


Remedial Investigation
Saddle Rock Park
Wenatchee, Washington

Prepared for
City of Wenatchee
Funded through a Washington State Department of Ecology Integrated Planning Grant, G1300046

June 19, 2013
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REMEDIAL INVESTIGATION
SADDLE ROCK PARK
WENATCHEE, WASHINGTON

1.0 INTRODUCTION

This report summarizes field observations and the analytical results of soil samples collected as part of a remedial investigation (RI) at Saddle Rock Park in Wenatchee, Washington. The Washington State Department of Ecology (Ecology) recently listed a number of historical prospects and waste rock piles on the property, referred to as Gold Knob Prospects, in their ISIS database of confirmed or suspected contaminated sites and issued an early notice letter to the City. Ecology's action followed two independent evaluations of the sites: a Phase I Environmental Site Assessment (Phase I) conducted by Cascadia Technical Services in April 2011, and a site investigation by Ecology in May 2011. Both the Cascadia ESA and the Ecology investigations identified arsenic concentrations in excess of the Model Toxics Control Act (MTCA) Method A soil cleanup levels (20 mg/kg) for unrestricted land use.

The City of Wenatchee purchased the property to use as a park, and is identifying priorities for improving trails and parking areas and maintaining the park. Saddle Rock Park is a popular destination for recreation and student field trips, so it is important to both the City and Ecology to identify public health risks on the property.

The objectives of the RI were to:

- Characterize areas of concern (AOCs) on the property;
- Collect soil samples from the AOCs and analyze them for arsenic and other metals;
- Collect soil samples from undisturbed locations at the park to establish background levels of arsenic and other metals;
- Identify the effects of arsenic and other metals on the environment at the site; and
- Determine the potential for future releases of arsenic and other metals to the environment from the waste rock piles and adits at the site.

This remedial investigation focuses on obtaining the data needed to evaluate risk at the site and to implement a cost-effective cleanup action plan.

1.1 Overview

Saddle Rock Park is a 325-acre property located on the outskirts of the City of Wenatchee (City) in Chelan County, Washington (Figure 1). For the past 100 years, the property was used primarily as a community recreation area owned by the Washington State Department of Natural Resources (DNR). In 1909, the City began working to acquire the property for preservation as a public park or natural protected area, and in 2011 the City purchased the land with assistance from the Chelan-Douglas Land Trust (CDLT).

1.2 Demographics, Land Ownership, and Current Land Use

The property is located in the city of Wenatchee, Washington. According to United States Census Bureau 2011 estimates, the population of Wenatchee is 32,373, the land area of the city is 7.77 square miles, and the population density is 4,110 persons per square mile. There are 13,175 housing units and 2,943 business firms registered in the city (US Census Bureau 2013).

The park is owned by the City and protected from development by a conservation easement held by the CDLT. The legal description assigned by the Chelan County Assessor and Treasurer is Township 22N, Range 20E WM, Section 16, Property ID 57419.

The property is operated by the City as a public park. According to the real estate excise tax affidavit, the land use code is "91 – Undeveloped Land," and the property is exempt from property tax per chapter 84.36 RCW. The areas to the north and east are zoned as Residential Single Family, Residential Low Density, and Office Mixed Use.

2.0 PHYSICAL SETTING

2.1 Topography and Geographic Features

The park is characterized by a dynamic topography that includes steep slopes and rock outcrops. The elevation is approximately 980 feet above mean sea level (MSL) at the northeast margin of the property and increases to 2,080 feet above MSL on the west side of the property. Vegetation is generally sparse, especially in rocky areas, and consists of shrubs, grasses, and a few trees. Several pathways are visible on aerial photographs, including one graded road previously used by motorized vehicles (now banned) that is heavily traveled by hikers and horseback riders, and several unimproved hiking trails that support less foot traffic. The most obvious natural geographic feature is the Saddle Rock outcrop for which the park is named, and the most visible manmade feature is a power line near the east side of the property.

2.2 Regional Geology

The property is at the west end of the Columbia Plateau and in the northwest corner of the Columbia Basin Physiographic region. The region was affected by the Wisconsin glaciation and contains features characteristic of glacial activity including sandy loam soils, glaciofluvial material, and erosion zones. A geologic survey of the area identified Miocene-age flood basalt to the east of the property and Eocene-age Swakane biotite-plagioclase-quartz gneiss to the west of the Columbia River (Reiss-Landreau Research 2012; Tabor et al. 1982).

Geologic units: According to the cultural resources report prepared by Reiss-Landreau Research (RLR) in 2012, mass wasting visible on the northeast and southeast sides of the Saddle Rock outcrop probably occurred during the Late Pleistocene or early Holocene. As presented on Figure 2, the park contains the seven geologic units listed below:

- Ec(2ch) Chumstick Formation, continental sedimentary deposits or rocks
- ED(2chn) Nahahum Canyon Member, Chumstick Formation, continental sedimentary deposits or rocks
- OEian Intrusive andesite
- Oc(2) Wenatchee Formation, continental sedimentary deposits or rocks
- PLMIs Pliocene-Miocene mass wasting deposits, mostly landslides
- Qaf Alluvial fan deposits
- Qfs Quaternary mass wasting deposits, mostly landslides

Soil Units: The property contains soil units from the Bjork, Cashmere, and Cowiche series (Figure 3). The dominant soil type is the Bjork silt loam series, which is a mix of clay, silt, and sand found on steep hillsides (45 to 65 percent slope) and formed in material that was deposited by the wind or moved by overland flow or creep to the base of slopes. The Bjork soil climate is characterized as semiarid with warm, dry summers and cold, moist winters, and annual precipitation of 9 to 14 inches. The top 12 inches of this soil type is typically grayish brown to dark brown silt loam that is moist, slightly hard, firm, slightly sticky and slightly plastic, and is mildly alkaline (pH 7.6) (USDA 2002). There is also a Bjork series rock outcrop complex present. Most of the samples for this RI were collected from areas of Bjork series soil.

The southeast corner of the park contains soil of the Cashmere sandy loam series. This soil type is fine to coarse sandy loam and is found on glacial outwash terraces or terrace escarpments of variable steepness (0 to 65 percent slope). The top 12 inches of this soil type is typically dark grayish brown, moist, soft, nonsticky and nonplastic, and neutral (pH 6.6), and its origin and climate are similar to the Bjork series (USDA 2007). Only one sample for this RI was collected from the Cashmere series soil unit.

The southwest corner of the park contains soil of the Cowiche silt loam series. This soil type forms in uplands of variable steepness (0 to 70 percent slope) in material that was deposited by the wind or moved by overland flow or creep to the base of hill slopes. The top 12 inches of this soil type is generally grayish brown to very dark grayish brown loam, moist, soft, slightly sticky and slightly plastic, and neutral (USDA 1999). None of samples collected for the RI were located in the Cowiche soil unit.

2.3 Surface Water, Groundwater, and Meteorology

The park does not contain any surface water features.

There are no wells on the property so there is no reliable groundwater elevation data; however, a water well report from 1997 indicates that a certified well driller encountered groundwater at 340 feet below the ground surface at a nearby property. This report is available on the Ecology website.

The Wenatchee climate is characterized as semi-arid; according to the National Weather Service, average annual rainfall is 9 inches, and the maximum and minimum annual rainfalls on record are 14 inches in 1983 and 4.5 inches in 1976. The greatest 24-hour total rainfall on record is 0.73 inch. The average temperature is 52 degrees Fahrenheit, and the maximum and minimum average daily temperatures are 61 and 42 degrees, respectively (NWS 2013).

3.0 PARK HISTORY

For the past 100 years the property has been used primarily as a community recreation area; however, discrete areas of the property were exploited by miners who staked claims there in the late 1800s through the mid-1900s. The City began working to acquire the property in 1909 in order to preserve it as a natural area, and finally purchased the land in 2011. Saddle Rock Park is now permanently protected by a conservation easement held by CDLT.

3.1 Historical Mining Activity

There is a long documented history of prospecting and mining activity at Saddle Rock and in the surrounding area. In a cultural resources survey of the area, RLR identified three mines within the Saddle Rock Park property boundary (Sunrise Mine, Squaw Saddle Mine, and Gold Knob Mine), and one mine (Cannon Mine) adjacent to the property boundary and south of the park entrance. In addition, RLR found historical mining claims dating back to 1908 at locations throughout the park; in general, each claim area was 20 acres with dimensions of 1,500 feet by 600 feet. Although these claims are in the public record, many of them were never explored or mined and, therefore, may not have resulted in environmental impacts.

Ownership of the mines and mining claims is attributed to numerous mining companies and individuals including: Squaw Saddle Mining and Milling Company; Charles Robert Browne; E.H. Lovitt; Martin Keegan; J.J. Keegan; Patrick Heley; Thomas Keegan; and James A O'Connor (RLR 2013). For details on the mining claims and ownership, please refer to the complete cultural resources report by RLR in Appendix A.

3.2 Previous Site Investigations

Two environmental investigations were recently completed. Cascadia Technical Services (Cascadia) conducted a Phase I Environmental Site Assessment (Phase I) in April 2011, and in May 2011 Ecology conducted its own evaluation. Both the Cascadia Phase I and the Ecology investigation identified arsenic concentrations in excess of the Model Toxics Control Act (MTCA) Method A soil cleanup levels for unrestricted land uses (20 mg/kg).

In its Phase I report, Cascadia wrote that soil was highly erodible and could easily migrate with stormwater runoff and through trail use, creating a public exposure risk (Cascadia 2011). After Ecology reviewed Cascadia's soil analysis, Jason Shira, the Ecology project manager, visited the park and screened five waste rock piles with a portable X-ray fluorescence (XRF) spectrometer. The XRF screening confirmed that arsenic concentrations were higher than MTCA Method A and reported background levels for the region. Ecology also collected samples from several waste rock piles for laboratory analysis. The analytical results confirmed the elevated arsenic concentrations. In addition, seven other metals (aluminum, antimony, barium, mercury, selenium, silver, and vanadium) were detected in excess of the MTCA Method B direct contact cleanup levels or ecological indicator soil concentrations (Shira 2011).

