed during the summer of 2009. Surface soil samples were taken in recreation areas impacted by mine waste or naturally occurring hazardous substances and evaluated to identify contaminants of concern and potentially high risk recreation areas. Based on the soil sample results recommendations were developed to further characterize health risk factors to recreationists at specific locations.

Abandoned Mines in California

The California Department of Conservation (DOC) estimates that there are approximately 47,000 abandoned mine land (AML) sites in California (CDOC, 2000). A large percentage of these AML sites are located on public lands in the Sierra Nevada Region including National Forest, State Park and BLM lands. These public lands are widely used, especially in easily accessible areas like the western slope of the Sierra Nevada. This area is also the heart of the Gold Country. Roads cut 100 years ago to move mining equipment now provide easy access to hundreds of abandoned mines.

Abandoned mines can present significant physical and chemical hazards to recreationists such as hikers and riders of horses, mountain bikes, dirt bikes, all terrain vehicles (ATVs), and other off-highway vehicles (OHVs). In most cases, access to AML sites is unrestricted and hazards are not identified or readily apparent.

Common types of abandoned mines in the Sierra include placer and hydraulic mines and hard rock mines. Hard rock gold mines excavated quartz veins and mineralized rock from deep in the earth, and brought that material to the surface where it was crushed and processed to remove the gold, leaving behind piles of waste rock and processed tailings. Less common but also hazardous abandoned mines include copper- zinc mines which often produce acid mine drainage, and asbestos mines located in areas of serpentine and ultramafic rock.



Physical Hazards of AML Sites

Physical hazards at abandoned mine land (AML) sites include unmarked or concealed shafts or tunnels that result in serious injury and death to recreationists in California on an annual basis. The national Mine Safety and Health Administration's "Stay out Stay Alive" program promotes public awareness of mine hazards and includes efforts to close hazardous mine shafts and tunnels. Physical hazards are comparatively easy and inexpensive to close, so any AML assessment efforts should include identification of significant physical hazards and reporting to the proper authorities.

Chemical Hazards of AML Sites

Chemical hazards at abandoned mine land sites include heavy metals that are hazardous to human health, such as lead and arsenic, but may also include other hazardous materials such as abandoned fuel tanks and asbestos. The effects of chemical hazards are perhaps less immediate than those of physical hazards, but potentially just as serious.

Contaminants at AML sites occur in different ways:

- 1) Mine waste can have elevated concentrations of naturally occurring toxic metals such as arsenic and lead which were disturbed and distributed by the mining process and released into the environment.
- 2) Naturally mineralized soil in areas surrounding gold deposits can contain arsenic at concentrations considered hazardous to human health. Mineralized soil often does not appear different from other soil and can only be identified by laboratory testing.
- 3) Imported chemicals that were used to recover gold can remain in the environment, specifically mercury that was mined in the California Coast Range and brought to the Sierra gold mines and added to placer sediments and crushed ore to recover gold. Consequently a large percentage of the mercury was lost to the environment where it remains today.
- 4) Areas of serpentine and ultramafic rock, which often contain asbestos minerals, that are exposed to the surface can be disturbed by mining-related activities.

AML features present a hazardous attraction to recreationists who may use mine waste piles as jumps or challenging terrain, who may stop to explore shafts or tunnels and who may ride in areas with unmarked physical hazards, such as open shafts. Inhalation and dermal absorption of heavy metals at AML sites is an unknown risk to most recreationists. Recreational activities which likely create fugitive dust at or near AML sites include OHV riding (ATVs, quad runners, dirt bikes and four wheel drive vehicles), mountain biking, horseback riding, running, and hiking. Depending on the conditions, riding over piles of mine waste or on trails with mineralized soil or naturally occurring

asbestos (NOA) creates airborne dust. During wet riding conditions, mud is thrown up and sticks to skin, equipment and cloths. This can result in exposure to toxins through dermal absorption, incidental ingestion or inhalation of dust after the mud dries.



Dust generated in recreation areas is inhaled to some extent by the recreationists themselves, but more often by riders following the lead rider or by secondary exposure to others nearby such as hikers, campers or people who happen to be near trails. Children who are recreating are closer to the ground and may be subject to even higher dust exposure than adults. Furthermore, dust or mud can be tracked into homes or vehicles where exposure of young and more vulnerable household members may occur. Dust at AML sites commonly has elevated levels of arsenic, lead and other heavy metals. Elevated levels of asbestos are also of concern at AML sites or other areas underlain by ultramafic and serpentine rock.

A general discussion of the health effects of commonly-encountered chemical hazards at AML sites is presented below:

Arsenic

Arsenic is a well known carcinogen that causes cancer of the skin, lungs, bladder and kidneys as well as various non-cancerous skin conditions. Arsenic exposure is linked to diseases of the heart, lungs and brain. The bioavailability of arsenic in Sierra Nevada soils (the amount that is absorbed by the human body when ingested) has only recently begun to be studied. The degree of human health risk associated with exposure by inhaling particles during recreational activities has not been studied with respect to the amount of arsenic absorbed and the impact of exposure on human health.

Lead

Lead adversely affects numerous body systems and causes health impairment and disease that arise after periods of exposure as short as days. The frequency and severity of medical symptoms increases with the concentration of lead in the blood. Common symptoms of acute lead poisoning are loss of appetite, nausea, vomiting, stomach cramps, constipation, difficulty sleeping, fatigue, moodiness, headache,

joint or muscle aches, anemia, and decreased sexual drive. Acute health poisoning from uncontrolled occupational exposures has resulted in fatalities.

Asbestos

Asbestos is proven to cause asbestosis, lung cancer, pulmonary fibrosis, mesothelioma and possibly gastrointestinal, colorectal, throat, kidney, esophagus and gallbladder cancers. Asbestos has been classified as a known human carcinogen by the U.S. Department of Health and Human Services, the Environmental Protection Agency, and the International Agency for Research on Cancer (UCD, 2005). Mesothelioma is the most common form of cancer associated with asbestos exposure, and is almost always caused by inhalation of asbestos fibers.

Asbestos is a group of highly fibrous minerals associated with serpentine and ultramafic rock. Minerals containing asbestos, such as chrysotile and tremolite, are found in distinct geological zones across the Sierra Nevada foothills. Serpentine and ultramafic rock from mine waste rock or quarries has been used as aggregate for road surfacing. Marc Schenker, a professor and chair of the UC Davis Department of Public Health Sciences, recently concluded that exposure to naturally occurring asbestos is linked to lung cancer and should be taken seriously (UCD, 2005). Inhalation of asbestos fibers in dust from serpentine rock or soil disturbed during recreational activities may increase a rider's risk of serious lung diseases including asbestosis, lung cancer and mesothelioma, particularly if the rider also smokes cigarettes.

Silica

Silicosis is a form of lung disease caused by inhalation of crystalline silica dust. It causes inflammation and scarring of the lungs or nodular lesions. Humans and horses breathing dust containing silica is a concern in areas that have weathered granitic rock or siliceous sandstone. Silicosis is an occupational hazard and is more common in horses than in riders. It can take up to ten years for symptoms to show, however heavy exposure can result in symptoms occurring in six months to two years.

Mercury

Mercury damages the brain, nerves and the immune system. Mild mercury poisoning causes tingling in the lips, tongue, fingers and toes. In some cases, these symptoms do not appear until long after exposure. Severe mercury poisoning causes headaches, memory loss, difficulty coordinating movement and vision, dizziness, metallic taste in the mouth, muscle spasms, pain and stiffness in joints and muscles, and heart disease. The primary exposure to mercury in the Sierra is by consuming fish contaminated with mercury. The exposure to mercury through inhalation of contaminated dust is less likely though still a concern.

Empire Mine State Park in Grass Valley, California is a well documented example of an area where a mining operation left mine waste and mineralized soil which was identified as a hazard to recreationists and where extensive remedial measures were required. The

park was created from abandoned mine lands in the City of Grass Valley where numerous small and large mines had operated from the 1850s to the 1950s. Environmental investigations directed by Cal/EPA Department of Toxic Substances Control (DTSC) in the 1990s and 2000s identified mine waste rock, mill tailings and naturally occurring soil with elevated metals concentrations exceeding hazardous waste levels. High arsenic concentrations were identified on trail surfaces used by hikers, runners, bicyclists and horseback riders. Several popular trail segments were closed, generating a high level of public concern. The subsequent remediation of the park included excavation and off haul of mine waste and soil, fencing of high risk areas and rerouting or resurfacing of trails.

Similar conditions to those at Empire Mine State Park are likely present on public lands in many locations in the Sierra Nevada Region. The Tahoe National Forest prepared a Motorized Travel Management Draft Environmental Impact Statement (DEIS) dated September 2008 which is currently in the public comment period (TNF, 2008). This document reports that there are currently 96 AML sites within 100 feet of roads and motorized trails in the Tahoe National Forest. Many more AML sites that have not been identified or are mapped as being farther than 100 feet away may also impact roads and trails since mine waste from AML sites is often spread over a large area. Maps included in the DEIS provided a valuable resource for the current study. In most cases, these potentially hazardous trail surfaces have not been identified, investigated or characterized, but nonetheless may present significant risk to recreationists.

A broad scale assessment of this toxic threat to public health is needed to inform users and regulatory agencies and to prioritize risk management decisions.

Preliminary assessment activities such as the current assessment must cover large areas in order to identify critical locations where more detailed information can be collected through soil sampling and dust monitoring.

PURPOSE AND SCOPE

The purpose of this study was to learn whether recreationists may be exposed to toxins from mine waste or naturally occurring hazardous materials on public lands in the Sierra Nevada. The project consisted of the development and implementation of an assessment of recreational trails on public land near abandoned mines which may be contaminated with mine waste or naturally occurring hazardous substances. Information from the assessment was used to identify recreation areas that warrant further assessment, raise awareness about chemical hazards associated with AML sites, and advocate for a risk assessment of recreational activities at AML sites with chemical hazards.

Scope

The *Gold Country Recreational Trails and Abandoned Mines Assessment* was performed in general accordance with the Recreational Trail Survey Protocol document prepared in January 2009 (TSF, 2009). The protocol was intended to inform this assessment and to be a useful document for additional investigations to further characterize recreational

exposure in the Sierra Nevada. The document presents a survey protocol and sampling methodology for conducting assessments. The following activities were performed as part of the Recreational Trails Assessment:

- Research local trail and abandoned mine land databases
- Select target trail and recreation areas for sampling using GIS
- Research recreational use patterns by interviewing users about common activities
- Conduct field investigation by mapping site features, documenting observed recreational activities, and taking surface soil samples
- Coordinate laboratory analysis with chain of custody forms and quality control criteria
- Select threshold criteria based on best available science and limited recreation-specific guidelines to determine potential contaminants of concern
- Compare soil sample results to selected threshold criteria
- Recommend additional field investigations and assessment of trail and recreation areas that have chemical hazards, defined as soils samples with concentrations that are above threshold criteria

METHODOLOGY

Site Selection

Recreation areas in the Sierra region in three different counties (Sierra, Nevada and Placer) were targeted for the *Recreational Trails Assessment*. The three general target areas included the Downieville area in Sierra County, the Nevada City area in Nevada County and the Foresthill area in Placer County.

The assessment's first step was to review available maps, documents, interviews, databases and internet sources to identify mine locations, trails, roadways, and recreation areas, and what activities were popular in the general area. Useful sources of information included the Motorized Travel Management Draft EIR for the Tahoe National Forest, which included detailed road and trail maps; the USGS Mineral Resources, Topographically Occurring Mine Symbols (TOMS), and Principal Areas of Mining Pollution (PAMP) databases; and other historic maps which identify abandoned mine locations. USGS topographic maps, recreational trail maps and guidebooks, and internet sites pertaining to recreational activities were also useful sources of information.

Geographical Information Systems (GIS, Arc View 9.3) was used to identify areas where abandoned mines in the TOMS and PAMP databases were within 30 feet of a recreational trail. This type of analysis is a common GIS query, by which the mapping program to identifies the proximity of two features, in this case a trail layer and a AML feature. The proximity of 30 feet was selected to ensure that AML features adjacent to the trail were captured in the query. In general, most GPS devices are accurate to within one to ten meters, or three to thirty feet. Without using this range, the GIS analysis would only have identified AML features that overlapped with the trail exactly, potentially missing

surrounding features that affect the trail, such as waste rock piles eroding onto the trail but was not mapped right on the trail. This query resulted in over 60 potential sites.

In order to narrow down the number of selected sites, only the sites that were in the most popular recreation areas were selected for sampling. The most popular recreation areas were identified by conducting interviews with ATV, horseback, dirt bike, and mountain bike riders. These interviews were informal and typically included employees and customers at Motor Sports outlets, guide and shuttle service providers, and employees of markets near recreation areas.

Based on the document research, GIS analysis, and interviews, a manageable number of sites/trail segments were selected in the Tahoe National Forest, nearby State Parks, BLM and other publicly accessible lands in the region to conduct the initial assessment.

Several of the selected assessment sites were located in areas that were underlain by geologic formations with naturally occurring asbestos (NOA). Mining activities that disturbed serpentine and ultramafic rock to reach gold-bearing quartz veins may have disturbed and distributed asbestos minerals.

It was not the original intent of this assessment to identify recreation areas with NOA, however when assessing chemical hazards at selected AML sites where recreation occurs it became apparent that a potentially significant human health concern was exposure to asbestos-laden dust. AML sites with NOA were included in the site assessment because dust-generating activities at these sites create a public health concern similar to heavy metal exposure.

Field Methods

The selected sites were accessed by hiking, biking or four wheel drive vehicles. The goal of the site visit was to locate the AML feature that was mapped on or near the recreational trail. On site visits, researchers used field maps that were created with GIS (Arc View 9.3) and were based on USGS Topographic maps, the TOMS and PAMP databases. They also identified trails (using the DEIS Travel Management layers created by the TNF), roadways and recreation areas, and parking/staging areas.

Once the site was located, researchers noted evidence of mine waste or serpentine rock on or near trails or roads, direct observations or evidence of ATV use, soil conditions and access points. Handheld recreational grade GPS units (Garmin Oregon 500) were used to mark AML features, soil sample locations, and potential high risk exposure locations. Field observations of mine features, apparent trail uses such as vehicle tracks, and frequency of use, access and trailhead locations were recorded in field notes. Observations of actual recreational use included number and type of users, dust or mud disturbance, distance between riders, and evidence of recreational use on or near mine waste or serpentine rock outcrops. Photographs were taken of significant AML features, soil sample locations and evidence of potential high risk exposure locations.

Soil Sampling

Representative surface soil sampling locations were selected on trail or roadway surfaces. Surface soil samples were taken any place where mine waste extended onto and/or adjacent to trails or ATV tracks, areas with serpentine rock, or areas where high concentrations of AML sites nearby might indicate mineralized soil. Soil samples were generally obtained from the upper one inch of soil on the trail or the top two to six inches of mine waste in areas which appeared likely to be a source of dust to recreationists.

Soil samples were collected by professional consulting geologist Kyle Leach, who has over 10 years of assessing abandoned mine sites in the northern Sierra region; and project coordinator and Science Director for The Sierra Fund, Dr. Carrie Monohan. Dr. Monohan holds a doctorate in Forest Engineering and Hydrology from the University of Washington, has been working on legacy mining contamination with The Sierra Fund since 2006, and prior to that was the project manager and principal investigator for the City of Nevada City Community Wide Brownfield Assessment, funded and advised by the Environmental Protection Agency Region 9.