4.0 REMEDIAL INVESTIGATION

Hart Crowser field scientists visited the park in November 2012 to measure the features at each area of concern (AOC) and estimate the volume of the waste rock piles (Figure 4). The information gathered was then used to prepare a Sampling and Analysis Plan/Quality Assurance Project Plan (SAP/QAPP) (Hart Crowser 2013). In February 2013, Hart Crowser returned to the park to collect soil samples from the waste rock piles and from background locations, and to measure the waste rock piles and adit features more accurately for this remedial investigation. A brief description of the background sample locations and AOCs is provided below. Please see Appendix B and the SAP for a detailed explanation of the sample collection procedures and select photographs of the waste rock features.

4.1 Characterization of Background Soil Conditions

Twenty background soil samples were collected from across the park to compare waste rock metals concentrations to natural background. Samples were collected from a depth of 0 to 6 inches at the locations shown on Figure 4. As a rule, the background samples were not collected in:

- Disturbed areas such as historical mining activity areas, landscaped or maintained areas, animal burrows, or beneath power lines;
- High-traffic areas such as roads and hiking trails; or
- Extremely steep, rocky, or otherwise inaccessible areas.

In cases where a proposed sample location was within an exclusion area as defined above, the field scientist identified an alternative sample location with similar geographical characteristics as close as possible to the original proposed location.

Background samples were submitted to Analytical Resources, Inc. (ARI) for analysis of inorganic metals and metalloids (aluminum, antimony, arsenic, barium, mercury, selenium, silver, and vanadium), which are collectively referred to as metals in this report. These metals have been identified by Ecology as potential chemicals of concern. Table 1 presents the background sample analytical results.

Upon receipt and validation of analytical results, statistical evaluation was performed using EPA's ProUCL 4.0 to determine natural background (defined as the 90th percentile). Summary statistics for background samples are presented in Table 2.

4.2 Waste Rock Piles

The waste rock piles at the park were identified as AOCs by Ecology when Jason Shira detected high levels of arsenic with the XRF. Hart Crowser field scientists visited the park in February 2013 to collect samples from the surface of each of the identified waste rock piles and from the area downslope from the toe of the piles. The estimated area and volume of the waste rock piles are presented in Table 3. The dimensions of the waste rock piles were estimated using field observations and GIS. The AOCs are described below.

- **Waste Rock Feature SR-01**: This AOC is 500 feet northwest of the main park entrance along the main hiking trail and includes a round rock outcrop and piles of mining waste rock. The RLR report indicates there was a mining claim at this AOC.

- **Waste Rock Feature SR-02:** This AOC is 800 feet northwest of the main park entrance and contains the largest volume of waste rock on the property. The RLR report indicates there was a mining claim at this AOC, and there is visible evidence of mining activity here including a segment of railway track and discarded lumber. There is an adit at this location and its entrance is filled with concrete. Ecology detected arsenic here with the XRF at concentrations up to 400 mg/kg during their 2011 field assessment.

- **Waste Rock Feature SR-03:** This AOC is 1,600 feet northwest of the main park entrance. The RLR report indicates there was a mining claim at this AOC, but Hart Crowser field scientists did not observe land disturbance indicating historical mining activity. Rock at this location appears be from construction activities associated with installation of power lines rather than from mining activity.

- **Waste Rock Feature SR-04:** This AOC is 4,500 feet northwest of the main park entrance. The RLR report indicates there was a mining claim at this AOC. Ecology detected arsenic here with the XRF at concentrations up to 400 mg/kg during their 2011 field assessment.

- **Waste Rock Feature SR-05:** This AOC is 3,400 feet northwest of the main park entrance. The RLR report indicates there was a mining claim at this AOC. Ecology detected arsenic here with the XRF at concentrations up to 1,500 mg/kg during their 2011 field assessment.

- **Waste Rock Feature SR-06:** This AOC is 2,600 feet west-northwest of the main park entrance. The RLR report indicates that there was a mining claim here, but Hart Crowser field scientists did not observe land disturbance indicating historical mining activity. The most prominent feature at this AOC is a road cut that has exposed the roots of a large evergreen tree upslope of the main hiking trail. It appears that rock at this area is associated with road construction. Ecology detected arsenic here with the XRF at concentrations up to 200 mg/kg during their 2011 field assessment.

- **Waste Rock Feature SR-07:** This AOC is 1,000 feet northwest of the main park entrance. The AOC includes a small shallow exploration at the top of a steep south-facing slope; however, no waste rock was observed.

- **Waste Rock Feature SR-08:** This AOC is located about 1,200 feet northwest of the main park entrance. XRF screening was not performed at this location.

4.3 Adit Features

There are five shallow adits or explorations at the Site located at waste rock features SR-01, SR-02, SR-04, SR-07, and SR-08. These openings were reported to be former mine entries or exploratory holes. The adits may contain elevated levels of inorganic contaminants of concern and may present a chemical hazard to humans and animals. Some of the adits extend below the ground surface and create steep-sided, narrow openings that present a fall or entrapment hazard to people and animals. Therefore, the adits may need to be closed permanently to eliminate these risks. Samples were not collected from adits or exploration features on the Site because of these physical hazards.

5.0 NATURE AND EXTENT OF SITE CONTAMINATION

Soil samples were collected from waste rock piles and downslope of waste rock piles to determine the nature and extent of mining impacts on human health and the environment at the Saddle Rock property. The analytical results for the soil samples are presented in Table 4. Summary statistics for each AOC are presented in Tables 5 through 12.

5.1 Data Quality and Reporting

A data quality validation review was performed upon receipt of laboratory results and before statistical evaluation of data, comparison to screening criteria, or human health and ecological risk screening.

Data quality is indicated by assessing their precision, accuracy, representativeness, completeness, and comparability (PARCC). All analyses were performed in a manner consistent with the methods and guidelines stated in the SAP/QAPP. The chemistry data were reviewed and validated by Hart Crowser chemists. Overall, the data quality objectives (DQOs), as set forth in the SAP, were achieved, and the data for this project are acceptable for use, as qualified.

Results for several analytes were qualified as estimated concentrations based on exceedances of quality control criteria. All results for antimony were qualified as estimated (J) due to matrix spike exceedances. Laboratory reporting limits (RL) for selenium were higher than the preliminary selenium screening level. The laboratory quantitated the metals to the method detection limit (MDL) and reported sample detections that fell between the MDL and the RL as estimated results. The RL for selenium exceeded the associated screening level developed for this project and the laboratory did not report any estimated results for selenium below the RL.

The chemical data quality review and laboratory reports are presented in Appendix C.

5.2 Soil Screening Criteria

Preliminary human health screening criteria were selected using MTCA Method B soil cleanup levels for unrestricted land use from Ecology's Cleanup Levels and Risk Calculation (CLARC) database or Method A soil cleanup levels for unrestricted land use (Table 740-1, WAC 173-340-900). Preliminary ecological protection screening levels were selected from MTCA ecological indicator soil concentrations for protection of terrestrial plants and animals (Table 749-3, WAC 173-340-900). The lowest of the criteria described above were used as the initial screening level.

In cases where screening criteria are less than the natural background concentrations, screening criteria default to natural background. Background concentration calculations were performed using EPA's ProUCL 4.0 to determine the 90th percentile concentrations. Since ProUCL provides results for multiple data distributions (normal, lognormal, gamma, and non-parametric), the

90th percentile background concentration was chosen using the best fit data distribution from the ProUCL Goodness-of-Fit (GOF) module. ProUCL calculation results are presented in Appendix D.

Natural background concentrations for soil were used as screening criteria for aluminum, arsenic, barium, iron, manganese, and vanadium because background concentrations are higher than MTCA cleanup levels. Potential screening levels, calculated natural background concentrations, and selected preliminary screening levels for soil are presented in Table 13.

It should be noted that these screening levels were developed to provide conservative criteria for identifying constituents and areas of potential concern at the site. Exceedances of these screening levels do not necessarily indicate that there are unacceptable risks to human health and ecological receptors or that active remediation is required.

5.3 Waste Rock Surface Soil

Five soil samples were collected from each waste rock pile of less than 1000 cy, and ten soil samples were collected from each waste rock pile of greater than 1000 cy. All samples taken from the waste rock piles were discrete samples collected from the upper 12 inches of soil. The sample locations were spaced evenly across the surface of each waste rock pile.

Three discrete samples were collected from the larger waste rock piles (SR-02, SR-03, and SR-08) and submitted for soil pH analysis to provide a qualitative indication of the potential for metal leaching and migration. Two composites created from the five discrete samples containing the highest metal concentrations from waste rock piles SR-02 and SR-03 were submitted for synthetic precipitation leaching procedure (SPLP) analysis to provide additional indications of the potential for metal leaching and migration.

Ten-point composite soil samples were collected from the area downslope of the toe of each waste rock pile. A composite sample was collected from each of the following three zones outside the area beyond any visible extent of the waste rock pile:

- 0 to 20 feet,
- 20 to 40 feet, and
- 40 to 60 feet

Sampling points were identified using a random number selection process. Coordinates of the individual discrete samples used in the composites were not recorded, and the composite sample locations on Figures 5 through 11 reflect the locations of the discrete archive samples.

Analytical results for the discrete and the composite samples were compared to screening levels and are described below for the different waste rock areas. The composite sample results were used to determine if there were downslope impacts from waste rock based on the average (composite) concentrations for each zone. Composite sample results discussed in the following subsections indicated potential impacts downslope of all waste rock piles. Additional characterization may be required during remedial design to more fully characterize the downslope extent of metal contamination.

5.3.1 Waste Rock Feature SR-01

SR-01 is located closest to the park entrance and the main hiking trail. The waste rock pile consists of mostly sedimentary rocks, which range in grain size from boulders to clay. The soils tended to be very gravelly clay. We estimated a volume of about 155 cy for the waste rock pile. Five discrete samples and three composite samples were collected from feature SR-01 (Figure 5).

Samples that exceeded screening levels are summarized below.

- All samples (SR-01-D01 through SR-01-D05) exceeded arsenic and mercury screening levels.

- Samples SR-01-D01, SR-01-D04, and SR-01-D05 exceeded iron screening levels.

- Samples SR-01-D01 and SR-01-D05 exceeded manganese screening levels.

- Sample SR-01-D03 exceeded the silver screening level.

Composite soil samples collected beyond the toe of the waste rock pile show similar screening level exceedances, though the levels of exceedances are generally lower than the levels in the waste rock piles and concentrations decrease with distance from the waste rock pile.

- All samples (SR-01-C01, SR-01-C02, and SR-01-C03) exceeded arsenic and mercury screening levels.

- Samples SR-01-C01 and SR-01-C02 exceeded silver screening levels.

- Sample SR-01-C01 exceeded selenium screening levels.

5.3.2 Waste Rock Feature SR-02

SR-02 is a large waste rock pile located close to the park entrance and is accessible from the main hiking trail. An adit filled with concrete is located close to the waste rock pile, which is a large mound. The waste rock pile consists of mostly sandy, clayey gravel. Large cobbles were observed at all sample locations. We estimated a volume of about 3,023 cy for the waste rock pile. Ten discrete samples and three composite samples were collected from feature SR-02. The composite samples were collected downslope from the base of the waste rock pile (Figure 6).

Samples that exceeded screening levels are summarized below.

- All samples (SR-02-D01 through SR-02-D10) exceeded arsenic, mercury, selenium, and silver screening levels.
- Sample SR-02-D05 exceeded lead screening levels.
- Sample SR-02-D08 exceeded iron screening levels.
- Sample SR-02-D09 exceeded barium and iron screening levels.

Composite soil samples collected beyond the toe of the waste rock pile showed fewer screening level exceedances, both in number and in magnitude and concentrations decrease with distance from the waste rock pile.

- All samples (SR-02-C01, SR-02-C02, and SR-02-C03) exceeded arsenic screening levels.
- Samples SR-02-C01 and SR-02-C02 exceeded mercury screening levels.
- Sample SR-02-C02 exceeded manganese screening levels.

5.3.3 Waste Rock Feature SR-03

SR-03 is a large waste rock feature with no obvious, visible mining activity. As mentioned earlier, the rock feature may be related to installation of the nearby power lines rather than mining activity. The waste rock pile consists of mostly sandy, clayey gravel or gravelly clay. We estimated a volume of about 2,002 cy for the waste rock pile. Ten discrete samples and three composite samples were collected from feature SR-03. The composite samples were collected downslope from approximately one-half of the base of the apparent waste rock pile (Figure 7).

Samples that exceeded screening levels are summarized below.

- All samples (SR-03-D01 through SR-03-D10) exceeded arsenic screening levels.

- Samples SR-03-D01, SR-03-D04, SR-03-D05, SR-03-D06, SR-03-D07, SR-0D-D08, SR-03-D09, and SR-03-D10 exceeded mercury screening levels.

- Samples SR-03-D01, SR-03-D02, SR-03-D03, SR-03-D04, SR-03-D05, SR-03-D06, SR-03-D07, SR-0D-D08, and SR-03-D09 exceeded silver screening levels.

- Samples SR-03-D01, SR-03-D03, SR-03-D04, SR-03-D05, SR-03-D06, SR-03-D07, SR-0D-D08, and SR-03-D09 exceeded selenium screening levels.

Composite soil samples collected beyond the toe of the waste rock pile showed fewer screening level exceedances, both in number and in magnitude and concentrations decrease with distance from the waste rock pile.

- All samples (SR-03-C01, SR-03-C02, and SR-03-C03) exceeded arsenic screening levels.

- Samples SR-03-C01 and SR-03-C02 exceeded mercury and silver screening levels.

- Sample SR-03-C03 exceeded barium screening levels.

5.3.4 Waste Rock Feature SR-04

SR-04 is a small waste rock pile with a nearby adit, located furthest from the main entrance to the park. The waste rock pile consists of mostly gravelly sandy silt. We estimated a volume of about 88 cy for the waste rock pile. Five discrete samples and three composite samples were collected from feature SR-04. The composite samples were collected downslope from the toe of the waste rock pile (Figure 8).

Samples that exceeded screening levels are summarized below.

- All samples (SR-04-D01 through SR-04-D05) exceeded arsenic screening levels.

- Sample SR-04-D02 exceeded iron and silver screening levels.

Composite soil samples collected beyond the toe of the waste rock pile showed similar screening level exceedances, with comparable levels though concentrations decrease with distance from the waste rock pile.

- All samples (SR-04-C01, SR-04-C02, and SR-04-C03) exceeded arsenic screening levels.

5.3.5 Waste Rock Feature SR-05

SR-05 has a waste rock pile with a very steep slope below the toe of the pile. The waste rock pile consists of mostly sandy, clayey gravel or gravelly clay. We estimated a volume of about 426 cy for the waste rock pile. Five discrete samples and three composite samples were collected from feature SR-05. The composite samples were collected down slope from the toe of the waste rock pile (Figure 9).

Samples that exceeded screening levels are summarized below.

- All samples (SR-05-D01 through SR-05-D05) exceeded arsenic and silver screening levels.

- Samples SR-05-D01, SR-05-D03, SR-05-D04, and SR-05-D05 exceeded mercury screening levels.

- Samples SR-05-D02, SR-05-D03, SR-05-D04, and SR-05-D05 exceeded selenium screening levels. Sample SR-05-D06, the field duplicate for SR-05-D01 also exceeded the selenium screening level.

- Samples SR-05-D04 and SR-05-D05 exceeded iron screening levels.

- Sample SR-05-D05 exceeded vanadium screening levels.

Composite soil samples collected beyond the toe of the waste rock piles showed similar screening level exceedances, though concentrations decrease with distance from the waste rock pile.

- All samples (SR-05-C01, SR-05-C02, and SR-05-C03) exceeded arsenic and silver screening levels.

- Sample SR-05-C01 exceeded selenium screening levels.

5.3.6 Waste Rock Feature SR-06

SR-06 had a small waste rock pile with no visible signs of historical prospecting or mining activity. This area is located at an obvious resting point on the main hiking trail and rock debris appears to be from a road cut rather than mining activity. The waste rock pile consists of mostly clayey sand. We estimated a volume of about 236 cy for the waste rock pile. Five discrete samples and three composite samples were collected from feature SR-06. The composite samples were collected downslope from the toe of the waste rock pile (Figure 10).

Two of the samples were collected from a cut bank above the trail that appeared to be native material, two samples were collected from the waste rock pile, and one sample was collected from the trail. Samples that exceeded screening levels are summarized below.

- All samples (SR-06-D01 through SR-06-D05) exceeded arsenic and mercury screening levels.

- Samples SR-06-D03 and SR-06-D04 exceeded barium screening levels.

- Samples SR-06-D04 and SR-06-D05 exceeded iron screening levels.

Composite soil samples collected beyond the toe of the waste rock pile showed similar screening level exceedances as the cut bank, trail, and waste rock pile samples. Unlike the other waste rock areas, there does not appear to be a consistent decrease in concentrations with distance from the SR-06 waste rock pile.

- All samples (SR-06-C01, SR-06-C02, and SR-06-C03) exceeded arsenic and mercury screening levels.

- Sample SR-06-C02 exceeded barium screening levels.

Given that arsenic concentrations do not appear to be decreasing with distance from the road cut, the extent of the area exceeding screening levels can not be reliably estimated and may be associated with native mineralized soils.

5.3.7 Waste Rock Feature SR-07

SR-07 had no apparent waste rock pile, and only a small shallow adit or exploration. The soil consisted of gravelly sand. Five discrete samples and two composite samples were collected from feature SR-07. The discrete samples were collected from a 15-foot radius around the adit. One composite sample was collected from the steep slope above the trail that crosses in front of the adit. The other composite sample was collected from the slope below the trail (Figure 11).

Samples that exceeded screening levels are summarized below.

- All samples (SR-07-D01 through SR-07-D05) exceeded arsenic, barium, and silver screening levels.

- Sample SR-07-D01 exceeded selenium screening levels.

Composite soil samples collected from the nearby slope below the adit showed similar screening level exceedances, though concentrations generally appear to decrease with distance from the adit.

- All samples (SR-07-C01 and SR-07-C02) exceeded arsenic, barium, and silver screening levels.

- Sample SR-07-C01 exceeded selenium screening levels.

5.3.8 Waste Rock Feature SR-08

SR-08 had a small waste rock pile, with a sealed adit upslope. The waste rock pile consists of mostly sandy, clayey gravel. We estimated a calculated volume of about 115 cy for the waste rock pile. Five discrete samples and three composite samples were collected from feature SR-08. The composite samples were collected downslope on the east side of the pile (Figure 11).

Samples that exceeded screening levels are summarized below.

- All samples (SR-08-D01 through SR-08-D05) exceeded arsenic, selenium, and silver screening levels.

- Samples SR-08-D01 and SR-08-D02 exceeded mercury screening levels.

Composite soil samples collected beyond the waste rock pile showed similar screening level exceedances, though at generally lower concentrations with increasing distance from the waste rock pile.

- Samples SR-08-C01 and SR-08-C02 exceeded arsenic screening levels.

- Sample SR-08-C01 exceeded mercury screening levels.

5.4 Impacts to Surface Water and Groundwater

5.4.1 Surface Water

Saddle Rock Park does not have any surface water bodies. Ruts were observed on the main trail, and some gullies are present in the park, but these features appeared to be related to seasonal rain and snowmelt. No erosional features were observed on the toe or main areas of the waste rock features. While there are localized erosional features on the face of the waste rock piles, most surface water runoff is likely to evaporate or infiltrate into the soil.

5.4.2 Groundwater Protection

Soil Concentrations Protective of Groundwater

While there are no wells installed in the park, a water well report from 1997 indicates that groundwater at an adjacent property is 340 feet below the ground surface. Although a number of soil metal concentrations exceed groundwater protection levels, it is highly unlikely that surface leaching and infiltration would impact groundwater due to the lack of precipitation and depth to groundwater.

All samples exceed soil concentrations protective of groundwater for arsenic and iron and many samples exceed groundwater protection criteria for manganese and vanadium. The natural background soil concentrations for these metals are higher than the groundwater protection cleanup levels. According to WAC 173-200, constituents for which the background concentration level is higher than the protection standard shall use the background concentration as the criteria.

Soil samples collected from waste rock piles SR-02 and SR-03 also exceeded groundwater protective levels for silver and samples from SR-06 were above protective levels for mercury.

Leachability

Additional waste rock leachability testing was performed to determine if leaching was a potential transport mechanism. Composite samples from the subsamples with the highest waste rock metal exceedances were analyzed for leachability. Subsamples from waste rock piles SR-02, SR-03, and SR-06 were composited at the analytical laboratory to provide sufficient sample volume for analysis. The results are presented in Table 14.