Samplers wore disposable latex gloves and dust masks. A disposable plastic scoop was used to collect a four ounce surface sample from the upper six inches of soil. The sampling equipment was decontaminated between samples with a moist disposable towel, and samples were placed into double zip lock baggies and immediately labeled with sample name, type of material, location, date, and sampler. Sample name suffixes were used to identify the type of sample including: TS = trail sample, MS = mine waste sample, and SERP = serpentine. GPS coordinates were obtained (when possible) for all sample locations, and approximate sample locations were also marked on field base maps. Soil sampling data was recorded in field notebooks. The GPS locations of soil samples were mapped using GIS and are presented in Figures 2-12.

Samples were placed and transported in a chilled cooler as soon as possible after collection, at the latest as soon as samplers returned to the vehicles. Samples were transported to the office for temporary storage and subsequently shipped to the analytical laboratories. Chain of custody documentation was maintained from the time the samples were collected until they were received by the analytical laboratory. Field duplicates were not collected as a part of this preliminary sampling effort, however laboratory duplicates are a standard component of the laboratory procedure as described in the ALS Quality Assurance Overview (Appendix A).

Laboratory Sample Analysis

The project coordinator reviewed all sample collection data and chain of custody documents for accuracy and determined constituents of concern prior to preparing an analytical laboratory request. Samples of mine waste or naturally occurring asbestos

from trails adjacent to AML sites were analyzed at ALS Chemex Laboratory in Reno, Nevada and if they were suspected to contain asbestos, at Asbestech Laboratory in Carmichael, California.

The ALS Chemex method is ME-ICP41m which measures 33 elements by Four Acid “Near Total” Digestion and ICP-AES with Quantitative Low Detection Mercury. Requested quantitation limits and associated Preliminary Remediation Goals (PRGs) are listed in the table below. The ALS Quality Assurance Overview is attached as Appendix A. See Appendix B for ALS Chemx lab methods for ME-ICP-41.

Element	Symbol	ALS Chemex Detection Limits (ME-ICP41m) (mg/kg)	EPA Action Level for Residential Soil (mg/kg)
Arsenic	As	2	22*
Barium	Ba	10	5374.91
Beryllium	Be	0.5	154.37
Cadmium	Cd	0.5	37.03
Chromium	Cr	1	210
Cobalt	Co	1	902.89
Copper	Cu	1	3128.55
Mercury	Hg	0.01	23.46
Nickel	Ni	1	1564.28
Lead	Pb	2	150
Antimony	Sb	2	31.29
Thallium	Tl	10	5.16
Vanadium	V	1	78.21
Zinc	Zn	2	23463.18

* US EPA PRG for non-cancer impacts commonly used in this region where background arsenic levels can range from 20-30 mg/kg.

Selected samples from areas of suspected asbestos containing rock (serpentine or ultramafic rock) were split and analyzed for asbestos at Asbestech by the CARB 435 Method. Copies of the analytical laboratory reports and chain of custody documents are attached in Appendix C.

Selection of Laboratory

ALS Chemex is an assay laboratory serving the mining industry and their analytical methods used for this project are not EPA-certified, however the cost of these analyses

are approximately 10% of the corresponding EPA certified Title 22 Metals analysis. The decision to have the samples from the project analyzed by ALS was based on the cost benefit in addition to a review and comparative evaluation of ALS metals results with results from an EPA laboratory.

A laboratory comparison between ALS and EPA was performed in September 2007 as part of the Nevada City's EPA Brownfields Assessment project using the results of 20 split samples which were analyzed at both ALS and an EPA laboratory. The results from the laboratory comparison are included in Appendix D. Comparison of analytical results for specific metal analytes including constituents of concern for the current project such as arsenic, lead, and chromium indicated that ALS results had consistently higher metals concentrations but the data corresponded well for most analytes of interest. Results of arsenic, chromium, nickel and mercury were within an acceptable variance range and were allowed by EPA Quality Assurance and Control to be used "as is" for the Nevada City Brownfields Assessment project. ALS results for lead were consistently higher than EPA results and thus lead results exceeding the Brownfield project goals were required to be verified by analyzing duplicate samples at an EPA-certified laboratory.

Based on the results of the EPA comparative study, ALS Chemex laboratory results were considered usable for this assessment project for the purpose of evaluation of comparative health risks and to prioritize sampling locations for further study. Because the ALS results are consistently high biased, due to a stronger acid digest, the results are considered protective of human health, in that if the data are below threshold levels then there would be no threat to human health. However, analytical data used to develop future site-specific remediation projects warrant verification for specific analytes at an EPA-certified analytical laboratory.

Evaluation of Sample Results and Constituents of Concern

Analytical laboratory results of soil and mine waste samples obtained during the project were reviewed and compared with various regulatory screening levels to evaluate potential constituents of concern (COCs) in project areas (Table 1). Screening levels considered included California Human Health Screening Levels (CHHSLs) prepared by Cal/EPA (Cal/EPA, 2005), Preliminary Remediation Goals (PRGs) prepared by US EPA (EPA, 2009), and Risk Management Criteria for Metals at BLM Mining Sites developed by US Department of the Interior Bureau of Land Management (BLM, 2004).

The selected screening levels were not meant to be used as cleanup goals or regulatory standards without consideration of site-specific factors and exposure scenarios. Rather, they were meant to be used early in the site screening process to help identify areas that required further evaluation.

Element	Symbol	ALS Chemex Detection Limits (ME- ICP41m)	US EPA PRGs for Residential Soil	Cal EPA Industrial CHHSLs	BLM Risk Management Criteria for Recreation	Initial Screening Level	Secondary Screening Level
		(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)
Arsenic	As	2	22	0.24	300	22	270
Chromium	Cr	1	210	100,000		210	100,000
Lead	Pb	2	80	320	1,000	80	1,000
Mercury	Hg	0.01	23.46				

Table 1: Screening Level Criteria

Laboratory data from the current investigation were compared with Cal/EPA's CHHSLs for industrial/commercial sites, US EPA's PRGs for residential and industrial/commercial sites and BLM criteria for mining sites which included screening levels for various recreational exposure scenarios. Site-specific screening levels developed for local AML sites and other factors related to mine waste and naturally occurring hazardous materials were also considered.

Based on a comparison of the metal concentrations in the 84 samples obtained during the subject assessment with established CHHSLs, PRGs and BLM criteria, the following metals are considered constituents of concern: arsenic, chromium and lead. Although no CHHSL has been established for naturally occurring asbestos (NOA), no safe level of asbestos exposure has been documented, thus any detection of NOA in project samples resulted in asbestos being considered a COC as well. Although mercury concentrations detected in site samples did not exceed regulatory screening levels, mercury was also considered a potential COC since detections of elevated mercury concentrations are likely from an anthropogenic source and thus indicate evidence of mining impacts.

This comparative evaluation of sample results, sample locations and apparent amount of recreational use were used to compare the AML site and trail segments in order to prioritize them for further evaluation.

The following paragraphs discuss regulatory screening levels and other factors related to each potential COC identified for the project:

Arsenic

The residential CHHSL for arsenic is 0.07 mg/kg and the industrial CHHSL is 0.24 mg/kg based on the carcinogenic effects of low levels of arsenic. These levels are well below typical background arsenic concentrations in soil in the Sierra Nevada region which commonly range to 20 mg/kg or higher. A screening level considered for this evaluation is the US EPA PRG for non-cancer health impacts of 22 mg/kg. A recreational exposure assessment performed by DTSC at the Empire Mine State Park in Grass Valley, CA established a site specific goal of 270 mg/kg which was determined based on assumed exposure to a recreational runner using park trails. The BLM criteria for exposure to a recreational ATV rider is 300 mg/kg.

This evaluation assumes the non-cancer PRG of 22 mg/kg arsenic an initial screening level and DTSC's site-specific recreational runner exposure level of 270 mg/kg a secondary screening level.

Chromium

Chromium has two valence states for which CHHSLs have been established. The residential and industrial CHHSL for Trivalent Chromium (Cr³⁺) is 100,000 mg/kg. The residential CHHSL for Hexavalent Chromium (Cr⁶⁺) is 17 mg/kg. The industrial CHHSL for total Chromium is 37 mg/kg. This evaluation considers the US EPA PRG for total chromium of 210 mg/kg which assumes a Cr³⁺ to Cr⁶⁺ ratio of 6 to 1. Cr⁶⁺ is a relatively unstable form of chromium which typically degrades to the Cr³⁺ state over time in the environment. Evaluations of numerous mine waste sites in the Sierra Nevada region suggest most total Chromium in mine waste is in the form of Trivalent Chromium (Cr³⁺). Speciation of Chromium requires a separate analysis for Cr⁶⁺ which is relatively expensive and for the current project would require re-sampling due to a short sample hold time. Cr⁶⁺ analysis was not performed during this investigation. However, ongoing research to speciate chromium and other metals from this project's assessment areas is being performed by a Chico State University graduate student in coordination with this project (results anticipated by Fall 2010).

This evaluation assumes the PRG for total chromium of 210 mg/kg an initial comparative screening level and the CHHSL for Cr³⁺ of 100,000 mg/kg a secondary comparative screening level.

Lead

Cal/EPA has recently lowered the residential CHHSL for lead from 150 mg/kg to 80 mg/kg. The industrial/commercial CHHSL has been lowered to 320 mg/kg. The US EPA PRG is 400 mg/kg for residential sites and 800 mg/kg for industrial/commercial sites. The BLM criteria for a camper or ATV rider is 1,000 mg/kg.

This evaluation assumes the residential CHHSL of 80 mg/kg of lead an initial comparative screening level and the BLM camper or ATV driver criteria of 1,000 mg/kg a secondary comparative screening level.

Asbestos

No safe level of asbestos exposure has been established, thus any detection indicates a potential health risk to exposed populations. Health risk generally increases with exposure concentration.

This evaluation assumes any asbestos detection an initial comparative screening level and 10% asbestos a secondary comparative screening level.

SAMPLE RESULTS AND DISCUSSION

The following sections summarize the comparative evaluation of the soil sample results to the selected screening levels for the constituents of concern. Eleven target areas selected for site visits, soil sampling and assessment are grouped into three general geographic areas: Downieville, Nevada City, and Foresthill.

It is important to note that no informational signs were observed in any location that was surveyed warning about the potential presence of toxic heavy metals or naturally occurring asbestos around abandoned mines.

Figure 1 (p 35) is a Project Location Map showing the eleven target areas, major roadways and population centers. Figures 2 through 12 indicate specific site investigation areas and approximate sample locations, while Tables 2-12 indicate sample results (pp 36-57).

Downieville Area

Eureka Diggings

The Eureka Diggings assessment area is located approximately five miles northwest of Downieville in Sierra County. It is accessed from State Highway 49, Cal-Ida Road, and Eureka Diggings Road. The reference map for the area is the USGS Goodyears Bar Quadrangle Topographic Map.

Field investigation activities at Eureka Diggings were performed on May 12, 2009. The site was accessed by four wheel drive truck and foot. Observed evidence of mining included extensive placer and hydraulic mining features including numerous piles of fine and coarse-grained quartz-rich placer deposits and occasional disturbed shale bedrock. Excavated pits and irregular topography were prevalent. Eroded hillsides surrounded the diggings area.

The area is popular for OHV riders including ATVs and dirt bikes. The Bee Tree Staging Area is located in the northeastern portion of the diggings area and is a well know staging area for nearby mountain bike routes. Numerous vehicle tracks were observed on and off established routes including on muddy low lying areas and up steep eroding



slopes apparently used as play areas. During the field investigation, several dirt bikers were observed in the Eureka Diggings area. Thirteen soil and mine waste samples were obtained from tracked areas on placer mine waste and low lying areas prone to mud and dust disturbance. Figure 2 is a sample location map of the area. Table 2 summarizes the results of soil sample analysis.

Analytical results of the 13 samples obtained from the Eureka Diggings assessment area indicated that arsenic was detected in one sample at over 22 mg/kg but no samples exceeded 270 mg/kg. Chromium exceeded 210 mg/kg in three samples but none exceeded 100,000 mg/kg. Lead did not exceed 80 mg/kg in any sample. No samples were analyzed for NOA since no serpentine rock was observed.

The results of this comparative evaluation suggest no sample locations warrant further evaluation.

Saddleback Road

The Saddleback Road assessment area is located approximately three miles northwest of Downieville in Sierra County. It is accessed from Highway 49 and Saddleback Road which consists of a graded dirt surface road in the investigation area. The reference map for the area is the USGS Downieville Quadrangle Topographic Map.

Field investigation activities were performed on May 12, 2009. The site was accessed by four wheel drive truck and foot. Several hard rock and placer gold mines are located along the road including the Monte Christo and White Bear Mines. Observed evidence of mining included mine waste extending to the edge of the roadway and possible use of



mine waste rock as road surfacing material. Serpentine rock was observed outcropping adjacent to the roadway in the northern portion of the accessed area. The area is used by mountain bikers, OHV riders, and four wheel drive vehicles to access popular routes to the north and west of Downieville. During the field investigation only sparse vehicle traffic was observed, likely because higher elevation recreation areas were not accessible at the time due to spring snow pack.

A total of six samples were obtained from the Saddleback Road area including three from apparent mine waste adjacent to roads and three from the road surface in mined areas or adjacent to serpentine rock. Figure 3 is a sample location map of the area. Table 3 summarizes the results of soil sample analysis.

Analytical results of the six samples obtained

from the Saddleback Road assessment area indicated that arsenic was detected in three samples at over 22 mg/kg but no samples exceeded 270 mg/kg (maximum of 54 mg/kg). Chromium exceeded 210 mg/kg in two samples and exceeded 1,000 mg/kg in one sample but no samples exceeded 100,000 mg/kg in any sample (maximum of 1,180 mg/kg). Lead exceeded 80 mg/kg and 1,000 mg/kg in one sample (1,570 mg/kg). Asbestos was detected at 14% chrysotile in the one sample analyzed for asbestos.

Based on a comparative evaluation of sample results from the Saddleback Road assessment area, lead is a COC at the sample SB-MS2 location (mine waste at the Monte Christo Mine). Asbestos is a COC at the sample SB-TS5 location (on Saddleback Road adjacent to serpentine rock outcrops in the northern portion of the assessment area).

Downieville East

The Downieville East assessment area which includes Downieville Mountain Bike trails and the Big Boulder Trail is located approximately nine miles northeast of Downieville in Sierra County. It is accessed from Packer Saddle Road. The reference maps for the area are the USGS Gold Lake and Sierra City Quadrangle Topographic Maps.

Field investigation activities were performed on June 13, 2009. The site was accessed by four wheel drive truck, foot and mountain bike. Several hard rock gold mines are located in the area including the Wallis Mine, the Willoughby Mine, and unnamed mines. Observed evidence of mining included excavated areas and collapsed shafts or tunnels, mine waste rock, and mineralized soil.

The Pacific Crest Trail crosses higher elevations in the eastern portion of the area. The area is crossed by several routes of the popular Downieville Downhill mountain bike trail system. Packer Saddle in the southern portion of the area is the main trailhead for mountain bike rides and the drop off point for commercial shuttle services out of Downieville. Numerous mountain bike riders were observed on trails during the field investigation as well as occasional ATVs and dirt bikes on Forest Service roads.

Ten samples were obtained from the Downieville East assessment area including three mine waste rock samples near trails or roads and seven trail surface samples near mines or in areas of mineralized soil. Figure 4 is a sample location map of the area. Table 4 summarizes the results of soil sample analysis.



Analytical results of the ten samples obtained from the Downieville East assessment area indicated that arsenic was detected in four samples at over 22 mg/kg but no samples exceeded 270 mg/kg (maximum of 66 mg/kg). Chromium did not exceed 210 mg/kg in any of the samples. Lead exceeded 80 mg/kg in one sample but did not exceed 1,000 mg/kg in any of the samples (maximum of 963 mg/kg). No samples were analyzed for NOA since no serpentine rock was observed.