Two different leaching methods were used to prepare the samples. The Synthetic Precipitation Leaching Procedure (SPLP) is designed to simulate leaching that might affect the *in situ* material exposed to acid rainfall. The Toxicity Characteristic Leaching Procedure (TCLP) is a more aggressive leaching test using acid at lower pH than the SPLP. The TCLP test is designed to simulate leaching of material in a municipal landfill and is the procedure specified for determining if material is characteristic dangerous waste.

Two of the composite samples (SR-02 and SR-03) were prepared and analyzed for SPLP leaching to determine if leachate from the waste rock piles would exceed groundwater criteria. Extraction fluid representing acid rain in the western United States (pH = 5.0) was used for leaching. WAC173-340-747(7) indicates that TCLP testing should be performed in high sulfur content mining wastes and in situations with pH less than 6.0. SPLP leaching was performed for the following reasons:

- Metals in the Saddle Rock ore body are mainly present in hydrothermal silica alterations that contain little to no sulfur; and

- While soil pH from three waste rock piles was moderately acidic, the volume and depth of visible waste rock is limited. The dominant native soil type (Bjork series) in the area is slightly alkaline (reported pH = 7.6) and would tend to neutralize any acidic leachate.

The SPLP leachate samples were analyzed for aluminum, arsenic, and silver. With the exception of arsenic, which is present at high concentrations in natural background, leachate concentrations for aluminum and silver were below MTCA groundwater cleanup levels. The arsenic concentration at SR-03 exceeded the MTCA Method A criterion for groundwater while the laboratory detection limit for SR-02 was higher than the Method A groundwater criterion. Arsenic is unlikely to impact groundwater due to the depth to groundwater (greater than 340 feet), low precipitation (annual average = 9 inches), and arsenic's strong binding to iron (III) oxides in soil. Additional discussion of the leach testing results is presented in Section 6.1.2.

The composite samples were prepared and analyzed for toxicity characteristics (TCLP) to determine if the soils at the waste rock piles would exceed hazardous waste criteria if transported to a landfill. The three composite samples did not fail TCLP criteria for arsenic or mercury and, therefore, excavated material would not be classified as dangerous waste.

6.0 FATE AND TRANSPORT OF CONTAMINANTS

This section describes the processes controlling release and transport of metals from waste rock pile sources found at the park. The fate and transport of metals are influenced by both their physical and chemical properties and the characteristics of the surrounding environment.

Most hard rock metal mines involve excavation and processing of ore rock to extract useful metals contained in minerals. In the case of Saddle Rock, ore from the small prospects was transported off-site for processing and smelting. Since it was not practical to recover all the minerals in the ore, non-recovered metal-rich minerals remain on site in rock (waste rock) that was removed to access the ore.

6.1 Potential Physical Transport Mechanisms and Routes

Metal transport can be influenced by both physical and geochemical processes. Physical transport of metals can potentially occur by any of the following processes:

- Water erosion of waste rock;
- Wind-borne transport of waste rock;
- Mass wasting by waste rock sliding down slope of the piles; and
- Leaching and dissolving of metals from waste rock.

6.1.1 Erosion and Physical Transport of Waste Rock

Precipitation, snowmelt, and wind are the primary mechanisms that could potentially erode and transport fine-grained material in the waste rock piles. Factors that influence the mass and distance that material is transported include wind velocity and duration, particle size, particle density, and particle angularity. Wind and water erosion would not affect larger (gravel and larger) waste rock material. Finer grained material from weathered waste rock could potentially be transported by these mechanisms.

A Phase 1 investigation performed by Cascadia (2011) reported that soils at the park were highly erodible and could easily migrate with stormwater runoff and, through trail use, create a public exposure risk. Erosion reported by Cascadia appeared to be primarily limited to the road and associated with large precipitation events. During our RI, small localized erosional features were observed on the face of the waste rock piles. While heavy precipitation events could physically transport fine-grained material, transport is likely limited to the immediate vicinity of the waste rock area. Most surface water runoff is likely to evaporate or infiltrate into the soil.

The dominant Saddle Rock area soil type is the Bjork silt loam series, which is a mix of clay, silt, and sand. The top 12 inches of this soil type is typically moist, slightly hard, firm, slightly sticky and slightly plastic, and mildly alkaline (pH 7.6) (USDA 2002). Other minor soil types include the Cashmere and Cowiche series. The Cowiche soil type is similar to the Bjork series, being slightly hard, firm, slightly sticky and slightly plastic with neutral pH. Windblown dust is unlikely to be a significant transport pathway due to the clayey, cohesive nature of most of the soil present at the park.

6.1.2 Leaching

Precipitation and snowmelt can leach metals from waste rock and tailings and transport them to surface water and groundwater. The rate of leaching and mass of metals leached depends upon the chemical speciation of the metal, surface area of the solid material, water and soil pH, and the amount of precipitation.

Waste rock soil pH was determined for discrete samples collected from SR-02, SR-03, and SR-08; soil pH for these waste rock samples were moderately acidic with pH of 3.53, 5.13, and 4.36, respectively.

Chemical species is the most significant factor influencing leaching. Metal oxides, hydroxides, sulfides, carbonates, and silica-aluminates typically have extremely low solubility in water within a pH range of 5.0 to 8.0. Under low pH conditions, solubility and leaching rates increase, especially for metal sulfides and carbonates.

Metals in the Saddle Rock ore body are mainly present in hydrothermal silica alterations that exhibit extremely low solubility. While waste rock was moderately acidic, the dominant native soil in the area is slightly alkaline (pH 7.6) and would neutralize any potential leachate. Arsenic is leachable in moderately acidic waste rock and under moderately to strongly alkaline conditions. Arsenic solubility is at its minimum under neutral pH conditions. Arsenic leaching and mobility are greatly reduced by its strong adsorption to naturally occurring iron (III) oxide minerals in the soil though, under reducing conditions, iron (III) can be converted to soluble iron (II), remobilizing adsorbed arsenic.

Low leachability was verified by Synthetic Precipitation Leaching Procedure (SPLP) extraction and analysis to determine if metals could be leached from waste rock under conditions mimicking acid rain.

The five archived discrete samples with the highest concentrations of aluminum (aluminum was also tested because ecological screening criteria are based on the soluble fraction), arsenic, and silver from SR-02 and SR-03 were combined and mixed to form SR-02 and SR-03 composite samples. Leachate concentrations for aluminum and silver were less than their respective MTCA Method B groundwater criteria of 16 and 0.08 mg/L. Leachate arsenic concentrations exceeded the groundwater criterion of 0.005 mg/L. Based on the estimated concentrations of the SR-02 and SR-03 composite samples the following percent leachabilities were calculated for aluminum, arsenic, and silver:

- Aluminum composite sample concentrations of 3,750 to 5,600 mg/kg resulted in percent leachability of 0.001 to 0.15 percent.

- Arsenic composite sample concentrations of 200 to 250 mg/kg resulted in percent leachability of less than 0.02 (less than detection limit) to 0.13 percent. While the SPLP test indicates a small fraction of the arsenic is leachable under acid conditions, it is unlikely to be very mobile in the environment since it is well documented that arsenic strongly binds to iron (III) oxides in soil.

- Silver composite sample concentrations of 11 to 12.5 mg/kg resulted in percent leachability of less than 0.0002 (less than detection limit) to 0.05 percent.

Laboratory SPLP results are summarized in Table 14.

As noted in Section 5, samples from SR-06 exceeded screening criteria for mercury. A composite sample created from the five archived discrete samples was extracted and analyzed using TCLP to determine if the waste rock would exceed hazardous waste criteria if transported to a landfill. The TCLP extract mercury concentration of 0.0002 mg/L was less than the groundwater criterion of 0.002 mg/L. Laboratory TCLP results are also summarized in Table 14.

6.2 Potential Geochemical Transport Mechanisms

The Saddle Rock ore body consists of sandstone and siltstone hydrothermal silica alterations that exhibit resistance to oxidation and other geochemical processes that would increase solubility and subsequent leaching and transport. Therefore, metals in waste rock are immobile under the range of soil pH conditions present at the Site. Metal leaching and transport as a dissolved phase is not a significant transport pathway from waste rock to groundwater or surface water.

The Saddle Rock deposits are in marked contrast to ore bodies that contain sulfide mineralization, where waste rock can potentially react with surface water and air to generate acid (acid mine drainage), which reacts with metals in the ore to form more soluble, leachable compounds.

7.0 HUMAN HEALTH AND ECOLOGICAL RISK ASSESSMENTS (HHRA)

A human health risk assessment and terrestrial ecological evaluation (TEE) were prepared to support remedial decision making for the RI/FS. The human health risk assessment was prepared following MTCA section WAC 173-340-708 and the TEE was prepared following MTCA sections WAC 173-340-7490 through 7494. The human health risk assessment and TEE, along with supporting documentation, are presented in Appendix D.

7.1 Human Health Risk Assessment

Risks and hazards to humans from potential exposure to elevated metals concentration at the waste rock piles and downslope areas were evaluated using methods consistent with MTCA.

The waste rock piles contain elevated levels of several metals that have migrated downslope of the toes of the waste rock piles. The recreational visitor was identified as the maximally exposed individual and this exposure scenario was used to characterize hazards and risks at the park. According to input provided by the City, workers visit the park on an infrequent basis (less than one day per week) and tend to focus their efforts on trailhead areas. Day use of trails adjacent to the waste rock pile sites by hikers, joggers, bicyclists, and horseback riders are the principal human exposure scenarios. Recreational visitors may be exposed to mining-related metals through incidental ingestion of soil. However, the waste rock piles themselves are relatively barren and would be unlikely to attract recreational visitors. The inhalation exposure pathway is considered a minor pathway because metals are not volatile and the areas of the waste rock piles are considered too small to contribute significantly to the wind-borne particulate load. Also, dermal uptake of metals contained in soil is generally considered to be a minor pathway.

Arsenic was the only metal identified as a constituent of potential concern (COPC). The arsenic soil screening levels (SSLs) are 1,429 mg/kg for noncarcinogenic effects and 397 mg/kg for carcinogenic effects. Since the arsenic exposure point concentration (EPC) for the combined waste rock pile and downslope areas (220.9 mg/kg) is less than either SSL, it is concluded that arsenic does not pose a hazard or risk to recreational visitors to the park.