Based on a comparative evaluation of sample results from the Downieville East assessment area, no COCs exceeded secondary comparative screening levels.

Columbo Mine

The Columbo Mine assessment area is located approximately two miles northwest of Sierra City in Sierra County. It is accessed from Highway 49 and Sierra Buttes Road. The reference map for the area is the USGS Sierra City Quadrangle Topographic Map.

Field investigation activities were performed on June 13, 2009. The site was accessed by two wheel drive vehicle and foot. The area is occupied by several hard rock gold mines including the Columbo Mine and the Monarch Mine. Dirt surfaced roads in the area are used by OHV and mountain bike riders. Observed evidence of mining included a mine tunnel and large piles of mine waste rock extending to the road area, some of which showed OHV tracks.

Four samples were obtained from the Columbo Mine assessment area including two from trails or road surfaces adjacent to mine waste and two from mine waste in accessible areas. Figure 5 is a sample location map of the area. Table 5 summarizes the results of soil sample analysis.

Analytical results of the four samples obtained from the Columbo Mine assessment area indicated that arsenic was detected in three samples at over 22 mg/kg and in two samples exceeding 270 mg/kg (maximum of 442 mg/kg). Chromium exceeded 210 mg/kg in all four of the samples but did not exceed 100,000 in any sample (maximum of 1,365 mg/kg). Lead exceeded 80 mg/kg in one sample but did not exceed 1,000 mg/kg in any sample (maximum of 129 mg/kg). No samples were analyzed for asbestos since no serpentine rock was observed.

Based on a comparative evaluation of sample results from the Columbo Mine assessment area, arsenic is a COC at the sample CM-MS2 and CM-MS3 locations (mine waste rock near trails at the Columbo Mine AML site west of Sierra City).

Downieville First Divide

The Downieville First Divide assessment area is located approximately one to two miles northeast of Downieville in Sierra County. It is accessed from Lavezzola Road in Downieville. The reference map for the area is the USGS Downieville Quadrangle Topographic Map.

Field investigation activities were performed on June 14, 2009. The site was accessed by two wheel drive vehicle, foot and mountain bike. Several hard rock and placer gold mines are located in the area. Observed evidence of mining included mine waste near mapped mine locations and prospects, and areas of mineralized soil.

The area is located in the lower portion of the very popular Downieville Downhill mountain bike trail system where several trails merge as they near Downieville. Numerous mountain bike riders were observed on the trails, often riding in groups and traveling at high speed.

Six samples were obtained from trails in the Downieville First Divide assessment area adjacent to apparent mine waste or mineralized soil. Figure 6 is a sample location map of the area. Table 6 summarizes the results of soil sample analysis.

Analytical results of the six samples obtained from the Downieville First Divide assessment area indicated arsenic was detected in three samples at over 22 mg/kg but did not exceed 270 mg/kg in any of the samples (maximum of 69 mg/kg). Chromium did not exceed 210 mg/kg in any of the samples. Lead did not exceed 80 mg/kg in any of the samples. No samples were analyzed for asbestos since serpentine or ultramafic rock was not observed.



Based on a comparative evaluation of sample results from the Downieville First Divide assessment area, no COCs were identified for recreational use.

Downieville West

The Downieville West assessment area is located approximately one to two miles southwest of Downieville in Sierra County. It is accessed from a trailhead on the south side of the North Yuba River in Downieville. The reference map for the area is the USGS Downieville Quadrangle Topographic Map.

Field investigation activities were performed on June 14, 2009. The site was accessed by foot and mountain bike. The site is located on the recently completed North Yuba Trail Extension which goes from Downieville to Goodyears Bar above the south side of the North Yuba River. Observed evidence of mining included two mine tunnels which appeared to have been recently sealed with hardened foam and bat grates, from which a small drainage discharge and mine waste rock extends across the trail.

The area is used by hikers and mountain bike riders. No riders were observed during the field visit, however a sign indicating the trail had not yet been completed may have discouraged riders. It is likely that the trail will see increased future use in the popular Downieville mountain bike trail system.

Four samples were obtained from the Downieville West assessment area including two from the trail surface adjacent to mine waste, one of mine waste near the trail edge, and one from mineralized soil on the trail. Figure 7 is a sample location map of the area. Table 7 summarizes the results of soil sample analysis.

Analytical results of the four samples obtained from the Downieville West assessment area indicated that arsenic was detected in three samples at over 22 mg/kg and two samples exceeded 270 mg/kg (maximum of 439 mg/kg). Chromium exceeded 210 mg/kg in one of the samples but did not exceed 100,000 mg/kg (maximum of 983mg/kg). Lead did not exceed 80 mg/kg in any of the samples. No samples were analyzed for asbestos since no serpentine rock was observed.

Based on a comparative evaluation of sample results from the Downieville West assessment area, arsenic is a COC at the SC-TS1 and SC-MS2 sample locations (trail surface and adjacent mine waste in Slug Canyon on the North Yuba Trail Extension approximately ¾ mile southwest of Downieville).



Goodyears Bar

The Goodyears Bar assessment area is located approximately five miles west of Downieville in Sierra County. It is accessed from Highway 49, Mountain House Road and the North Yuba Trail. The reference map for the area is the USGS Goodyears Bar Quadrangle Topographic Map.

Field investigation activities were performed on June 14, 2009. The site was accessed by foot. The North Yuba Trail is a popular hiking and mountain biking trail which crosses an approximately one quarter mile wide section of serpentine rock which forms the trail surface in this area. No evidence of mining was observed along the trail, however, the potential for naturally occurring asbestos in the serpentine rock prompted the investigation.

Two samples were obtained for serpentine soil and fractured rock on the North Yuba Trail surface. Figure 8 is a sample location map of the area. Table 8 summarizes the results of soil sample analysis.

Analytical results of the two samples obtained from the Goodyears Bar assessment area indicated arsenic was not detected in any of the samples at over 22 mg/kg. Chromium exceeded 210 mg/kg but did not exceed 100,000 mg/kg in either sample (maximum of 1,835 mg/kg). Lead did not exceed 80 mg/kg in any of the samples. Asbestos was detected in both samples at 15% chrysotile and 11% chrysotile.

Based on a comparative evaluation of sample results from the Goodyears Bar assessment area, chrysotile asbestos is a COC at the DV-TS8 SERP and DV-TS9 sample locations (North Yuba Trail approximately one half mile west of Mountain House Road).

Nevada City Area

Nevada City West

The Nevada City West assessment area includes several individual areas to the north and west of Nevada City including the Tribute Trail, Newtown Ditch Trail, relatively new trails in the Manzanita Diggings area and trails in the Round Mountain area. These areas are accessed from Champion Mine Road (Tribute and Newtown Ditch), State Highway 20 (Manzanita Diggings) and Rock Creek Road (Round Mountain). The reference map for the area is the USGS Nevada City Quadrangle Topographic Map.

Field investigation activities were performed on August 3 and 4, 2009. The sites were accessed by two wheel drive vehicle, foot and mountain bike. Trails in the area are popular and used by hikers, mountain bikers and horseback riders. Numerous hard rock, placer and hydraulic gold mines are located in the Nevada City assessment areas. Observed evidence of mining included hard rock mine waste rock adjacent to the Tribute Trail, hydraulic and placer mine waste in the Manzanita Diggings and mine prospect excavations and mounded soil adjacent to the Round Mountain Trail. Serpentine and ultramafic rock outcrops were observed along the Newtown Ditch Trail.

Eleven samples were obtained from the Nevada City West assessment areas including two trail surface samples adjacent to apparent mine waste on the Tribute Trail, three trail samples adjacent to serpentine or ultramafic rock on the Newtown Ditch Trail, three trail samples and one placer mine waste sample on the Manzanita Diggings and two trail samples at mine prospects on the Round Mountain Trail. Figure 9 is a sample location map of the area. Table 9 summarizes the results of soil sample analysis.

Analytical results of the 11 samples obtained from the Nevada City West assessment area indicated that arsenic was detected in three of the samples at over 22 mg/kg but did not exceed 270 mg/kg in any of the samples (maximum of 49 mg/kg). Chromium exceeded 210 mg/kg but did not exceed 100,000 in any sample (maximum of 2,370 mg/kg). Lead

did not exceed 80 mg/kg in any of the samples. Asbestos was detected in both samples analyzed for asbestos at 15% tremolite and 10% tremolite.

Based on a comparative evaluation of sample results from the Nevada City West assessment area, tremolite asbestos is a COC at the NC-TS20 and NC-TS22 sample locations along the Newtown Ditch Trail.

Nevada City East

The Nevada City East assessment area includes several trails and adjacent areas including the Gracie Mine, Cascade Ditch and Banner Mountain. These trails are located within approximately one to two miles southeast of Nevada City and are accessed by Gracie Road and Banner Mountain Trail. The reference maps for the area are the USGS Grass Valley and Chicago Park Quadrangle Topographic Maps.

Field investigation activities were performed on July 17, 2009 and August 7, 2009. The sites were accessed by two wheel drive vehicle, foot and mountain bike. Numerous hard rock and placer gold mines are present in the assessment area. The Gracie Mine is located at a trailhead for the D-S Canal Trail used by cross-country runners (Nevada Union High School XC Team) and hikers. The Gracie Road Trail is a newly constructed mountain bike trail located parallel to Gracie Road. Banner Mountain Trail is a dirt surfaced roadway accessed by residents, hikers, mountain bike riders and OHV users. The road accesses the Cascade Ditch Trail.

The Cascade Ditch Trail is a popular hiking, mountain biking and horseback riding trail used by local residents. Observed evidence of mining included hard rock mine waste rock adjacent to the Gracie Mine, placer mine features and mineralized soil along the Gracie Road Trail, hard rock mine waste along Banner Mountain Trail and possibly incorporated in the road surfacing material, and mineralized soil and mine prospects along the Cascade Ditch Trail.

A total of 15 samples were obtained from the Nevada City East assessment area including three trail samples in the Gracie Mine D-S Canal area, four trail samples adjacent to apparent mine waste along an access trail between Gracie Road and the Cascade Ditch, two road surface samples and one mine waste rock sample along Banner Mountain Trail, and one sample of mineralized soil along the Cascade Ditch above Banner Mountain Trail. Figure 10 is a sample location map of the area. Table 10 summarizes the results of soil sample analysis.



Analytical results of the 15 samples obtained from the Nevada City East assessment area indicated that arsenic was detected in 11 of the samples at over 22 mg/kg and exceeded 270 mg/kg in two of the samples (maximum of 4,050 mg/kg). Chromium did not exceed 210 mg/kg in any of the samples. Lead exceeded 80 mg/kg in one sample but did not exceed 1,000 mg/kg in any sample (maximum of 90 mg/kg). No samples were analyzed for asbestos since no serpentine rock was observed.

Based on a comparative evaluation of sample results from the Nevada City East assessment area, arsenic is a COC at the NC-TS24 and NC-TS25 sample locations (dirt road surface on Banner Mountain Trail and mine waste at the top of a steep slope between the road and Little Deer Creek approximately 2.5 miles southeast of Nevada City).

Foresthill Area

Foresthill OHV Area

The Foresthill OHV Area is located approximately eight miles northeast of Foresthill in Placer County. It is accessed from Foresthill Divide Road and Sugar Pine Road or Finning Mine Road and the Sugar Pine Staging Area. The reference maps for these areas are the USGS Foresthill and Dutch Flat Quadrangle Topographic Maps.

Field investigation activities were performed on June 1, 2009. The site was accessed by four wheel drive vehicle and foot. The area is a popular OHV use area and numerous established trails used by ATVs and dirt bikes cross the area. The Marall Chrome Mine is located in the OHV Area. Serpentine and ultramafic rock outcrops are located in the western portion of the Foresthill OHV Area.

The Marall Chrome Mine was observed to be an open pit mine roughly 800 feet long by 300 feet wide and up to 30 or more feet deep. Much of the base and sidewalls of the pit appeared to be composed of serpentine and ultramafic rock with some areas of apparent fibrous serpentine exposure.

OHV tire tracks crossed much of the pit area including mounded soil in the center of the pit which appeared to be used as a play area. The Marall Chrome Mine pit is also used as a public shooting range for target practice. Numerous shell casings and used targets were spread around the pit. A group of people using the area as a shooting range were observed during a second site visit on September 3, 2009.



Marall Chrome Mine pit

Serpentine and ultramafic rock outcrops and trail surfaces were also observed in areas extending to the northwest of the Marall Chrome Mine including portions of the Loop 4 Trail. Several ATVs and dirt bikes were observed using the area including a small boy on a mini ATV following closely behind an adult on a dirt bike and clearly being exposed to fugitive dust in a serpentine area.



Marall Chrome Mine pit

Ten samples were obtained from the Foresthill OHV Area including three from trail surfaces and three from apparent mine waste in the Marall Chrome Mine pit, four from serpentine or ultramafic rock trail surfaces in the Loop 4 area and one from soil on a trail immediately north of the Sugar Pine Staging Area. Figure 11 is a sample location map of the area. Table 11 summarizes the results of soil sample analysis.

Analytical results of the ten samples obtained from the Foresthill OHV Area assessment area indicated that arsenic was not detected in any of the samples at over 22 mg/kg. Chromium exceeded 210 mg/kg in ten of the samples and 1,000 mg/kg in eight of the samples but did not exceed 100,000 mg/kg in any sample (maximum of 9,220 mg/kg). Lead exceeded 80 mg/kg in five of the samples and exceeded 1,000 mg/kg in three of the samples (maximum of 4,790 mg/kg). Chrysotile asbestos was detected in all seven samples analyzed for asbestos and at over 10% in six of the samples (maximum of 40% chrysotile).

Based on a comparative evaluation of sample results from the Foresthill OHV Area assessment area, lead is a COC at the FS-TS5 SERP, FS-TS7, FS-TS8 SERP and FS-MS-9 sample locations (in the Marall Chrome Mine pit in and down slope of areas used for target practice). Chrysotile asbestos is a COC at the FS-TS1 SERP, FS-TS2 SERP, FS-TS3 SERP, FS-TS4 SERP, FS-TS5 SERP, FS-MS6 SERP and FS-TS8 SERP sample locations (in the Marall Chrome Mine pit and on trails crossing serpentine and ultramafic rock located to the northwest of the Marall Chrome Mine including the Loop 4 trail).

Michigan Bluff/ Western States Trail

The Michigan Bluff/ Western States Trail assessment area is located in and around the small town of Michigan Bluff approximately five miles east of Foresthill in Placer County. It is accessed from Foresthill Road and Michigan Bluff Road. The reference map for the area is the USGS Michigan Bluff Quadrangle Topographic Map.

Field investigation activities were performed on June 1, 2009. The site was accessed by two wheel drive vehicle and foot. The Western States Trail, used for the annual ultradistance run and the Tevis Cup long distance horseback ride and by hikers and mountain bikers crosses through the town and local roads and trails. Large placer and hydraulic mining operations are present in the Michigan Bluff area. Erosion features and placer mine waste were observed near the town and along the Western States Trail route.

Three samples were obtained from the Michigan Bluff/ Western States Trail assessment area including trail surfaces adjacent to placer mine features in the Michigan Bluff area and near a mapped AML site on the Foresthill Divide Loop Trail. Figure 12 is a sample location map of the area. Table 12 summarizes the results of soil sample analysis.

Analytical results of the three samples obtained from the Michigan Bluff/ Western States Trail assessment area indicated arsenic was detected in one of the samples at over 22 mg/kg but did not exceed 270 mg/kg in any samples. Chromium exceeded 210 mg/kg in two of the samples but did not exceed 100,000 mg/kg in any of the samples (maximum of 375 mg/kg). Lead did not exceed 80 mg/kg in any of the samples. No samples were analyzed for asbestos since no serpentine rock was observed.

Based on a comparative evaluation of sample results from the Michigan Bluff/ Western States Trail assessment area, no COCs were identified.

SUMMARY AND RECOMENDATIONS

The 2009 Recreational Trails and Abandoned Mine Assessment of mine waste and naturally occurring asbestos areas identified contaminants of concern (COC) in popular recreation areas. Comparison of soil sample results with various screening levels established by State and Federal Agencies identified arsenic, lead and asbestos as COCs associated with recreational activities near particular abandoned mines in the Sierra Region. The following specific locations in Downieville, Nevada City and Foresthill were identified as having constituents of concern above the secondary screening level and therefore present a potential threat to recreationists.

Summary of Results

Downieville Area

- In the Saddleback Road assessment area (Figure 3), lead is a COC in mine waste at the Monte Christo Mine (sample SB-MS2 location). Asbestos is a COC along Saddleback Road adjacent to serpentine rock outcrops in the northern portion of the assessment area (SB-TS5 location).
- In the Columbo Mine assessment area (Figure 5), arsenic is a COC in mine waste rock near trails at the Columbo Mine AML site west of Sierra City (sample CM-MS2 and CM-MS3 locations).
- In the Downieville West assessment area (Figure 7), arsenic is a COC for the trail surface and adjacent mine waste in Slug Canyon on the North Yuba Trail Extension approximately $\frac{3}{4}$ mile southwest of Downieville (sample SC-TS1 and SC-MS2 locations).

- In the Goodyears Bar assessment area (Figure 8), chrysotile asbestos is a COC along the North Yuba Trail approximately one half to one mile west of Mountain House Road (sample DV-TS8 SERP and DV-TS9 locations).

Nevada City Area

- In the Nevada City West assessment area (Figure 9), tremolite asbestos is a COC along the Newtown Ditch trail (sample NC-TS20 and NC-TS22 locations).
- In the Nevada City East assessment area (Figure 10), arsenic is a COC on the dirt road surface on Banner Mountain Trail and mine waste above Little Deer Creek approximately 2.5 miles southeast of Nevada City (sample NC-TS24 and NC-TS25 locations).

Foresthill Area

- In the Foresthill OHV Area assessment area (Figure 11), lead is a COC in the Marall Chrome Mine pit in and down slope of areas used for target practice (sample FS-TS5 SERP, FS-TS7, FS-TS8 SERP and FS-MS-9 locations). Chrysotile asbestos is a COC in the Marall Chrome Mine pit and on trails crossing serpentine and ultramafic rock located to the northwest of the Marall Chrome Mine including the Loop 4 trail (sample FS-TS1 SERP, FS-TS2 SERP, FS-TS3 SERP, FS-TS4 SERP, FS-TS5 SERP, FS-MS6 SERP and FS-TS8 SERP locations).

Recommendations

Results from the *Recreational Trails and Abandoned Mines Assessment* show an urgent need for the following measures:

1. Clear, visible advisories in areas that are known to be contaminated
2. Additional sampling of contaminated areas using EPA-certified laboratories
3. A dust exposure study that considers exposure scenarios of different recreational activities
4. A survey of recreationists to inform outreach to populations at risk of being exposed to contaminated dust during recreational activities in the Gold Country

Posted Warnings about Risk of Dusty Activities

Where dangerous levels of heavy metals or naturally occurring asbestos (NOA) have been found around trails that go through abandoned mines on public land, informational notices of the presence of these hazards should be immediately posted. Simple, clear and compelling public information materials need to be created and displayed on trails and trail staging areas in these areas. This information should also be added to websites, maps and other public education materials created by the public agency that is responsible for managing the lands around abandoned mines that have been to have contaminants of concern on site.

In particular, the trails around the Marall Mine should be posted immediately so people recreating in the area are aware of the high levels of lead, arsenic and naturally occurring asbestos on and around the trails.

Additional Sampling

Additional sampling and assessment efforts are recommended in areas where contaminants of concern were detected above secondary screening levels. Screening levels were not meant to be used as cleanup goals or regulatory standards but were meant to inform future sampling efforts. Site specific factors and exposure scenarios influence regulatory and human health thresholds of different contaminants. This analysis is meant to be used as a preliminary screening process to help determine sites with potential constituents of concern that are in need of further evaluation.

Additional soil sampling and analysis is needed in order to confirm preliminary results and to provide more detailed and comprehensive information to inform risk management decisions. Specific areas where additional sampling and analysis is recommended include:

- Additional lead sampling in the Marall Chrome Mine pit and down slope areas is warranted to define the extent of lead contamination and whether impacts to Pagge Creek are occurring. Additional lead analysis should be performed using EPA laboratory methods since the ALS Chemex laboratory has a high bias for lead analysis.
- Additional sampling and analysis for naturally occurring asbestos is warranted in areas of the Foresthill OHV Area, particularly in areas surrounding the Marall Chrome Mine, along Loop 4 trail and in other areas underlain by serpentine and ultramafic rock.
- Other areas warranting additional NOA sampling include areas along Saddleback Road in the Downieville area, the North Yuba Trail in the Goodyears Bar area, and the Newtown Ditch Trail in the Nevada City area.
- Areas warranting additional sampling for arsenic include the dirt road surface of Banner Mountain Trail in the Nevada City area, and mine waste at the Columbo Mine site in the Downieville area. Arsenic detected in the Slug Canyon area of the North Yuba Trail Extension near Downieville is apparently limited in extent and along a new, moderately used trail and thus may be less of a priority for additional investigation.

Additional samples should be analyzed at an EPA-certified lab and the results used to inform the development of a risk assessment for specific sites. Sites with a significant risk to human health will need remediation action plans approved by the California Department of Toxic Substances Control (DTSC). Future field sampling efforts should include 10% field duplicates.

Dust Exposure Study

During recreational activities, the primary exposure routes to contaminants in mine waste are likely through inhalation of dust and dermal contact. Dust monitoring is recommended to quantify dust exposure to specific COCs for recreational activities at the sites identified above so that a risk assessments and remediation action plans can be developed for high risk sites.

A dust exposure study should show whether different types of recreational activities result in different levels of dust exposure. Understanding the dust generated in different exposure scenarios will help quantify the levels of exposure to different user groups and can be used to inform the creation of a remediation action plan.

- It may be that OHVs generate the most dust among recreationists due to their higher rate of travel, tire surface area, and vehicle weight.
- Horseback riders report the amount of dust generated varies considerably from horse to horse since some horses kick up more dust than others. Horses generally kick up the most dust during downhill riding and lead horse riders are often exposed to dust due to the relatively slow rate of travel.
- Hikers and campers generate relatively little dust but may be exposed to dust from other recreationists' activities in high use or multiple use areas. Recreationists who camp near dusty areas are potentially exposed to elevated levels of contaminated dust because dust plumes linger and drift with prevailing air currents, prolonging exposure time and areal extent. DTSC's dusty road study found asbestos dust remained airborne after all visible dust had attenuated (DTSC, 2005).

In addition, understanding the effectiveness of precautionary measures, such as dust masks or increasing the distance between riders, is an important component of a dust study and may help protect sensitive populations. Children on small ATVs were observed riding within the dust cloud of leading adults. Riders who follow ATVs or dirt bikes may be exposed to more dust than the lead rider and increasing the distance between riders may reduce dust exposure. Dust masks or other dust breathing protection may also help reduce exposure to contaminated dust.

Dust monitoring activities should be performed by qualified professionals with adequate health and safety training and protective equipment. In preliminary discussions, DTSC staff have expressed interest in advising, assisting, or participating in future dust monitoring activities identified by this study. County staff should also be consulted and included prior to a dust exposure study at AML sites in the Sierra.

The results from a dust study, including both recreational activities resulting in the highest risk of exposure and the effectiveness of precautionary measures, is a critical component of a comprehensive risk assessment.

Survey of Recreationists

A survey of recreationists is recommended for areas identified in this study, as well as in other areas of the Sierra where recreational activities may result in human exposure to mine toxins or naturally occurring asbestos.

Interview questions which may be included in a *Recreationist Survey* include:

- How often do you ride?
- Where do you ride?
- How long do you ride each time?
- Do you ride in groups, how many in a group, how far apart do you ride?
- Do you use dust protection?
- What time of year is dust most prevalent?
- Are you aware of toxins in mine waste, asbestos and their related health issues?

Surveys should focus on the highest risk activities including OHV use, horseback riding and to a lesser extent mountain bike riding. Survey interviews should be conducted at any location where willing participants can be located. Because of the transient nature of the target use groups, promising locations for the survey interviews include local staging areas or parking areas where ATV trailers, vehicles with bike racks or horse trailers are known to park such as the Sugar Pine Staging Area in the Foresthill OHV Area and trailheads for the Newtown Ditch Trail and North Yuba Trail.

It is anticipated that some groups or individuals may not cooperate with a direct survey, particularly those who are concerned with potential trail closures or who may be riding illegally in closed areas. In this case, remote survey methods, such as trip cameras, could be considered as an alternative method to collecting user frequency information.

The *Recreationist Survey* should also include visits to staging areas during times of high use, vehicle counts. Observers could be stationed with cameras at target areas to document actual use conditions such as amount of trail or off-trail travel, contact with mine waste, visual dust disturbance, group use and distance between riders and how long airborne dust lingers.

Recreational use assessments and user surveys should be considered for other areas of the Sierra Nevada where high densities of AML sites or naturally occurring asbestos and recreational trails overlap. Locations for future surveys could include other National Forests such as the Plumas National Forest and Eldorado National Forest.

The results of the recreationist survey can be used to inform site-specific risk assessment calculations, especially for arsenic. Results will also help develop effective outreach and education programs for recreationists to raise awareness about the dangers of mining toxins and preventative measures to reduce or minimize exposure, and perhaps most importantly specific areas to avoid.

REFERENCES

- Bureau of Land Management (BLM). (2004). *Risk Management Criteria for Metals at BLM Mining Sites*. Technical note 390 rev. October 2004.
- California Department of Conservation (CDOC). (2000). *California's Abandoned Mines: A Report on the Magnitude and Scope of the Issue in the State*. Volumes I & II. Department of Conservation.
- California Department of Toxic Substances Control (DTSC) 2005, Study of airborne asbestos from a serpentine road in Garden Valley, California: Sacramento, California, California Environmental Protection Agency, 48 p.
- California Environmental Protection Agency (Cal/EPA). (2009). *Use of California Human Health Screening Levels (CHHSLs) in Evaluation of Contaminated Properties*. California Environmental Protection Agency, January 2005.
- Environmental Protection Agency (EPA). (2009). Risk Assessment Guidance for Superfund (RAGS). *Identification of Preliminary Remediation Goals*. [http://www.epa.gov/reg3hwmd/risk/human/rb-concentration table/Generic Tables/xls/composite sl table run DECEMBER2009.xls](http://www.epa.gov/reg3hwmd/risk/human/rb-concentration%20table/Generic%20Tables/xls/composite%20sl%20table%20run%20DECEMBER2009.xls)
- Tahoe National Forest (TNF). (2008). *Motorized Travel Management Draft EIR for the Tahoe National Forest*. September 2008. http://www.fs.fed.us/r5/tahoe/projects_plans/ohv_inv/DEIS_overview.shtml
- The Sierra Fund (TSF). (2009). *Northern Sierra Recreational Exposure Assessment and User Survey Protocol*. January 2009.
- The Sierra Fund (TSF). (2008). *Mining's Toxic Legacy: An Initiative to Address Mining Toxins in the Sierra Nevada*. March 2008.
- University of California at Davis (UCD). (2005). *Naturally Occurring Asbestos Linked to Lung Cancer*. http://www.ucdmc.ucdavis.edu/newsroom/releases/archives/cancer/2005/asbestos_cancer7-2005.htm

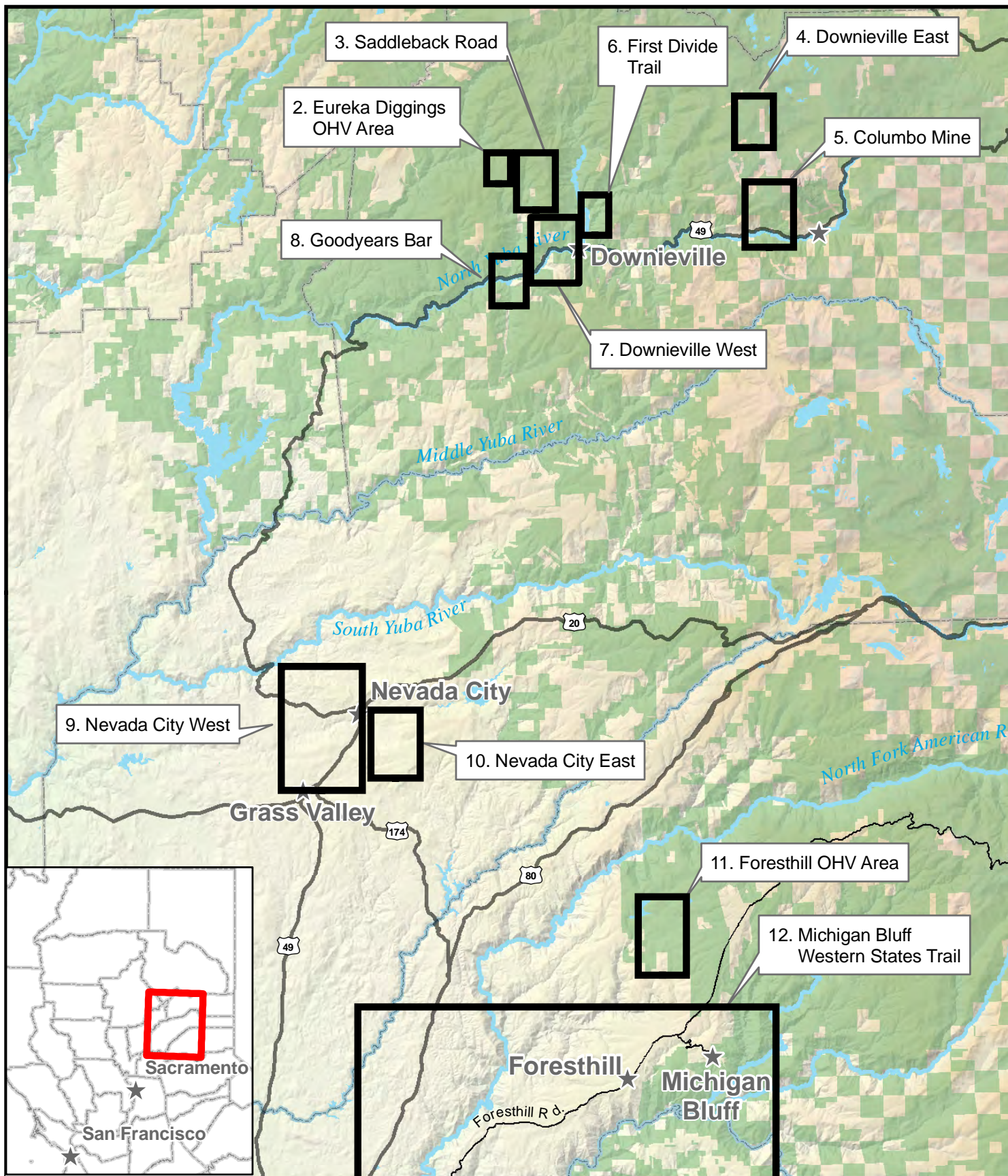


The Sierra Fund's
Gold Country Recreational Trails and Abandoned Mines Assessment