Potential exposure for the recreational visitor was characterized as minor (*de minimis*) based on site-specific estimates of exposure frequency and the fraction of time spent on these areas. Consequently, hazards and risks to human health were assessed and were found to be below a level of concern. Uncertainties associated with this health assessment are unlikely to underestimate risks or hazards.

7.2 Terrestrial Ecological Evaluation

Hazards to plants and animals were assessed by comparing ecologically protective SSLs for plants, soil biota, and wildlife to reasonable maximum exposure point concentrations (EPCs) for soil. EPCs were derived for three potential ecological exposure areas: the waste rock piles, downslope areas, and the entire 325-acre property. Results of the assessment for the waste rock pile and downslope exposure areas show potential hazards (hazard quotient greater than 1) from arsenic, mercury, and selenium at all waste rock pile sites to one or more receptor groups (i.e., plants, soil biota, and wildlife).

8.0 REMEDIAL INVESTIGATION SUMMARY AND CONCLUSIONS

Eight areas identified by Ecology as waste rock piles from historical mining activities were sampled and analyzed for metals as part of the Saddle Rock Park remedial investigation. No features indicating mining activity were observed at three of the areas (SA-03, SA-06, and SA-07). It appears that rock in these areas is a result of construction activities from road building or power line installation.

Samples from the surface of each waste rock pile and from the area downslope from the toe of the piles had metal concentrations above preliminary human health or ecological screening levels. The only waste rock area metals initially identified by Ecology as potential chemicals of concern that were above natural background concentrations were arsenic, mercury, selenium, and silver. Based on the physical and geochemical properties of soil and rock at the park, metals are relatively immobile and are unlikely to impact groundwater or the surrounding environment.

The human health risk assessment determined that potential exposure for the recreational visitor are minor (*de minimis*) based on site-specific estimates of exposure frequency and the fraction of time spent on these areas.

Results of the ecological assessment for the waste rock pile and downslope exposure areas show potential hazards (hazard quotient greater than 1) from arsenic, mercury, and selenium at all sites to one or more receptor groups (plants, soil biota, and wildlife).

9.0 REFERENCES

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Table 1 - Background Sample Analytical Results

Sample ID Sampling Date Sample Depth	MTCA Method B Screening Levels	Draft Screening Levels[e]	BG-D01 2/21/2013 0 - 6"	BG-D02 2/21/2013 0 - 6"	BG-D03 2/21/2013 0 - 6"	BG-D04 2/22/2013 0 - 3"	BG-D05 2/22/2013 0 - 6"	BG-D21 2/22/2013 Dup of BG-D05	BG-D06 2/22/2013 0 - 6"
Metals in mg/kg									
Aluminum	80,000	22,524	16700	20500	19000	12000	10600	12000	7250
Antimony	32	5	0.2 UJ	0.2 UJ	0.2 UJ	0.3 UJ	0.2 UJ	0.2 UJ	0.2 UJ
Arsenic[a]	0.67/24	14.4	3.1	4.9	12.2	5.9	4.9	4.6	5.9
Barium	16,000	160	175	130	157	88	69.5	83.3	86.5
Chromium[b]	120,000/240	42	13.6	15.3	17.3	15.3	5.3	6.1	18
Iron	56,000	29,324	28800	33900	21000	18100	19300	20000	26600
Lead[c]	250	50	13.1	8.3	9.7	10.2	9	9.7	12.9
Manganese	11,000	753	748	776	515	305	334	336	472
Mercury[d]	24	0.1	0.02	0.031	0.02	0.01	0.01 U	0.01 U	0.011
Selenium	400	0.3	*0.6 U*	*0.6 U*	*0.6 U*	*0.7 U*	*0.5 U*	*0.5 U*	*0.5 U*
Silver	400	2	0.2 U	0.2 U	0.6	0.3 U	0.2 U	0.2 U	0.2 U
Vanadium	5.6	44.9	42.5	45	32.9	27.9	26.1	26.4	48.5

Table 1 - Background Sample Analytical Results

Sample ID Sampling Date Sample Depth	MTCA Method B Screening Levels	Draft Screening Levels[e]	BG-D07 2/20/2013 0 - 6"	BG-D08 2/22/2013 0 - 6"	BG-D09 2/22/2013 0 - 6"	BG-D22 2/22/2013 Dup of BG-D09	BG-D10 2/20/2013 0 - 6"	BG-D11 2/20/2013 0 - 6"	BG-D12 2/22/2013 0 - 6"
Metals in mg/kg									
Aluminum	80,000	22,524	18100	18700	18200	17900	12900	19700	21600
Antimony	32	5	0.2 UJ	0.2 UJ	0.2 UJ	0.2 UJ	0.2 UJ	0.2 UJ	0.2 UJ
Arsenic[a]	0.67/24	14.4	3.7	2.9	7	7.4	55.6	4.7	5.9
Barium	16,000	160	144	113	148	148	129	121	167
Chromium[b]	120,000/240	42	17	10.1	15.9	15.3	8.2	8.8	11.3
Iron	56,000	29,324	34000	25400	22800	23200	17700	24400	20800
Lead[c]	250	50	7.4	10.4	7.3	8.1	8	13.7	9.4
Manganese	11,000	753	597	400	479	478	382	417	654
Mercury[d]	24	0.1	0.013	0.061	0.02	0.02	0.05	0.02	0.07
Selenium	400	0.3	*0.6 U*	*0.5 U*	*0.5 U*	*0.5 U*	*0.6 U*	*0.5 U*	*0.6 U*
Silver	400	2	0.2 U	0.2 U	0.2	0.2	0.2 U	0.2 U	0.2 U
Vanadium	5.6	44.9	57.1	35.2	34.4	32.8	21.8	25.6	26.1

Table 1 - Background Sample Analytical Results

Sample ID Sampling Date Sample Depth	MTCA Method B Screening Levels	Draft Screening Levels[e]	BG-D13 2/22/2013 0 - 6"	BG-D14 2/22/2013 0 - 6"	BG-D15 2/22/2013 0 - 6"	BG-D16 2/20/2013 0 - 6"	BG-D17 2/21/2013 0 - 3.5"	BG-D18 2/22/2013 0 - 2"	BG-D19 2/21/2013 0 - 2"	BG-D20 2/21/2013 0 - 3"
Metals in mg/kg										
Aluminum	80,000	22,524	20200	10800	17400	17700	22800	18800	24600	14100
Antimony	32	5	0.2 UJ	0.2 UJ	0.2 UJ	0.2 UJ	0.3 UJ	0.4 UJ	0.2 UJ	0.3 UJ
Arsenic[a]	0.67/24	14.4	6.3	4.8	7.1	5.7	181	14.6	10.2	2.8
Barium	16,000	160	110	89.7	111	134	141	135	86.3	118
Chromium[b]	120,000/240	42	14	8.6	10.8	15	7.6	12	11.8	16
Iron	56,000	29,324	27200	16000	24100	21400	21200	19800	24800	17300
Lead[c]	250	50	12.5	4	19.3	11.6	12.8	31.1	12.5	7.3
Manganese	11,000	753	753	662	722	399	411	616	781	529
Mercury[d]	24	0.1	0.02	0.03	0.02	0.01	0.04	0.03	0.02	0.01 U
Selenium	400	0.3	*0.6 U*	*0.6 U*	*0.6 U*	*0.6 U*	*0.6 U*	*0.9 U*	*0.6 U*	*0.6 U*
Silver	400	2	0.2 U	0.2 U	0.2 U	0.2 U	0.5	0.4 U	0.2 U	0.3 U
Vanadium	5.6	44.9	32.8	24.6	26.2	37.5	22.3	27.6	37.9	25.4

a - cacinogenic/non-carcinogenic

b - chromium(+3)/chromium(+6)

c - MTCA Method A

d - as $HgCl_2$

e - Lowest of MTCA Method A, MTCA Method B, and Ecological Indicator Screening Critria or natural background where background is higher than criteria.

Table 2 - Background Sample Summary Statistics

Parameter	Data Distribution	Number Samples	Number Non-Detects	Minimum	Maximum	Mean	Median	Standard Deviation	90th Percentile
Aluminum	normal	22	0	7250	24600	16889	18000	4397	22524
Antimony	undetermined	22	22	0.2 U	0.3 U	NA	0.2 U	NA	NA
Arsenic[a]	nonparametric	22	0	2.8	181	16.4	5.9	38.3	14.4
Barium	normal	22	0	69.5	175	122	125	29.3	159.6
Chromium[b]	normal	22	0	5.3	18	12.4	12.8	3.8	17.3
Iron	lognormal	22	0	16000	34000	23082	22100	4866	29324
Lead[c]	lognormal	22	0	4	31.1	11.3	9.95	5.43	17.4
Manganese	lognormal	22	0	305	781	535	497	157	753
Mercury[d]	lognormal	22	3	0.01	0.07	0.025	0.02	0.11	0.049
Selenium	undetermined	22	22	0.5 U	0.7 U	NA	0.6 U	NA	NA
Silver	lognormal	22	18	0.2	0.6	0.375	0.2 U	0.206	0.039
Vanadium	gamma	22	0	21.8	57.1	32.6	30.4	9.17	44.6

Data distribution determined by ProUCL Goodness-of-Fit
Undetermined - Too few detected results to determine the data distribution or calculate a standard deviation
NA - Could not be calculated due to non-detected results

Table 3 - Dimensions of Waste Rock Piles

Area of Concern	Area (square feet)	Depth (feet)	Volume (cubic feet)	Volume (cubic yards)
SR-01	2089	2	4178	155
SR-02	12569	6.5	81699	3023
SR-03[a]	9020	6	54120	2002
SR-04	474	5	2370	88
SR-05	4608	2.5	11520	426
SR-06[a]	3187	2	6374	236
SR-07[b]	---	---	---	---
SR-08	1242	2.5	3105	115

[a] Hart Crowser did not observe land disturbance at these locations. Rock accumulations at these locations do not appear to be associated with mining activities.
[b] No waste rock pile was observed in this location.