TABLES AND FIGURES

INDEX OF TABLES AND FIGURES

TABLE	TITLE	PAGE
Figure 1	Project Location Map	35
Figure 2	Eureka Diggings Map	36
Table 2	Eureka Diggings Sample Results	37
Figure 3	Saddleback Road Map	38
Table 3	Saddleback Road Sample Results	39
Figure 4	Downieville East Map	40
Table 4	Downieville East Sample Results	41
Figure 5	Columbo Mine Map	42
Table 5	Columbo Mine Sample Results	43
Figure 6	Downieville First Divide Trail Map	44
Table 6	Downieville First Divide Sample Results	45
Figure 7	Downieville West Map	46
Table 7	Downieville West Sample Results	47
Figure 8	Goodyears Bar Map	48
Table 8	Goodyears Bar Sample Results	49
Figure 9	Nevada City West Map	50
Table 9	Nevada City West Sample Results	51
Figure 10	Nevada City East Map	52
Table 10	Nevada City East Sample Results	53
Figure 11	Foresthill OHV Area Map	54
Table 11	Foresthill OHV Area Sample Results	55
Figure 12	Michigan Bluff/Western States Trail Map	56
Table 12	Michigan Bluff/Western States Trail Sample Results	57



Legend

- ★ Cities
- ~ Highways
- ~ Rivers
- ~ Lakes
- ~ National Forest

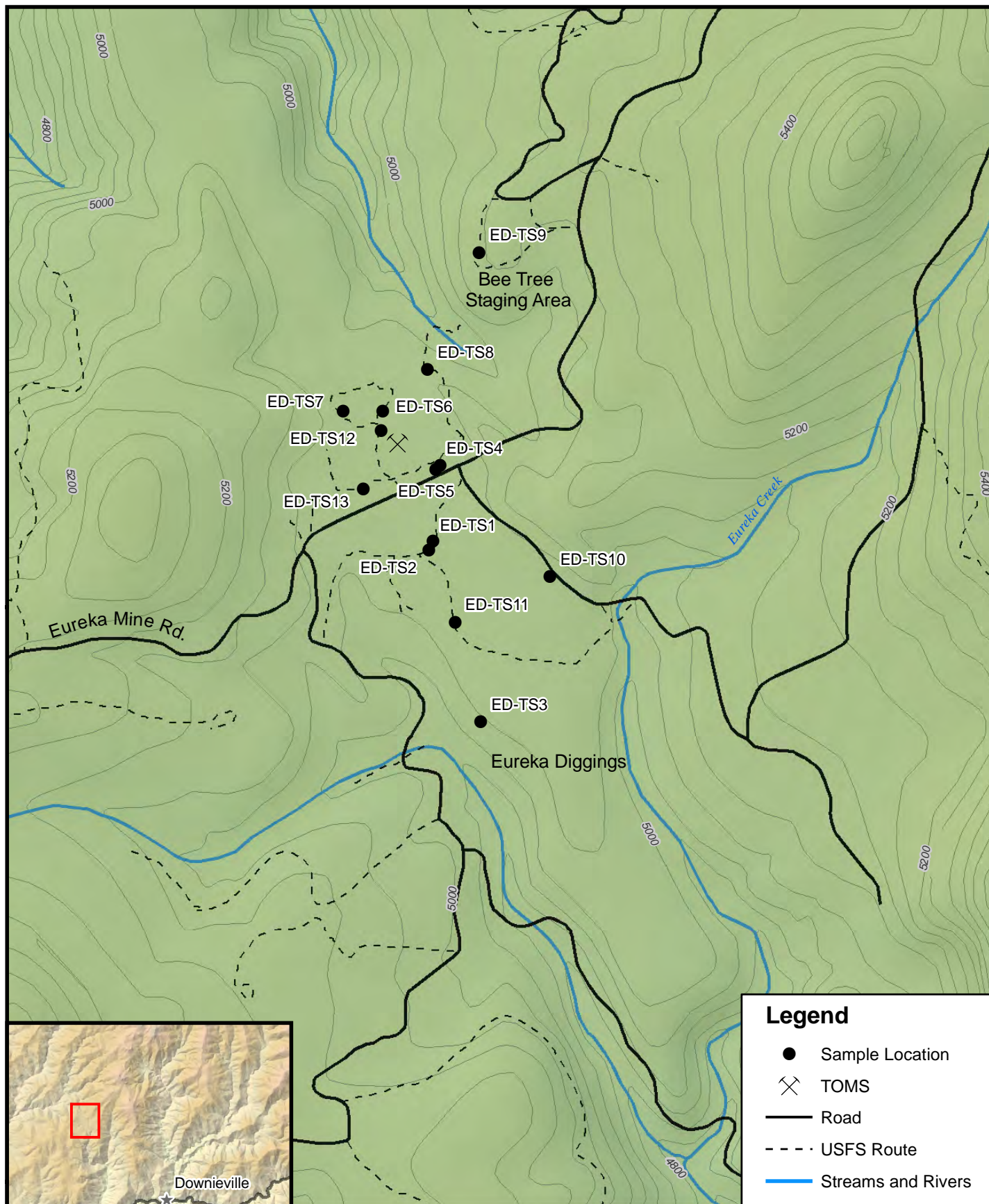
Project Location Map



THE SIERRA FUND



Figure 1



Eureka Diggings

USGS Goodyears Bar Quadrangle

0 375 750 1,500
Feet



THE SIERRA FUND



Figure 2

Table 2: Eureka Diggings

Sample Name	Sample Date	Location	As mg/kg	Cr mg/kg	Hg mg/kg	Pb mg/kg	Asbestos %	Comments
ED-TS 1	5/12/2009	Eureka Diggings	9	171	0.1	8	na	On OHV road/trail, red silty clay
ED-TS 2	5/12/2009	Eureka Diggings	13	85	0.04	10	na	20ft south of sample 1, weathered shale pile that erodes onto road
ED-TS3	5/12/2009	Eureka Diggings	7	158	0.08	20	na	On OHV road/trail at base of bluff
ED-TS4	5/12/2009	Eureka Diggings	9	138	0.03	20	na	On OHV trail with riding bumps
ED-TS5	5/12/2009	Eureka Diggings	10	220	0.04	7	na	On OHV trail at base of riding bump
ED-TS6	5/12/2009	Eureka Diggings	10	116	0.09	14	na	On OHV trails in open area
ED-TS7	5/12/2009	Eureka Diggings	13	293	0.1	14	na	On slope of play hill, clay mixed with silt
ED-TS8	5/12/2009	Eureka Diggings	8	137	0.04	5	na	On OHV trail
ED-TS 9	5/12/2009	Eureka Diggings	18	151	0.12	57	na	Beetree staging area, open space, silty sand with gravel
ED-TS10	5/12/2009	Eureka Diggings	14	129	0.2	11	na	On OHV road in SW corner of diggings
ED-TS 11	5/12/2009	Eureka Diggings	29	136	0.09	8	na	On OHV road southwest of diggings
ED-TS12	5/12/2009	Eureka Diggings	12	133	0.13	21	na	On OHV road northwest corner of diggings, silty sand with clay and gravel
ED-TS13	5/12/2009	Eureka Diggings	9	214	0.07	15	na	On OHV road, west side of diggings, silty sand with clay and gravel

mg/kg=milligrams per kilogram, na=not analyzed, (As=total arsenic, Cr=total chromium, Pb=total lead; analyzed by ME-ICP 61 assay method) (Hg= total mercury analyzed by Hg -CV41 cold furnace method), (Asbestos=percent asbestos, analyzed by CARB Method 435,

*Chrysotile, **Tremolite)

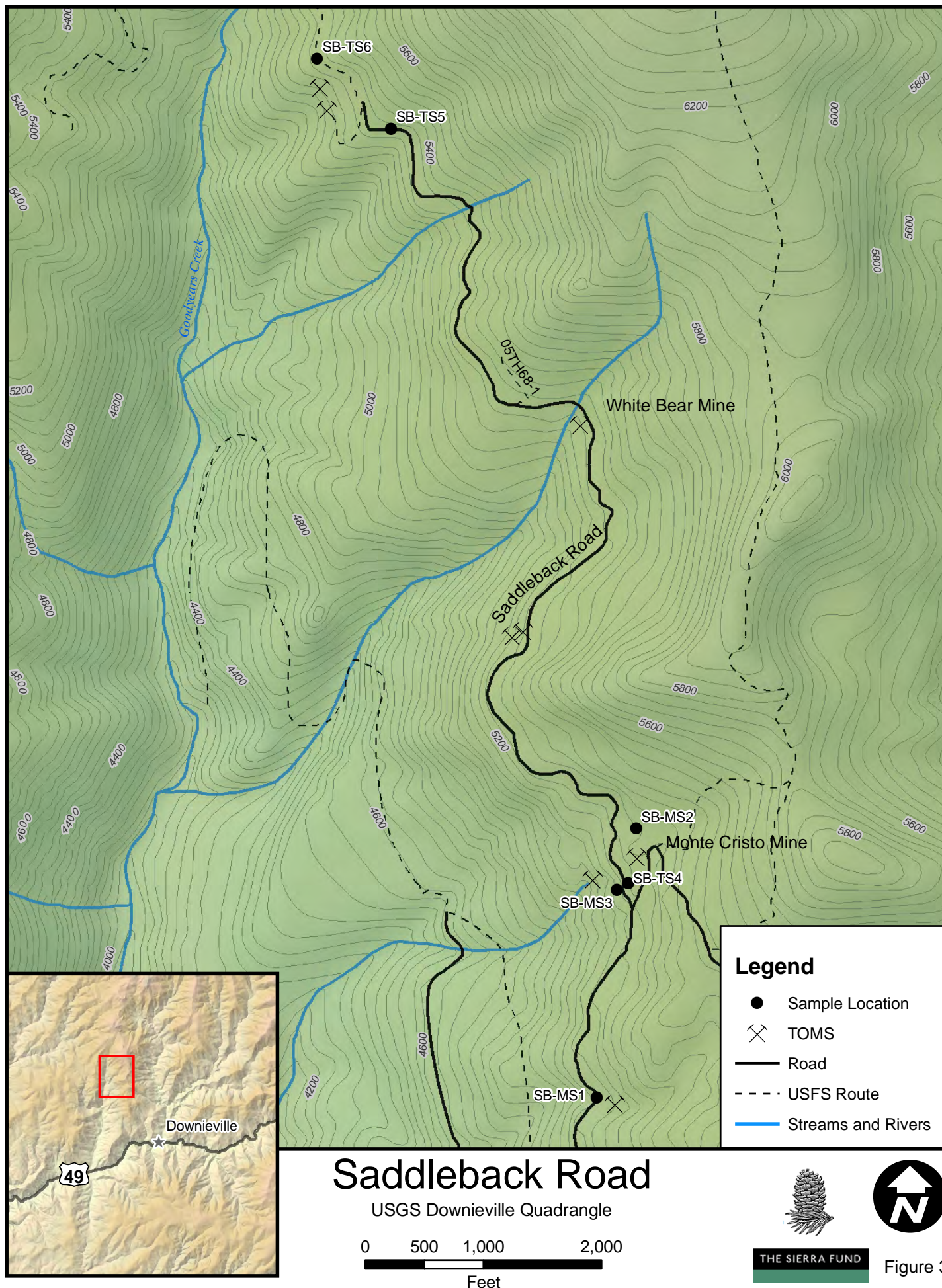


Table 3: Saddleback Road

Sample Name	Sample Date	Location	As mg/kg	Cr mg/kg	Hg mg/kg	Pb mg/kg	Asbestos %	Comments
SB-MS1	5/12/2009	Saddleback Rd.	43	276	0.14	29	na	Waste rock outside of collapsed mine shaft on Saddleback Road, serpentine, quartz and weathered metamorphic rock
SB-MS2	5/12/2009	Saddleback Rd.	14	189	7.3	1570	na	Monte Cristo mine; placer waste with creek running through it, scrap metal waste near by
SB-MS3	5/12/2009	Saddleback Rd.	16	112	0.3	32	na	Monte Cristo mine; hard rock waste pile eroding onto road
SB-TS4	5/12/2009	Saddleback Rd.	37	187	0.22	19	na	Sample of fine dust from the road below Monte Cristo mine site
SB-TS5	5/12/2009	Saddleback Rd.	13	1180	0.03	5	14%*	Serpentine outcrop, eroding onto road, approximately 300ft long outcrop
SB-TS6	5/12/2009	Saddleback Rd.	54	220	0.06	9	na	Road sample above Telegraph mine site

mg/kg=milligrams per kilogram, na=not analyzed, (As=total arsenic, Cr=total chromium, Pb=total lead; analyzed by ME-ICP 61 assay method) (Hg= total mercury analyzed by Hg -CV41 cold furnace method), (Asbestos=percent asbestos, analyzed by CARB Method 435, *Chrysotile, **Tremolite)

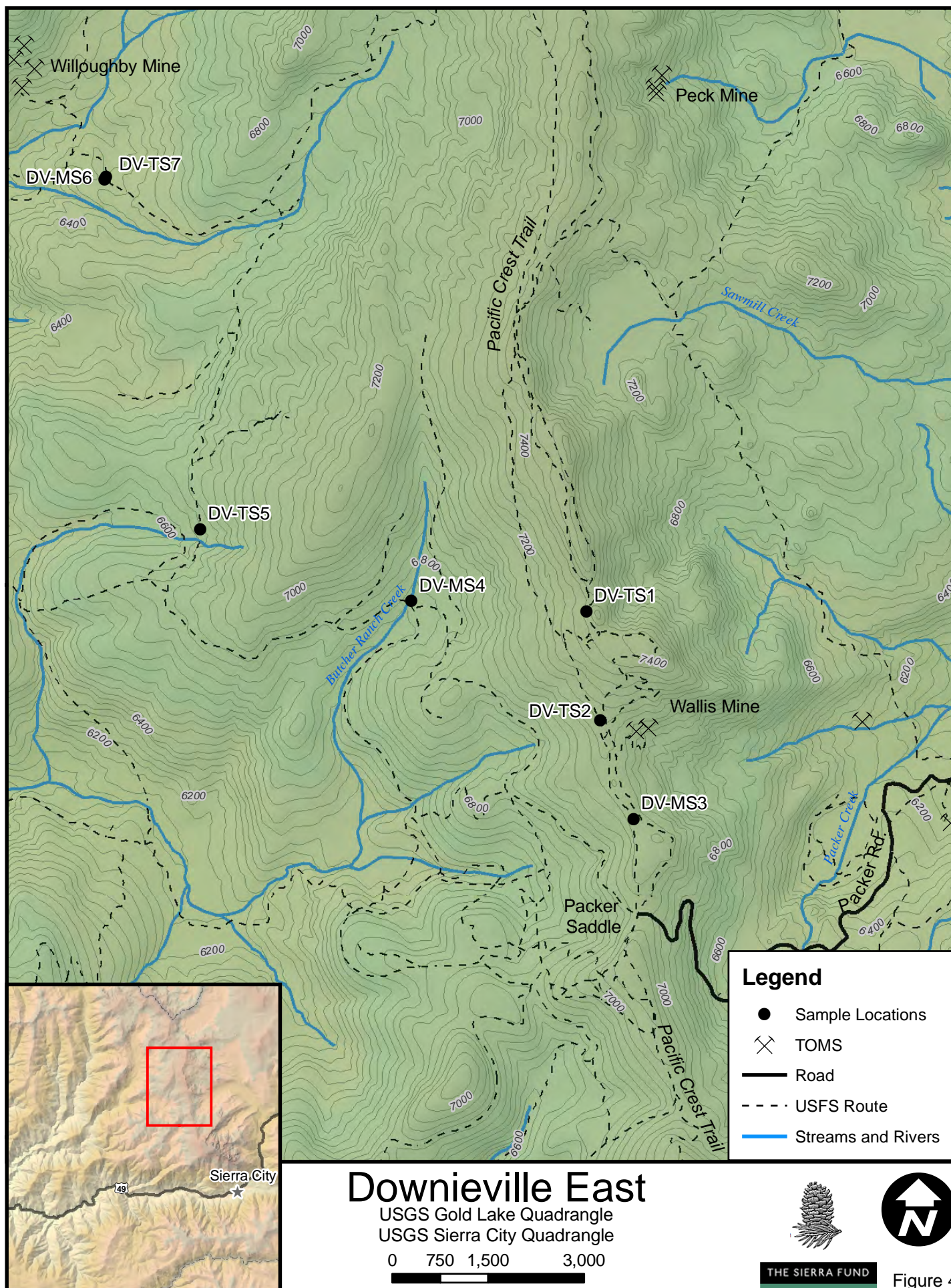


Table 4: Downieville East

Sample Name	Sample Date	Location	As mg/kg	Cr mg/kg	Pb mg/kg	Asbestos %	Comments
DV-TS1	6/13/2009	Downieville	11	26	46	na	Pacific Crest Trail
DV-TS2	6/13/2009	Downieville	<5	14	6	na	OHV road 100 yards from Pacific Crest Trail
DV-MS3	6/13/2009	Downieville	66	153	34	na	Depression on Pacific Crest Trail
DV-MS4	6/13/2009	Downieville	16	36	26	na	Placer Mine waste along Butcher Creek
DV-TS5	6/13/2009	Downieville	50	72	26	na	Mine waste eroding onto road
DV-MS6	6/13/2009	Downieville	36	73	963	na	Hard rock mine waste below open mine shaft or tunnel near Pauly Creek
DV-TS7	6/13/2009	Downieville	30	48	28	na	Dirt road below mine waste
BB-TS1	6/14/2009	Big Boulder Trail	9	58	14	na	Trail with possible mine waste, below assumed mine location
BB-TS2	6/13/2009	Big Boulder Trail	<5	6	6	na	Trail crossing mine waste ~40ft below portal
BB-TS3	6/13/2009	Big Boulder Trail	<5	8	13	na	Sand silt, white sand, trail on terrace below mine portal

mg/kg=milligrams per kilogram, na=not analyzed, (As=total arsenic, Cr=total chromium, Pb=total lead; analyzed by ME-ICP 61 assay method)
(Hg= total mercury analyzed by Hg -CV41 cold furnace method), (Asbestos=percent asbestos, analyzed by CARB Method 435, *Chrysotile,
**Tremolite)

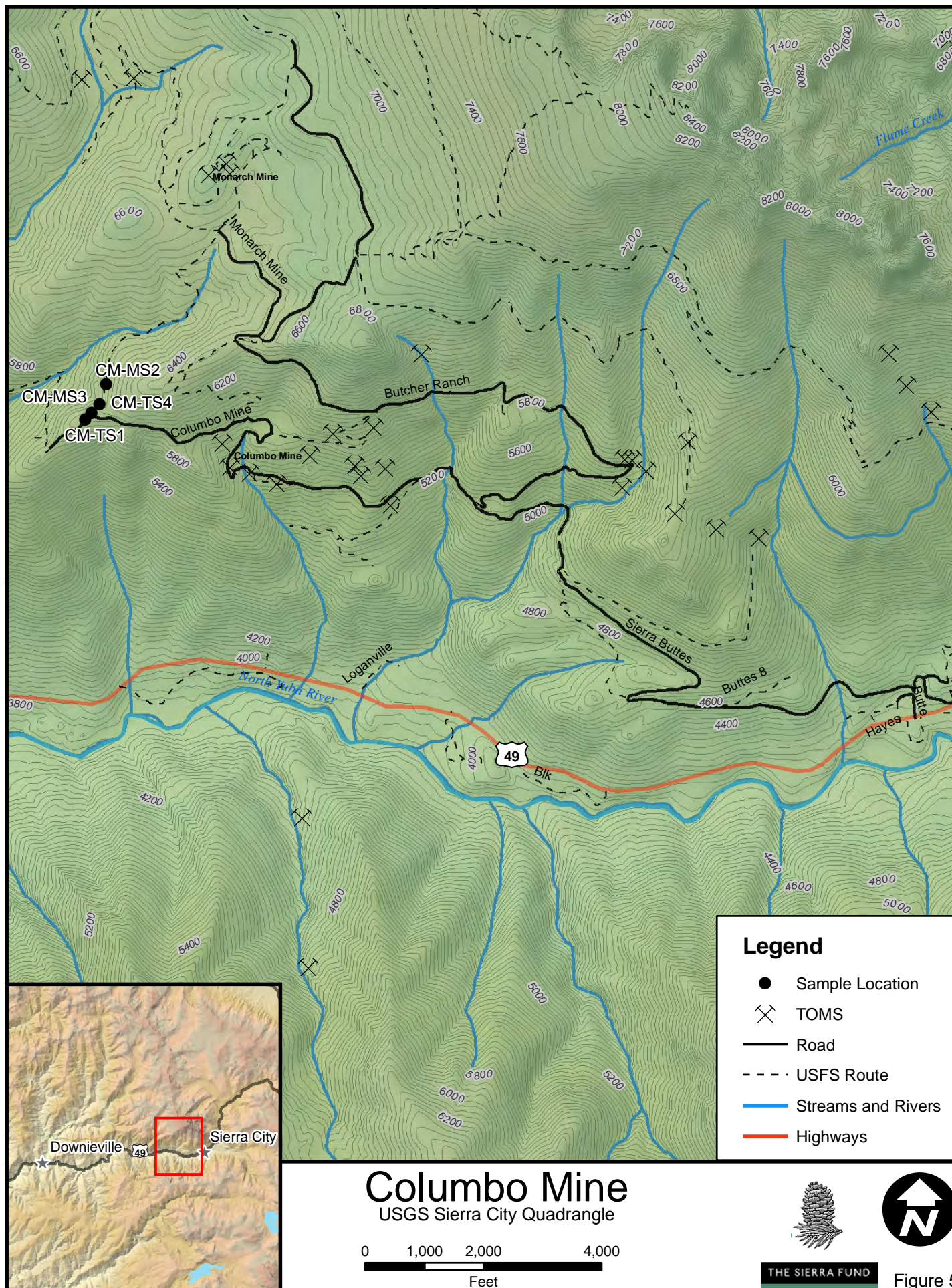


Table 5: Columbo Mine Sampling Locations

Sample Name	Sample Date	Location	As mg/kg	Cr mg/kg	Pb mg/kg	Asbestos %	Comments
CM-TS1	6/13/2009	Columbo Mine	18	338	20	na	Colombo Mine, ATV and mountain bike trail
CM-MS2	6/13/2009	Columbo Mine	442	690	129	na	Colombo Mine, Waste rock pile above shaft on trail
CM-MS3	6/13/2009	Columbo Mine	388	1365	28	na	Colombo Mine waste rock pile below shaft
CM-TS4	6/13/2009	Columbo Mine	35	870	30	na	Colombo Mine, center staging area

mg/kg=milligrams per kilogram, na=not analyzed, (As=total arsenic, Cr=total chromium, Pb=total lead; analyzed by ME-ICP 61 assay method)

(Hg= total mercury analyzed by Hg -CV41 cold furnace method), (Asbestos=percent asbestos, analyzed by CARB Method 435, *Chrysotile,

**Tremolite)

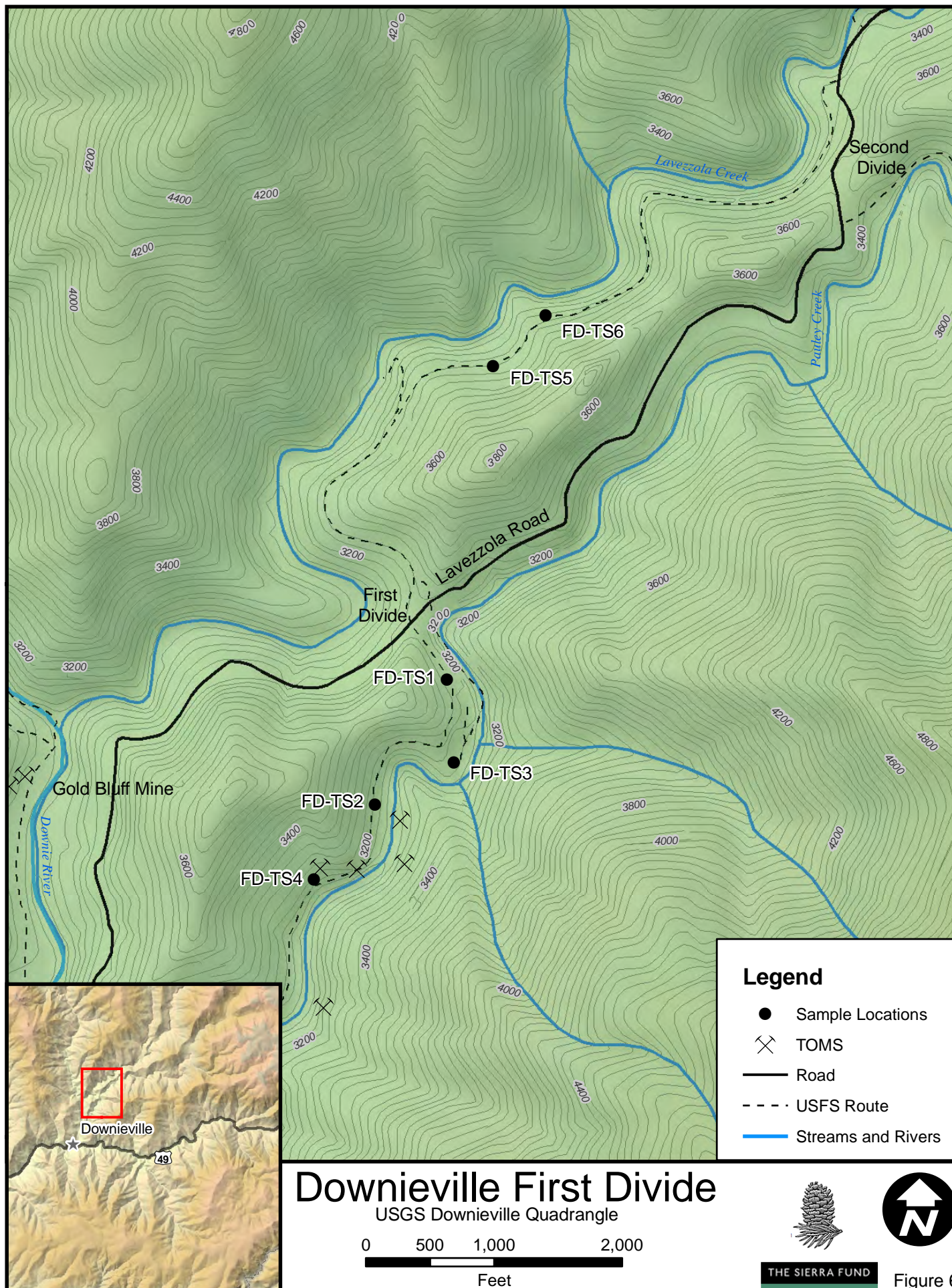


Table 6: Downieville First Divide Trail

Sample Name	Sample Date	Location	As mg/kg	Cr mg/kg	Pb mg/kg	Asbestos %	Comments
FD-TS1	6/14/2009	First Divide	30	32	24	na	Possible mine waste pile eroding onto trail
FD-TS2	6/14/2009	First Divide	9	45	13	na	First Divide Trail down from parking area, Price, Price, Preston Mine claim
FD-TS3	6/14/2009	First Divide	10	7	3	na	On outcropping of First Divide Trail below parking area, strange white powder
FD-TS4	6/14/2009	First Divide	15	66	52	na	Hole below site on First Divide possible mine below Lavazola Rd.
FD-TS5	6/14/2009	First Divide	42	28	24	na	1/2 mile above parking area on First Divide Trail, mineralized quartz soil on trail
FD-MS6	6/14/2009	First Divide	69	41	40	na	1/2 mile above parking area on First Divide Trail, big quartz vein goes into hill and excavation material eroding onto trail and across the ditch

mg/kg=milligrams per kilogram, na=not analyzed, (As=total arsenic, Cr=total chromium, Pb=total lead; analyzed by ME-ICP 61 assay method)

(Hg= total mercury analyzed by Hg -CV41 cold furnace method), (Asbestos=percent asbestos, analyzed by CARB Method 435, *Chrysotile,

**Tremolite)

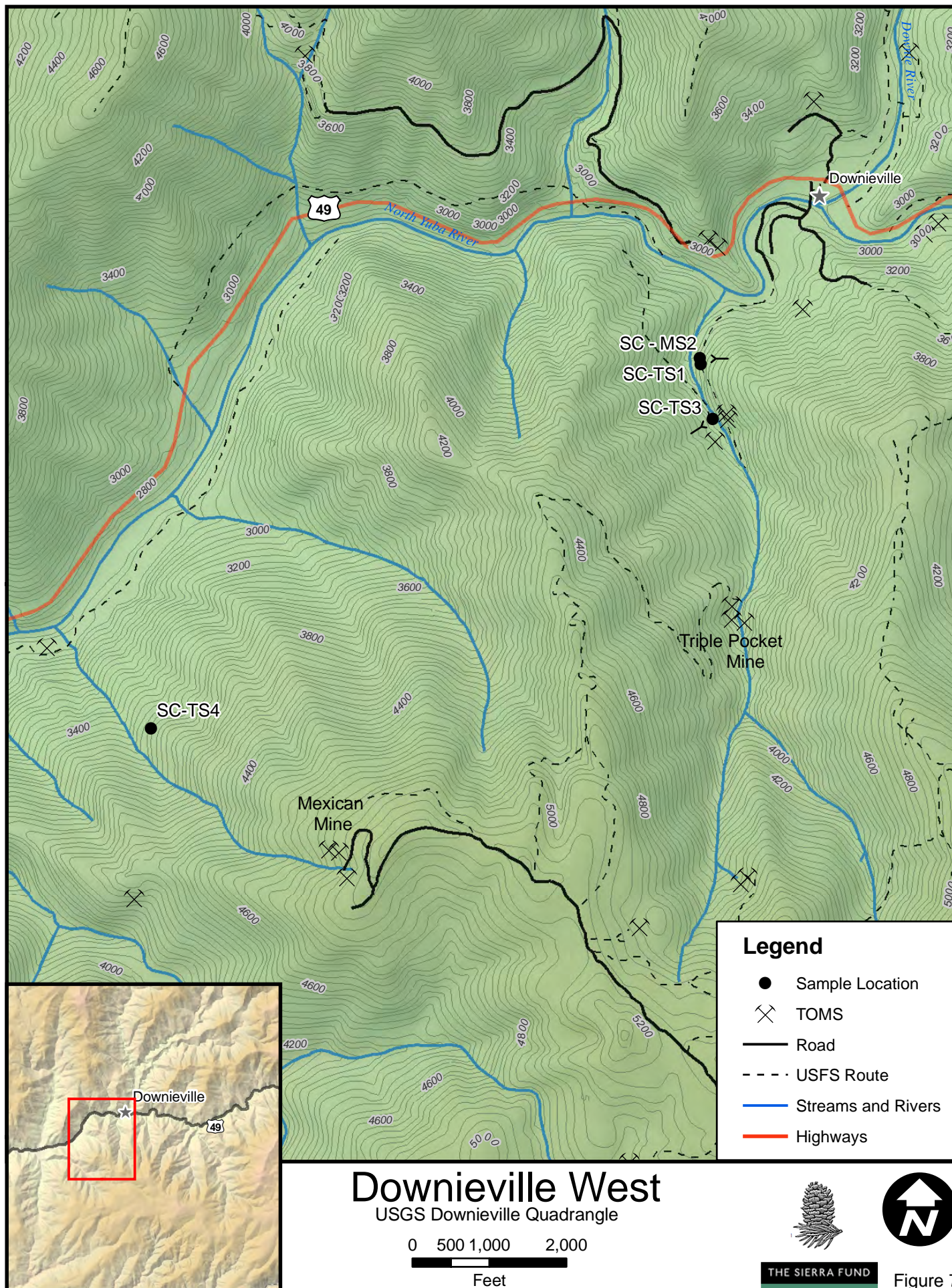


Table 7: Downieville West

Sample Date	Location	Sample Name	As mg/kg	Cr mg/kg	Pb mg/kg	Asbestos %	Comments
6/14/2009	Slug Canyon	SC-TS1	439	188	38	na	Trail 50 feet north of small creek (mine discharge) which crosses the trail and enters Slug Canyon. 0-0.5 inches scraped off trail = mine waste- grey silty sand and gravel
6/14/2009	Slug Canyon	SC-MS2	400	165	24	na	Waste rock on slope just off trail edge down slope of trail. Fresher mine waste – grey sand w quartz and mineralized rock fragments. 0-4" depth
6/14/2009	Slug Canyon	SC-TS3	118	983	18	na	Trail next to the second tunnel shown on Slug Canyon Trail soil 0-1" immediately down slope of second tunnel sealed with foam and bat grate, 100 feet past new wood bridge
6/14/2009	Slug Canyon	SC-TS4	16	91	33	na	Trail down slope of a quartz prospect above the N. Yuba. Grey brown silty sand with angular gravel. 0-0.5" scraped off trail surface

mg/kg=milligrams per kilogram, na=not analyzed, (As=total arsenic, Cr=total chromium, Pb=total lead; analyzed by ME-ICP 61 assay method)
(Hg= total mercury analyzed by Hg -CV41 cold furnace method), (Asbestos=percent asbestos, analyzed by CARB Method 435, *Chrysotile,
**Tremolite)