Table 4 - Waste Rock Pile Sample Analytical Results

			Waste Rock Pile SR01								
			Waste Rock Discrete						Composite Samples from Toe of Waste Rock Pile		
Sample ID Sampling Date Sample Depth	MTCA Method B Screening Levels	Draft Screening Levels[e]	SR01-D01 2/18/2013 0 - 12"	SR01-D06 2/18/2013 Dup of SR01-D01	SR01-D02 2/18/2013 0 - 12"	SR01-D03 2/18/2013 0 - 12"	SR01-D04 2/18/2013 0 - 12"	SR01-D05 2/18/2013 0 - 12"	SR01-C01 2/18/2013 0 - 6"	SR01-C02 2/18/2013 0 - 6"	SR01-C03 2/19/2013 0 - 6"
pH											
Metals in mg/kg											
Aluminum	80,000	22,524	17600	18500	15700	8320	17800	17800	14900	16200	15700
Antimony	32	5	0.2 UJ	0.2 UJ	0.2 UJ	0.2 UJ	0.2 UJ	0.2 UJ	0.2 UJ	0.2 UJ	0.2 UJ
Arsenic[a]	0.67/24[a]	14.4	178	136	53.3	209	212	139	145	71	58.7
Barium	16,000	160	84.7	84.2	119	74	105	101	110	124	128
Chromium[b]	120,000/240[b]	42	13.7	13.9	10.8	7.9	13.2	12.6	12.7	11.6	11.8
Iron	56,000	29,324	42300	39400	23100	26700	33900	37200	28300	24200	21700
Lead[c]	250[c]	50	14.3	14.4	12.2	14.9	15.8	11.4	12.7	11.7	16.2
Manganese	11,000	753	899	943	511	154	672	898	537	507	486
Mercury[d]	24[d]	0.1	0.38 J	0.302 J	0.33	0.59	0.26	0.36	0.26	0.23	0.18
Selenium	400	0.3	*0.6 U*	*0.6 U*	*0.6 U*	*2 U*	*0.6 U*	*0.6 U*	0.8	*0.6 U*	*0.6 U*
Silver	400	2	1.7	1.4	1	9.4	1.3	1.1	2.5	2.4	1.5
Vanadium	5.6	44.9	21.9	22.1	25.6	12	24.4	21.4	23.1	23.4	26.8

Table 4 - Waste Rock Pile Sample Analytical Results

			Waste Rock Pile SR02									
			Waste Rock Discrete									
Sample ID Sampling Date Sample Depth	MTCA Method B Screening Levels	Draft Screening Levels[e]	SR02-D01 2/19/2013 0 - 12"	SR02-D02 2/19/2013 0 - 12"	SR02-D03 2/19/2013 0 - 12"	SR02-D11 2/19/2013 Dup of SR02-D03	SR02-D04 2/19/2013 0 - 12"	SR02-D05 2/19/2013 0 - 12"	SR02-D06 2/19/2013 0 - 12"	SR02-D07 2/19/2013 0 - 12"	SR02-D08 2/19/2013 0 - 10"	SR02-D09 2/19/2013 0 - 12"
pH			3.53									
Metals in mg/kg												
Aluminum	80,000	22,524	1360	1970	3260	3140	2640	3510	1270	2380	17600	16200
Antimony	32	5	0.2 UJ	0.2 UJ	0.2 UJ	0.2 UJ	0.2 UJ	0.2 UJ	0.2 UJ	0.2 UJ	0.2 UJ	0.2 UJ
Arsenic[a]	0.67/24[a]	14.4	82.8	162	204	218	190	183	99.6	172	116	513
Barium	16,000	160	60	57.2	55.7	50.6	59.8	63.7	46.7	35.2	114	180
Chromium[b]	120,000/240[b]	42	1.6	1.4	3.6	1.9	2.1	2.6	1.6	1.2	14.4	10.6
Iron	56,000	29,324	12200	7490	14000	13200	11400	12900	8270	5750	31300	42600
Lead[c]	250[c]	50	4.7	12.9	20.7	13.7	18	59.1	11.6	24.3	12.7	28.3
Manganese	11,000	753	2.8	3.1	19.2	10	16.1	16.4	2.5	3.2	316	111
Mercury[d]	24[d]	0.1	0.277	0.23	0.245	0.168	0.455	0.27	0.4	1.02	0.502	0.69
Selenium	400	0.3	1.3	1.5	1.4	1.4	2.2	1.5	1.2	3.6	0.7	2.8
Silver	400	2	12.9	14	8.1	9.6	16.9	12.8	14.9	19.1	3.3	5.8
Vanadium	5.6	44.9	4	1.5	7.6	3.8	4.5	5	2.2	1.2	28	21.6

Table 4 - Waste Rock Pile Sample Analytical Results

			Waste Rock Pile SR02 cont'd				Waste Rock Pile SR03					
			Waste Rock Discrete	Composite Samples from Toe of Waste Rock Pile			Waste Rock Discrete					
Sample ID	MTCA Method B Screening Levels	Draft Screening Levels[e]	SR02-D10	SR02-C01	SR02-C02	SR02-C03	SR03-D01	SR03-D02	SR03-D03	SR03-D04	SR03-D05	SR03-D06
Sampling Date			2/19/2013	2/19/2013	2/19/2013	2/19/2013	2/20/2013	2/20/2013	2/20/2013	2/20/2013	2/20/2013	2/20/2013
Sample Depth			0 - 12"	0 - 6"	0 - 6"	0 - 6"	0 - 11"	0 - 10"	0 - 8"	0 - 7"	0 - 8"	0 - 6"
pH							5.13					
Metals in mg/kg												
Aluminum	80,000	22,524	2570	19200	16600	18700	4890	3390	3270	5670	4310	2800
Antimony	32	5	0.3 UJ	0.2 UJ	0.2 UJ	0.2 UJ	0.2 UJ	0.2 UJ	0.2 UJ	0.2 UJ	0.2 UJ	0.2 UJ
Arsenic[a]	0.67/24[a]	14.4	148	28.2	26	15.7	417	104 J	106	57	88.3	83.9
Barium	16,000	160	50.1	148	139	148	99.3	17.2	116	56.9	36.6	19.2
Chromium[b]	120,000/240[b]	42	2.2	14.2	15.3	14.6	2.4	1.7	2.3	3.7	2.5	1.4
Iron	56,000	29,324	7210	24100	21400	23700	9440	2330	10100	9130	5360	3250
Lead[c]	250[c]	50	21.2	15.6	22.8	8.7	7.2	5.1	11.1	10.3	2.9	7.3
Manganese	11,000	753	8.5	611	794	629	13.9	10.7	16.9	84.7	32.9	9.9
Mercury[d]	24[d]	0.1	0.702	0.191	0.1	0.045	1.09	0.095	0.057	0.169	0.676	0.93
Selenium	400	0.3	2.7	*0.6 U*	*0.6 U*	*0.6 U*	2.9	*0.5 U*	1.4	0.7	0.7	1.2
Silver	400	2	17.4	0.7	0.9	0.6	9.6	3.8	6.5	4.7	5.8	10.8
Vanadium	5.6	44.9	2.2	31.5	28.8	29.2	3	1.8 J	3.1	8.3	3.1	1.5

Table 4 - Waste Rock Pile Sample Analytical Results

			Waste Rock Pile SR03 cont'd							
			Waste Rock Discrete					Composite Samples from Toe of Waste Rock Pile		
Sample ID Sampling Date Sample Depth	MTCA Method B Screening Levels	Draft Screening Levels[e]	SR03-D07 2/20/2013 0 - 12"	SR03-D08 2/20/2013 0 - 12"	SR03-D09 2/20/2013 0 - 9"	SR03-D10 2/20/2013 0 - 12"	SR03-D11 2/20/2013 Dup of SR03-D10	SR03-C01 2/20/2013 0 - 6"	SR03-C02 2/20/2013 0 - 6"	SR03-C03 2/20/2013 0 - 6"
pH										
Metals in mg/kg										
Aluminum	80,000	22,524	2630	4550	4290	16100	15600	12100	14500	19100
Antimony	32	5	0.2 UJ	0.2 UJ	0.2 UJ	0.2 UJ	0.2 UJ	0.2 UJ	0.2 UJ	0.2 UJ
Arsenic[a]	0.67/24[a]	14.4	174	200	108	79.2	77.1	71.5	42.4	23.7
Barium	16,000	160	50.7	21.9	85.2	142	134	116	125	205
Chromium[b]	120,000/240[b]	42	1.7	3.1	3.4	6.2	5.9	10.8	11.1	15.8
Iron	56,000	29,324	10900	3320	4200	21200	18900	16500	21100	21200
Lead[c]	250[c]	50	14.4	6.8	3	6.3	6.4	10.5	9.9	10.9
Manganese	11,000	753	10.1	13	46.6	249	238	303	482	507
Mercury[d]	24[d]	0.1	0.565	0.61	0.199	0.13	0.139	0.108	0.118	0.06
Selenium	400	0.3	2	0.9	1.3	*0.5 U*	*0.5 U*	*0.5 U*	*0.5 U*	*0.6 U*
Silver	400	2	16.3	18.7	8.2	1.5	1.3	4.7	2.9	1.4
Vanadium	5.6	44.9	2.1	2.5	4.9	20.4	20.7	22.5	24	29.8

Table 4 - Waste Rock Pile Sample Analytical Results

			Waste Rock Pile SR04								
			Waste Rock Discrete		Waste Rock Discrete				Composite Samples from Toe of Waste Rock Pile		
Sample ID	MTCA	Draft	SR04-D01	SR04-D02	SR04-D03	SR04-D06	SR04-D04	SR04-D05	SR04-C01	SR04-C02	SR04-C03
Sampling Date	Method B	Screening	2/21/2013	2/21/2013	2/21/2013	2/21/2013	2/21/2013	2/21/2013	2/21/2013	2/21/2013	2/21/2013
Sample Depth	Screening Levels	Levels[e]	0 - 12"	0 - 12"	0 - 12"	Dup of SR04-D03	0 - 12"	0 - 12"	0 - 6"	0 - 6"	0 - 6"
pH											
Metals in mg/kg											
Aluminum	80,000	22,524	7900	7550	9330	8560	8810	8350	11000	12300	13900
Antimony	32	5	0.2 UJ	0.2 UJ	0.2 UJ	0.2 UJ	0.2 UJ	0.2 UJ	0.2 UJ	0.2 UJ	0.2 UJ
Arsenic[a]	0.67/24[a]	14.4	106	124	134	130	69.9	54.8	102	69.1	61.3
Barium	16,000	160	43	51.7	71.2	69.5	70	56.1	68.1	107	107
Chromium[b]	120,000/240[b]	42	4.9	5.2	6.4	6.4	6.9	6.9	6.1	8.6	8.2
Iron	56,000	29,324	24900	29400	29100	28400	22600	18800	21400	21000	21400
Lead[c]	250[c]	50	13.2	18.6	12.5	12.2	12.3	12.6	8.4	12.2	10.7
Manganese	11,000	753	163	185	200	192	238	187	251	337	343
Mercury[d]	24[d]	0.1	0.04	0.078	0.05	0.05	0.038	0.025	0.03	0.026	0.02
Selenium	400	0.3	*0.5 U*	*0.5 U*	*0.5 U*	*0.5 U*	*0.5 U*	*0.6 U*	*0.5 U*	*0.5 U*	*0.6 U*
Silver	400	2	1.4	9.6	1.8	1.6	1.8	1.8	1.2	0.7	0.5
Vanadium	5.6	44.9	17.2	16.2	18	17.9	19.2	19.9	16.7	20.8	20.8