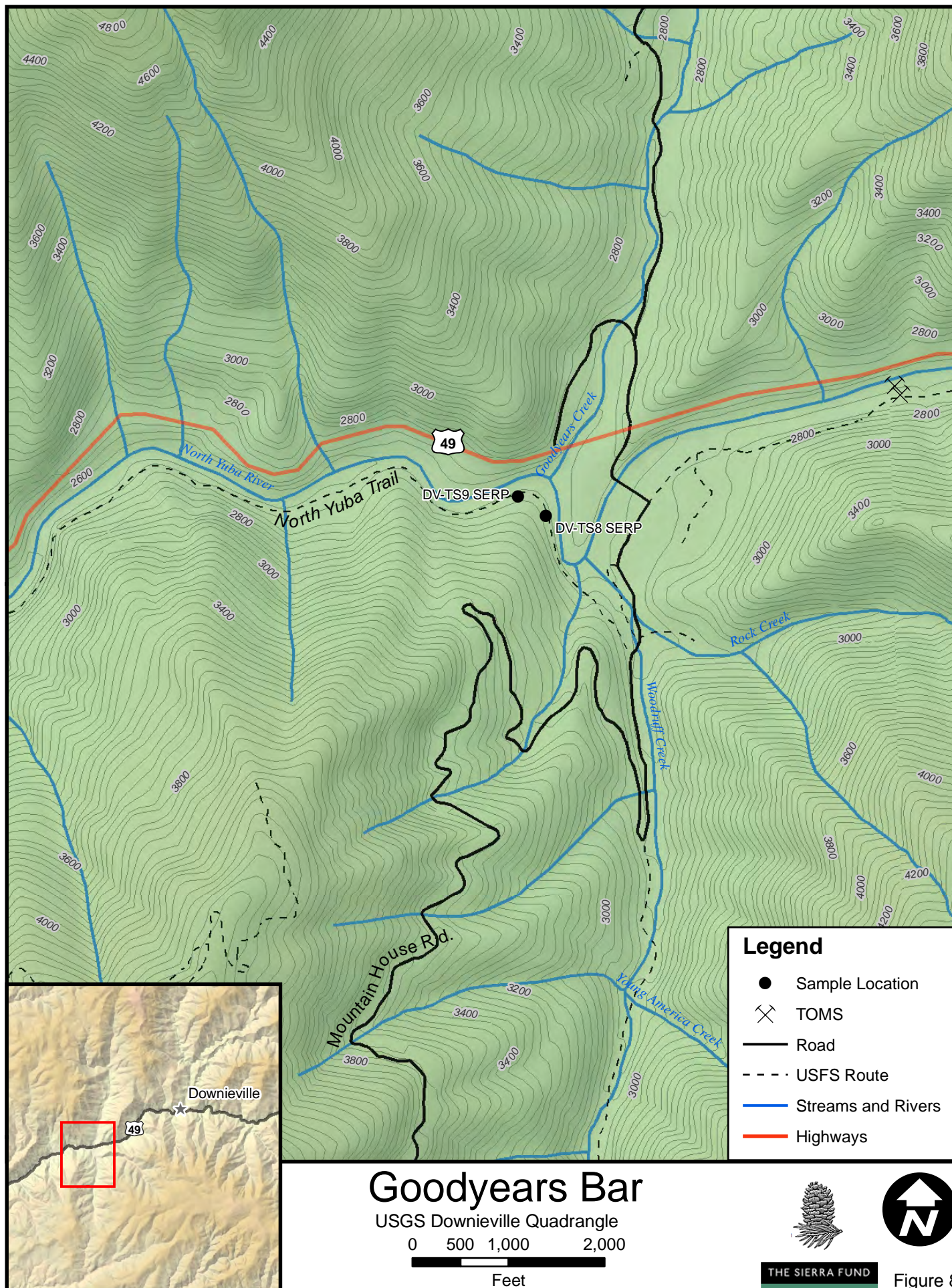


Figure 8

Table 8: Goodyears Bar

Sample Date	Location	Sample Name	As mg/kg	Cr mg/kg	Pb mg/kg	Asbestos %	Comments
6/14/2009	Downieville	DV-TS8 SERP	<5	1035	8	15%*	North Yuba Trail 1/2 mile west of Mountain House Rd.
6/14/2009	Downieville	DV-TS9 SERP	<5	1835	3	11%*	North Yuba Trail 3/4 mile west of Mountain House Rd.

mg/kg=milligrams per kilogram, na=not analyzed, (As=total arsenic, Cr=total chromium, Pb=total lead; analyzed by ME-ICP 61 assay method)

(Hg= total mercury analyzed by Hg -CV41 cold furnace method), (Asbestos=percent asbestos, analyzed by CARB Method 435, *Chrysotile,

**Tremolite)

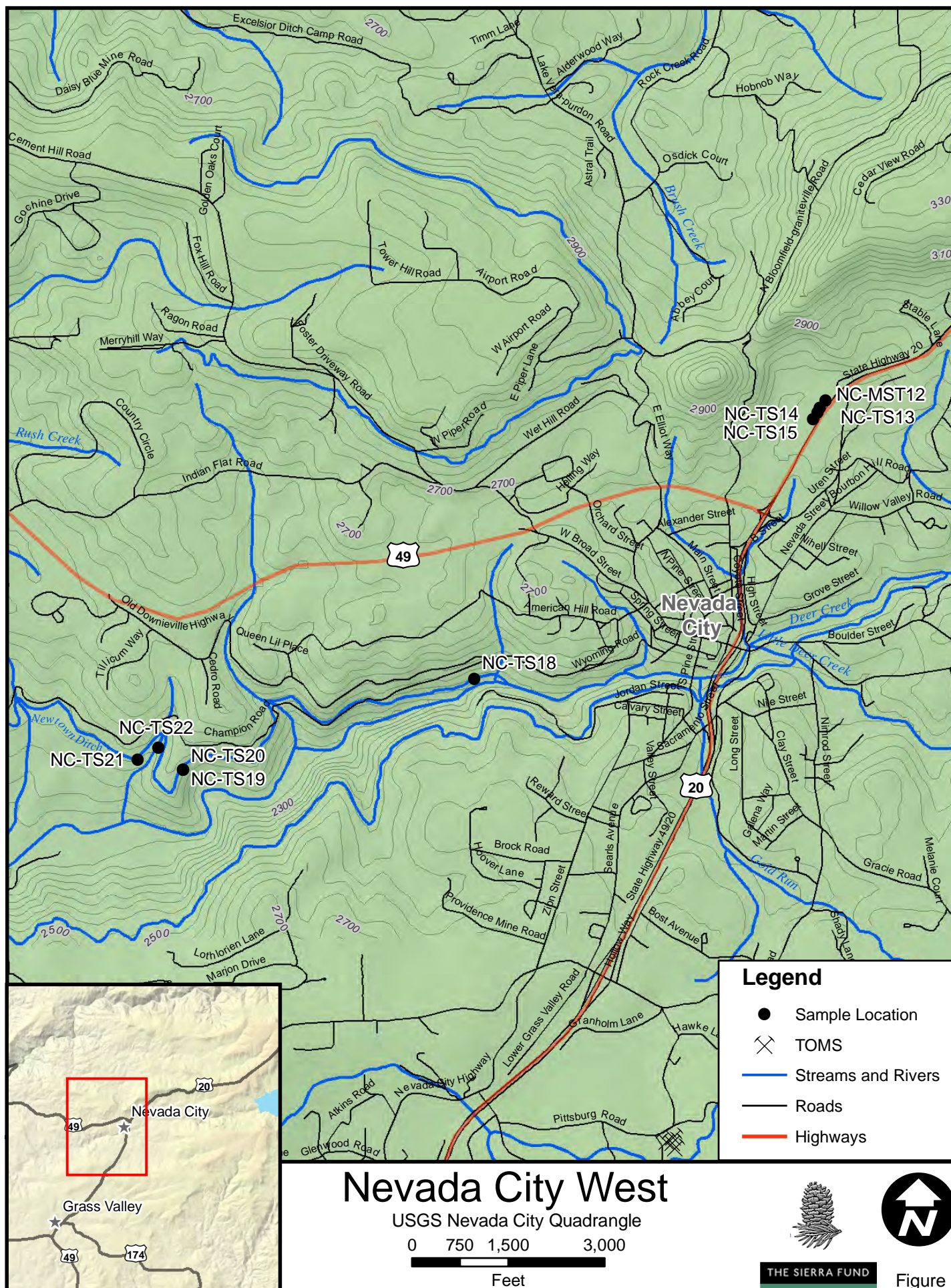


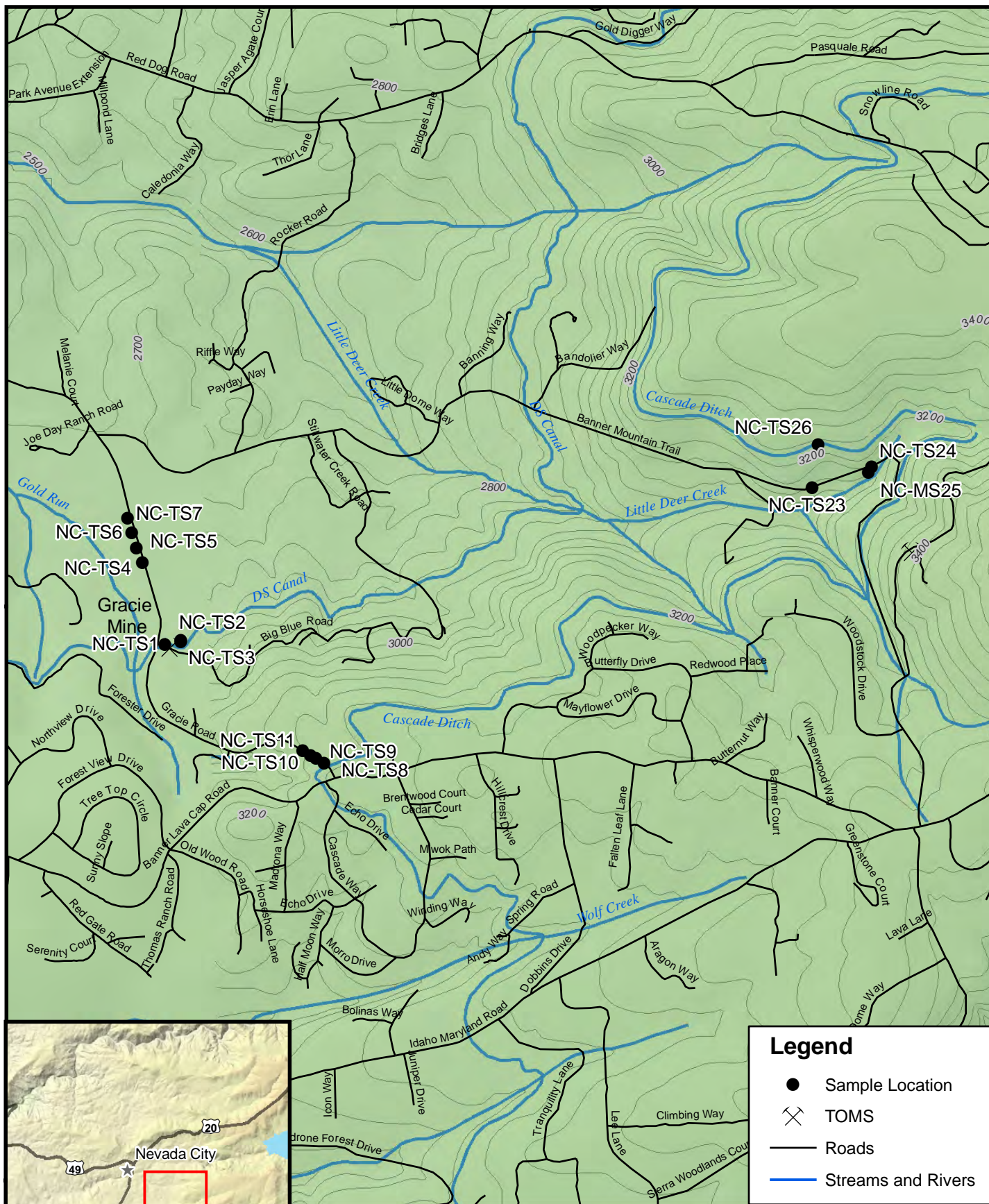
Table 9: Nevada City West

Sample Name	Sample Date	Location	As mg/kg	Cr mg/kg	Pb mg/kg	Asbestos %	Comments
NC-TS18	8/3/2005	Tribute Trail	<5	22	24	na	Tribute trail section Champion Rd. to NID, 50 yards uphill from NID road before it enters woods, sampled dusty spot on newly constructed trail
NC-TS19	8/3/2005	Tribute Trail	6	14	30	na	At mine waste pile cut by new trail, granitic fractured rock in silty sand
NC-TS20	8/3/2005	Newtown Ditch	5	2120	12	15%**	On Newtown ditch trail across from serpentine outcrops cut by ditch construction, assumed serpentine on trail
NC-TS21	8/3/2005	Newtown Ditch	26	2250	41	na	Newtown ditch trail across from ultramafic rock excavation spoils dusty area of trail
NC-TS22	8/3/2005	Newtown Ditch	19	2370	31	10%**	Trail on Newtown ditch across from serpentine rock outcrop, serpentine rock on trail surface
NC-MST12	7/17/2009	Manzanita Diggings	8	19	23	na	Manzanita Diggings along trail near Highway 20, waste was to the right of the trail
NC-TS13	7/17/2009	Manzanita Diggings	42	59	31	na	Manzanita Diggings in cut through mound of fine grained placer spoils
NC-TS14	7/17/2009	Manzanita Diggings	<5	84	26	na	Manzanita Diggings steep hill trail goes down through mound of placer mine waste
NC-TS15	7/17/2009	Manzanita Diggings	49	84	57	na	Manzanita Diggings samples in lower bumps and turns
NC-TS16	8/3/2005	Round Mountain	7	59	18	na	150ft above Rock Creek Road on flume trail, at small mound below depression just above trail
NC-TS17	8/3/2005	Round Mountain	6	72	17	na	200 yards past NC-16 going east on trail at 3rd largest mound, ~10 cubic yards mound just below trail

mg/kg=milligrams per kilogram, na=not analyzed, (As=total arsenic, Cr=total chromium, Pb=total lead; analyzed by ME-ICP 61 assay method)

(Hg= total mercury analyzed by Hg -CV41 cold furnace method), (Asbestos=percent asbestos, analyzed by CARB Method 435, *Chrysotile,

**Tremolite)



Legend

- Sample Location
- ✕ TOMS
- Roads
- Streams and Rivers

Nevada City East

USGS Grass Valley Quadrangle
USGS Chicago Park Quadrangle

0 480 960 1,920
Feet



THE SIERRA FUND



Figure 10

Table 10: Nevada City East

Sample Name	Sample Date	Location	As mg/kg	Cr mg/kg	Pb mg/kg	Asbestos %	Comments
NC-TS1	7/17/2009	Gracie Mine	62	88	20	na	DS Canal trail used by cross country team at the Gracie Mine, near Gracie Rd Big Blue Rd. Intersection
NC-TS2	7/17/2009	Gracie Mine	93	72	24	na	Between Gracie Rd and Gate
NC-TS3	7/17/2009	Gracie Mine	224	63	24	na	On DS trail, on inside of gate
NC-TS4	7/17/2009	Gracie Mine	87	87	74	na	On west side of the road, in a cut of a mound
NC-TS5	7/17/2009	Gracie Mine	107	91	35	na	100ft downhill on trail from TS4 in a mound cut
NC-TS6	7/17/2009	Gracie Mine	73	100	28	na	At lower part of trail convergence next to borrow pit
NC-TS7	7/17/2009	Gracie Mine	150	51	33	na	Below borrow pit on trail with trash mixed in near road, just down hill from fallen logs
NC-TS8	7/17/2009	Cascade Trail	15	51	20	na	Cascade Canal access trail, loop from Cascade Canal to Rd. Pull off goes through mine waste
NC-TS9	7/17/2009	Cascade Trail	14	52	19	na	1/4 way down, on trail where it crosses a ditch that runs downhill
NC-TS10	7/17/2009	Cascade Trail	35	68	21	na	In mounded area 1/2 way down from top of trail
NC-TS11	7/17/2009	Cascade Trail	26	54	19	na	3/4 way down the hill from the top of the trail
NC-TS23	8/7/2009	Banner Mountain	236	136	27	na	On dirt road below mapped location of Union Mine
NC-TS24	8/7/2009	Banner Mountain	402	67	27	na	On road adjacent to exposure of mine waste extending from road down to creek, mine waste may be in roadbed and beneath
NC-MS25	8/7/2009	Banner Mountain	4050	30	90	na	Mine waste sample at break on slope just off trail by road edge, top of steep slope extending down to Little Deer Creek (Banner Mtn. Extension Trail)
NC-TS26	8/8/2009	Banner Mountain	127	46	15	na	Cascade Ditch trail bend at intersection with steep trail going uphill to the north

mg/kg=milligrams per kilogram, na=not analyzed, (As=total arsenic, Cr=total chromium, Pb=total lead; analyzed by ME-ICP 61 assay method)

(Hg= total mercury analyzed by Hg -CV41 cold furnace method), (Asbestos=percent asbestos, analyzed by CARB Method 435, *Chrysotile,

**Tremolite)

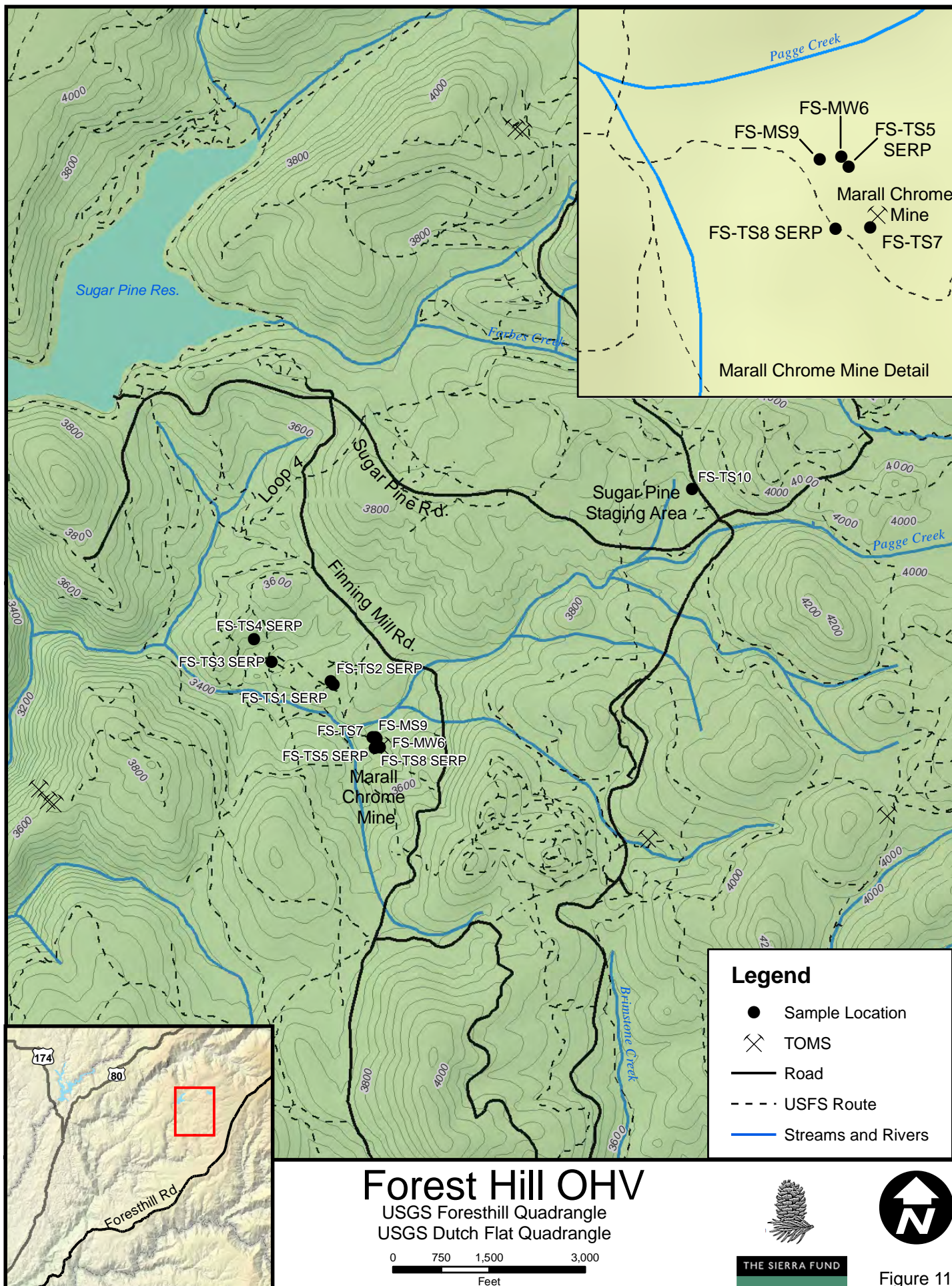


Table 11: Foresthill OHV Area

Sample Name	Sample Date	Location	As mg/kg	Cr mg/kg	Pb mg/kg	Asbestos %	Comments
FS-TS1 SERP	6/1/2009	Foresthill	<5	1610	19	12%*	Trail 4 in Forest Hill OHV Use Area, near Pagge Creek
FS-TS2 SERP	6/1/2009	Foresthill	<5	6490	11	2%*	Trail 4 in Forest Hill OHV Use Area, dust in road past mound
FS-TS3 SERP	6/1/2009	Foresthill	<5	2940	22	15%*	Trail 4 in Forest Hill OHV Use Area, serpentine rock with fibrous appearance
FS-TS4 SERP	6/1/2009	Foresthill	<5	1495	16	20%*	Trail 4 in Forest Hill OHV Use Area, on steep slope of play mound
FS-TS5 SERP	6/1/2009	Foresthill		1190	1540	12%*	In Marall Chrome Mine pit in center of open area (target practice area)
FS-MW6 SERP	6/1/2009	Foresthill	<5	578	123	40%*	In Marall Chrome Mine pit in depression on side of open area crushed fibrous serpentine rock
FS-TS7	6/1/2009	Foresthill	27	710	4790	na	In Marall Chrome Mine, dust from slope of play hill (Target practice area)
FS-TS8 SERP	6/1/2009	Foresthill	<5	1200	453	15%*	In Marall Chrome Mine pit, on side of open pit
FS-MS9	6/1/2009	Foresthill	9	3560	4190	na	Marall Chrome Mine in outwash depression at low end of pit
FS-TS10	6/1/2009	Foresthill	11	9220	22	na	At Forest Hill OHV recreation staging area, in North corner at entrance to Trail 1

mg/kg=milligrams per kilogram, na=not analyzed, (As=total arsenic, Cr=total chromium, Pb=total lead; analyzed by ME-ICP 61 assay method) (Hg= total mercury analyzed by Hg -CV41 cold furnace method), (Asbestos=percent asbestos, analyzed by CARB Method 435, *Chrysotile, **Tremolite)

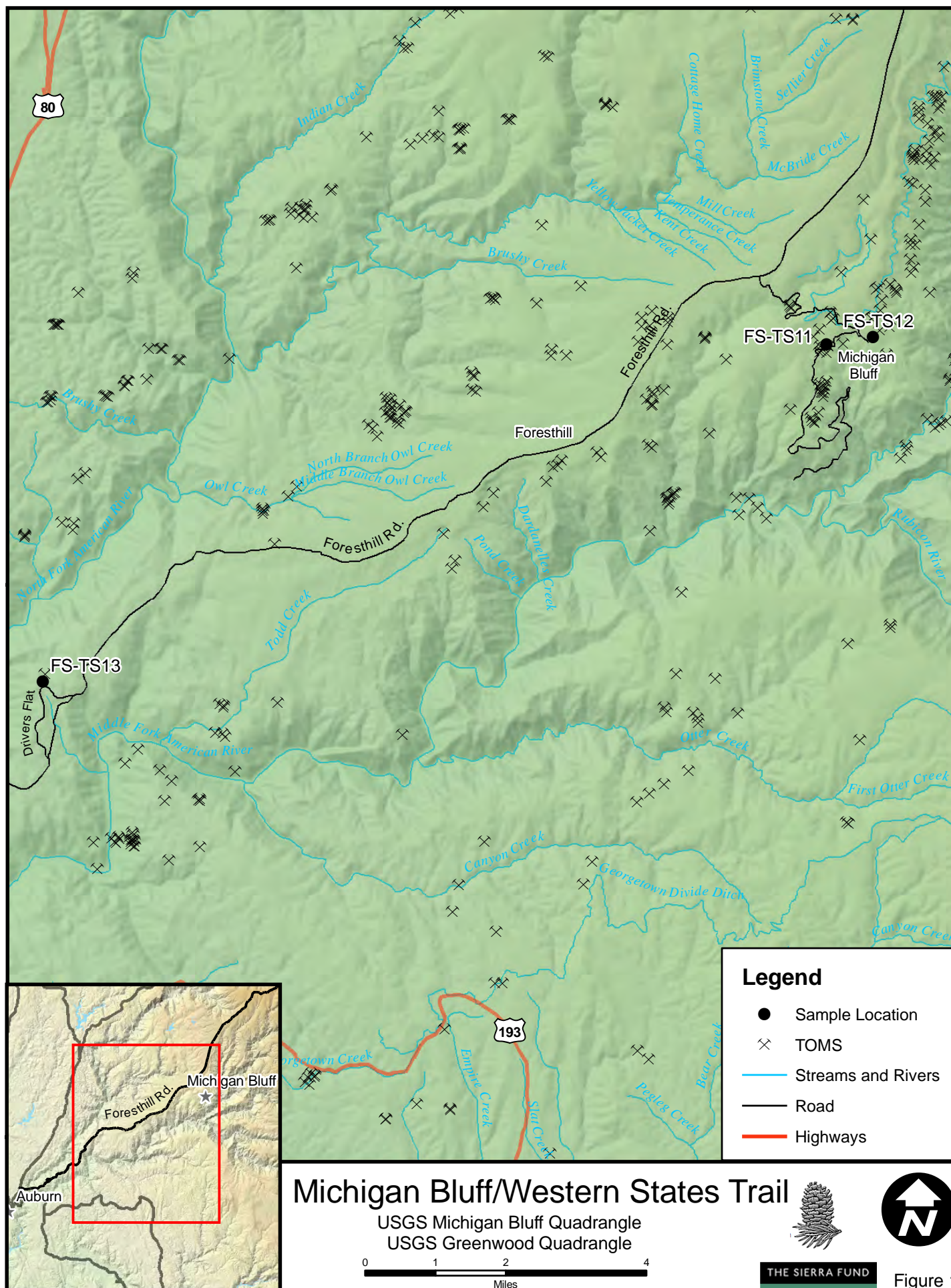


Table 12: Michigan Bluff/Western States Trail

Sample Name	Sample Date	Location	As mg/kg	Cr mg/kg	Pb mg/kg	Asbestos %	Comments
FS-TS11	6/1/2009	Foresthill	55	251	16	na	On Western States Trail in town of Michigan Bluff
FS-TS12	6/1/2009	Foresthill	<5	85	20	na	On Western States Trail west of Michigan Bluff
FS-TS13	6/1/2009	Foresthill	5	375	33	na	Forest Hill Divide loop trail

mg/kg=milligrams per kilogram, na=not analyzed, (As=total arsenic, Cr=total chromium, Pb=total lead; analyzed by ME-ICP 61 assay method) (Hg= total mercury analyzed by Hg -CV41 cold furnace method), (Asbestos=percent asbestos, analyzed by CARB Method 435, *Chrysotile, **Tremolite)



Mining's Toxic Legacy Initiative

RESOURCES

As a part of the **Mining's Toxic Legacy Initiative**, The Sierra Fund is building a toolbox to help Sierra Nevada community members and leaders learn about and address the issue of legacy mining toxins. The following documents are available online at www.sierrafund.org:

Mining's Toxic Legacy: An Initiative to Address Legacy Mining Toxins in the Sierra Nevada

This 85-page report is the first-ever comprehensive look at the ongoing environmental, cultural and human health impacts of the Gold Rush. Also available: 8-page Executive Summary.

Protecting Public Health and the Environment from Legacy Mining Toxins: A Primer for Nonprofit Organizations in the Sierra Nevada

This document summarizes the key issues that confront land trusts and land and water conservation organizations working in the Sierra Nevada.

Protecting Public and Environmental Health from Legacy Mining Toxins: A Primer for Local Government Officials in the Sierra Nevada

This document summarizes the key issues that confront local government officials with legacy mining in their jurisdiction.

Building a Mining Toxins Working Group: A Blueprint for California

This working document is meant to guide collaboration among and encourage community involvement in the many efforts to address legacy mining contamination in the Sierra Nevada.

Coming Soon:

2009 Gold Country Angler Mercury Exposure Survey

The purpose of this study was to learn whether people who eat sport fish caught in Sierra Nevada waters are being exposed to mercury. The Gold Country Angler Survey targeted anglers who fish in mercury-impacted waterways to characterize fishing activities, fish consumption patterns, and health hazard awareness.



THE SIERRA FUND

432 Broad Street - Nevada City, CA 95959
(530) 265-8454 - info@sierrafund.org

www.sierrafund.org