Table 4 - Waste Rock Pile Sample Analytical Results

			Waste Rock Pile SR05								
			Waste Rock Discrete			Waste Rock Discrete			Composite Samples from Toe of Waste Rock Pile		
Sample ID	MTCA	Draft	SR05-D01	SR05-D06	SR05-D02	SR05-D03	SR05-D04	SR05-D05	SR05-C01	SR05-C02	SR05-C03
Sampling Date	Method B	Screening	2/21/2013	2/21/2013	2/21/2013	2/21/2013	2/21/2013	2/21/2013	2/21/2013	2/21/2013	2/22/2013
Sample Depth	Screening Levels	Levels[e]	0 - 12"	Dup of SR05-D01	0 - 12"	0 - 12"	0 - 12"	0 - 12"	0 - 6"	0 - 6"	0 - 6"
pH											
Metals in mg/kg											
Aluminum	80,000	22,524	3640	3980	6140	7970	9290	9360	7080	9840	6580
Antimony	32	5	0.2 UJ	0.2 UJ	0.2 UJ	0.2 UJ	0.2 UJ	0.2 UJ	0.2 UJ	0.2 UJ	0.2 UJ
Arsenic[a]	0.67/24[a]	14.4	216 J	226	122	200	713	1290	121	138	96.2
Barium	16,000	160	75.8	77.5	110	88.4	77	56.1	94.6	152	110
Chromium[b]	120,000/240[b]	42	3.7	4.4	6.3	7.3	10.2	21	7.2	8.1	5.5
Iron	56,000	29,324	19200	18400	17100	25900	33500	32300	15400	16400	15700
Lead[c]	250[c]	50	10.5	10.8	8.8	11.2	6.9	3.9	12.2	10.8	9.4
Manganese	11,000	753	34.3	27.7	292	79.2	96.1	94.9	253	473	299
Mercury[d]	24[d]	0.1	0.306	0.33	0.029	0.13	0.15	0.18	0.052	0.05	0.039
Selenium	400	0.3	*2 U*	3.1	0.6	1.3	1.3	1.8	0.7	*0.6 U*	*0.5 U*
Silver	400	2	12.6	13.4	11	5.6	2.8	2.6	12.7	4.4	6.6
Vanadium	5.6	44.9	11.6	15.3	20.1	20	35.7	105	18.4	22.1	16.1

Table 4 - Waste Rock Pile Sample Analytical Results

			Waste Rock Pile SR06								
			Waste Rock Discrete				Waste Rock Discrete		Composite Samples from Toe of Waste Rock Pile		
Sample ID Sampling Date Sample Depth	MTCA Method B Screening Levels	Draft Screening Levels[e]	SR06-D01 2/22/2013 0 - 10"	SR06-D02 2/22/2013 0 - 10"	SR06-D03 2/22/2013 0 - 12"	SR06-D06 2/22/2013 Dup of SR06-D03	SR06-D04 2/22/2013 0 - 12"	SR06-D05 2/22/2013 0 - 12"	SR06-C01 2/22/2013 0 - 6"	SR06-C02 2/22/2013 0 - 6"	SR06-C03 2/22/2013 0 - 6"
pH											
Metals in mg/kg											
Aluminum	80,000	22,524	9630	7950	9150	7780	8240	8600	15000	21400	16900
Antimony	32	5	0.2 UJ	0.2 UJ	0.2 UJ	0.2 UJ	0.2 UJ	0.2 UJ	0.2 UJ	0.2 UJ	0.2 UJ
Arsenic[a]	0.67/24[a]	14.4	31.2	52.6	77.9	92.3	87.7	454	274	298	237
Barium	16,000	160	128	155	167	157	166	130	154	179	154
Chromium[b]	120,000/240[b]	42	2.6	5	2	2	3	3	5.3	5.9	5.5
Iron	56,000	29,324	27600	28700	23200	24300	32300	30100	25800	24100	23000
Lead[c]	250[c]	50	6	9.2	6.1	6.7	7.5	9	8.1	9.3	10.2
Manganese	11,000	753	18.7	8	24.9	24.7	36.7	95.5	283	383	309
Mercury[d]	24[d]	0.1	47.2	20.5	25.5	28.9	27	15.1	4.61	0.21	1.2
Selenium	400	0.3	*0.6 U*	*0.6 U*	*0.5 U*	*0.5 U*	*0.6 U*	*0.5 U*	*0.6 U*	*0.6 U*	*0.6 U*
Silver	400	2	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.4	0.3	0.5	0.4
Vanadium	5.6	44.9	28.3	19.1	22.1	21.5	32.5	20.3	17.6	19.1	18.7

Table 4 - Waste Rock Pile Sample Analytical Results

			Waste Rock Pile SR07							
			Waste Rock Discrete					Waste Rock Discrete	Composite Samples from Toe of Waste Rock Pile	
Sample ID	MTCA	Draft	SR07-D01	SR07-D06	SR07-D02	SR07-D03	SR07-D04	SR07-D05	SR07-C01	SR07-C02
Sampling Date	Method B	Screening	2/20/2013	2/20/2013	2/20/2013	2/20/2013	2/20/2013	2/20/2013	2/20/2013	2/20/2013
Sample Depth	Screening Levels	Levels[e]	0 - 12"	Dup of SR07-D01	0 - 12"	0 - 8"	0 - 10"	0 - 11"	0 - 6"	0 - 6"
pH										
Metals in mg/kg										
Aluminum	80,000	22,524	6800	5560	9290	9140	7270	5330	9030	8520
Antimony	32	5	0.2 UJ	0.2 UJ	0.2 UJ	0.2 UJ	0.2 UJ	0.2 UJ	0.3 UJ	0.2 UJ
Arsenic[a]	0.67/24[a]	14.4	367	423	304	313	269	372	266	181
Barium	16,000	160	196	183	222	267	225	166	216	238
Chromium[b]	120,000/240[b]	42	5.1	3.8	8	8	5.4	3.2	7.8	7.2
Iron	56,000	29,324	22200	20900	27300	27300	23500	19000	26100	27600
Lead[c]	250[c]	50	27.5	25	13.5	13.1	23.5	27.4	12.9	12
Manganese	11,000	753	77.3	70.9	171	190	116	55.8	186	177
Mercury[d]	24[d]	0.1	0.06	0.05	0.03	0.035	0.05	0.061	0.04	0.049
Selenium	400	0.3	1.7	*2 U*	*2 U*	*2 U*	*2 U*	*2 U*	1.6	*2 U*
Silver	400	2	10.8	9.2	9.9	9	9.2	8.4	9.2	6.3
Vanadium	5.6	44.9	11.8	10.3	18.2	18.5	11.7	9	17.8	18.1

Table 4 - Waste Rock Pile Sample Analytical Results

			Waste Rock Pile SR08								
			Waste Rock Discrete						Composite Samples from Toe of Waste Rock Pile		
Sample ID Sampling Date Sample Depth	MTCA Method B Screening Levels	Draft Screening Levels[e]	SR08-D01 2/19/2013 0 - 12"	SR08-D02 2/19/2013 0 - 12"	SR08-D03 2/19/2013 0 - 12"	SR08-D06 2/19/2013 Dup of SR08-D03	SR08-D04 2/19/2013 0 - 12"	SR08-D05 2/19/2013 0 - 12"	SR08-C01 2/19/2013 0 - 6"	SR08-C02 2/19/2013 0 - 6"	SR08-C03 2/20/2013 0 - 6"
pH			4.36								
Metals in mg/kg											
Aluminum	80,000	22,524	8110	4650	1910	2070	2180	2410	16700	16700	16700
Antimony	32	5	0.2 UJ	0.2 UJ	0.2 UJ	0.2 UJ	0.2 UJ	0.2 UJ	0.2 UJ	0.2 UJ	0.2 UJ
Arsenic[a]	0.67/24[a]	14.4	306	412	366	372	305	387	26.5	15.6	9
Barium	16,000	160	122	153	138	125	112	126	138	131	141
Chromium[b]	120,000/240[b]	42	5.7	3.5	1	1.3	1.6	1.6	8.5	10.2	9.2
Iron	56,000	29,324	23900	22400	16500	14900	15600	16600	22400	21200	21500
Lead[c]	250[c]	50	13.9	12.9	17.6	15.7	15.6	21.6	9.8	7.6	7.7
Manganese	11,000	753	249	58.6	8	9.4	9.6	11.8	342	323	332
Mercury[d]	24[d]	0.1	0.198	0.14	0.08	0.075	0.04	0.067	0.11	0.09	0.18
Selenium	400	0.3	3.3	3.8	3	3.6	2.8	3.1	*0.5 U*	*0.6 U*	*0.6 U*
Silver	400	2	29.4	19.7	9.4	10.7	8.2	8.9	0.7	0.7	0.3
Vanadium	5.6	44.9	11.2	7.3	2.4	2.9	3.6	4.5	28	31.5	28.4

a - cacinogenic/non-carcinogenic
b - chromium(+3)/chromium(+6)
c - MTCA Method A
d - as $HgCl_2$
e - Lowest of MTCA Method A, MTCA Method B, and Ecological Indicator Screening Critria or natural background where background is higher than the lowest screening criterion.

Table 5 - Waste Rock Pile SA-01 Summary Statistics

Parameter	Data Distribution	Number Samples	Number Non-Detects	Minimum	Maximum	Mean	Median	Standard Deviation	UCL 95
Aluminum	nonparametric	6	0	8320	18500	15953	17700	3856	18337
Antimony	undetermined	6	6	0.2 U	0.2 U	NA	0.2 U	NA	NA
Arsenic[a]	normal	6	0	53.3	212	154.6	158.5	59.42	203
Barium	gamma	6	0	74	119	94.65	92.85	16.58	111
Chromium[b]	normal	6	0	7.9	13.9	12.02	12.9	2.304	13.9
Iron	normal	6	0	23100	42300	33767	35550	7484	39924
Lead[c]	normal	6	0	11.4	15.8	13.83	14.35	1.681	15.2
Manganese	normal	6	0	154	943	679.5	785	306.6	932
Mercury[d]	lognormal	6	0	0.26	0.59	0.37	0.345	0.116	0.489
Selenium	undetermined	6	6	0.6 U	2 U	NA	0.6 U	NA	NA
Silver	nonparametric	6	0	1	9.4	2.65	1.35	3.32	4.67
Vanadium	normal	6	0	16.2	19.9	18.07	17.95	1.335	19.9

Data distribution determined by ProUCL Goodness-of-Fit
Undetermined - Too few detected results to determine the data distribution or calculate a standard deviation
NA - Could not be calculated due to non-detected results

Table 6 - Waste Rock Pile SA-02 Summary Statistics

Parameter	Data Distribution	Number Samples	Number Non-Detects	Minimum	Maximum	Mean	Median	Standard Deviation	UCL 95
Aluminum	nonparametric	11	0	1270	17600	5082	2640	5895	7820
Antimony	undetermined	11	11	0.7 U	3.6 U	NA	0.2 U	NA	NA
Arsenic[a]	lognormal	11	0	82.8	513	189.9	172	115.5	262
Barium	nonparametric	11	0	35.2	180	70.27	57.2	41.44	90.0
Chromium[b]	nonparametric	11	0	1.2	14.4	3.927	2.1	4.372	6.06
Iron	lognormal	11	0	5750	42600	15120	12200	11422	23506
Lead[c]	lognormal	11	0	4.7	59.1	20.65	18	14.37	33.9
Manganese	gamma	11	0	2.5	316	46.25	10	94.73	124
Mercury[d]	gamma	11	0	0.168	1.02	0.451	0.4	0.261	0.628
Selenium	gamma	11	0	0.7	3.6	1.845	1.5	0.866	2.42
Silver	normal	11	0	3.3	19.1	12.25	12.9	5.018	15
Vanadium	lognormal	11	0	1.2	28	7.418	4	8.9	19.2

Data distribution determined by ProUCL Goodness-of-Fit
Undetermined - Too few detected results to determine the data distribution or calculate a standard deviation
NA - Could not be calculated due to non-detected results

Table 7 - Waste Rock Pile SA-03 Summary Statistics

Parameter	Data Distribution	Number Samples	Number Non-Detects	Minimum	Maximum	Mean	Median	Standard Deviation	UCL 95
Aluminum	nonparametric	11	0	2630	16100	6136	4310	4889	8458
Antimony	undetermined	0	11	0.2 U	0.2 U				
Arsenic[a]	lognormal	11	0	57	417	135.9	104	102.5	199
Barium	normal	11	0	17.2	142	70.82	56.9	46.71	96.4
Chromium[b]	lognormal	11	0	1.4	6.2	3.118	2.5	1.619	4.38
Iron	lognormal	11	0	2330	21200	8921	9130	6308	16587
Lead[c]	gamma	11	0	2.9	14.4	7.345	6.8	3.444	9.74
Manganese	nonparametric	11	0	9.9	249	65.97	16.9	90.64	109
Mercury[d]	lognormal	11	0	0.057	1.09	0.424	0.199	0.367	1.09
Selenium	lognormal	11	3	0.5 U	2.9	1.145	0.9	0.749	2
Silver	gamma	11	0	1.3	18.7	7.927	6.5	5.626	12.7
Vanadium	lognormal	11	0	1.5	20.7	6.491	3.1	7.2	14.5

Data distribution determined by ProUCL Goodness-of-Fit
Undetermined - Too few detected results to determine the data distribution or calculate a standard deviation
NA - Could not be calculated due to non-detected results

Table 8 - Waste Rock Pile SA-04 Summary Statistics

Parameter	Data Distribution	Number Samples	Number Non-Detects	Minimum	Maximum	Mean	Median	Standard Deviation	UCL 95
Aluminum	normal	6	0	7550	9330	8417	8455	637.5	8941
Antimony	undetermined	0	6	0.2 U	0.2 U	NA	NA	NA	NA
Arsenic[a]	normal	6	0	54.8	134	103.1	115	33.34	131
Barium	normal	6	0	43	71.2	60.25	62.8	11.73	69.9
Chromium[b]	normal	6	0	4.9	6.9	6.117	6.4	0.861	6.83
Iron	normal	6	0	18800	29400	25533	26650	4248	29028
Lead[c]	nonparametric	6	0	12.2	18.6	13.57	12.55	2.491	15.1
Manganese	lognormal	6	0	163	238	194.2	189.5	24.77	217
Mercury[d]	lognormal	6	0	0.025	0.078	0.0468	0.045	0.0178	0.0707
Selenium	undetermined	6	6	0.5 U	0.6 U	NA	NA	NA	NA
Silver	nonparametric	6	0	1.4	9.6	3	1.8	3.237	4.99
Vanadium	normal	6	0	16.2	19.9	18.07	17.95	1.335	19.2

Data distribution determined by ProUCL Goodness-of-Fit
Undetermined - Too few detected results to determine the data distribution or calculate a standard deviation
NA - Could not be calculated due to non-detected results

Table 9 - Waste Rock Pile SA-05 Summary Statistics

Parameter	Data Distribution	Number Samples	Number Non-Detects	Minimum	Maximum	Mean	Median	Standard Deviation	UCL 95
Aluminum	Normal	6	0	3640	9360	6730	7055	2548	8826
Antimony	undetermined	0	6	0.2 U	0.2 U				
Arsenic[a]	gamma	6	0	122	1290	461.2	221	458	1138
Barium	gamma	6	0	56.1	110	80.8	77.25	17.72	98.6
Chromium[b]	lognormal	6	0	3.7	21	8.817	6.8	6.398	20.6
Iron	lognormal	6	0	17100	33500	24400	22550	7264	32965
Lead[c]	normal	6	0	3.9	11.2	8.683	9.65	2.835	11.0
Manganese	lognormal	6	0	27.7	292	104	87.05	96.73	292
Mercury[d]	normal	6	0	0.029	0.33	0.188	0.165	0.113	0.281
Selenium	lognormal	6	1	0.6 U	3.1	1.68	1.55	0.847	2.25
Silver	normal	6	0	2.6	13.4	8	8.3	4.925	12.1
Vanadium	gamma	6	0	11.6	105	34.62	20.05	35.45	79.8

Data distribution determined by ProUCL Goodness-of-Fit

Undetermined - Too few detected results to determine the data distribution or calculate a standard deviation

NA - Could not be calculated due to non-detected results

Table 10 - Waste Rock Pile SA-06 Summary Statistics

Parameter	Data Distribution	Number Samples	Number Non-Detects	Minimum	Maximum	Mean	Median	Standard Deviation	UCL 95
Aluminum	gamma	6	0	7780	9630	8558	8420	718	9212
Antimony	undetermined	0	6	0.2 U	0.2 U	NA	NA	NA	NA
Arsenic[a]	lognormal	6	0	31.2	454	132.6	82.8	159.1	454
Barium	normal	6	0	128	167	150.5	156	17.33	165
Chromium[b]	gamma	6	0	2	5	2.933	2.8	1.108	4.07
Iron	normal	6	0	23200	32300	27700	28150	3457	30544
Lead[c]	lognormal	6	0	6	9.2	7.417	7.1	1.411	8.84
Manganese	lognormal	6	0	8	95.5	34.75	24.8	31.19	95.5
Mercury[d]	lognormal	6	0	15.1	47.2	27.37	26.25	10.93	41.4
Selenium	undetermined	6	6	0.5 U	0.6 U	NA	NA	NA	NA
Silver	undetermined	6	5	0.2 U	0.4	NA	NA	NA	NA
Vanadium	gamma	6	0	19.1	32.5	23.97	21.8	5.259	29.1

Data distribution determined by ProUCL Goodness-of-Fit

Undetermined - Too few detected results to determine the data distribution or calculate a standard deviation

NA - Could not be calculated due to non-detected results

Table 11 - Waste Rock Pile SA-07 Summary Statistics

Parameter	Data Distribution	Number Samples	Number Non-Detects	Minimum	Maximum	Mean	Median	Standard Deviation	UCL 95
Aluminum	Lognormal	6	0	5330	9290	7232	7035	1702	9098
Antimony	undetermined	6	6	1.7 U	2 U	NA	NA	NA	NA
Arsenic[a]	gamma, lognormal	6	0	269	423	341.3	340	56.03	397
Barium	lognormal	6	0	166	267	209.8	209	36	245
Chromium[b]	lognormal	6	0	3.2	8	5.583	5.25	2.04	8
Iron	lognormal	6	0	19000	27300	23367	22850	3390	26655
Lead[c]	normal	6	0	13.1	27.5	21.67	24.25	6.655	27.1
Manganese	lognormal	6	0	55.8	190	113.5	96.65	55.89	190
Mercury[d]	normal	6	0	0.03	0.061	0.0477	0.05	0.0128	0.0582
Selenium	undetermined	6	5	1.7	2 U	NA	NA	NA	NA
Silver	gamma	6	0	8.4	10.8	9.417	9.2	0.83	10.2
Vanadium	lognormal			9	18.5	13.25	11.75	4.083	18.0

Data distribution determined by ProUCL Goodness-of-Fit
Undetermined - Too few detected results to determine the data distribution or calculate a standard deviation
NA - Could not be calculated due to non-detected results

Table 12 - Waste Rock Pile SA-08 Summary Statistics

Parameter	Data Distribution	Number Samples	Number Non-Detects	Minimum	Maximum	Mean	Median	Standard Deviation	UCL 95
Aluminum	Lognormal	6	0	1910	8110	3555	2295	2452	7468
Antimony	undetermined	0	6	2 U	2 U	NA	NA	NA	NA
Arsenic[a]	normal	6	0	305	412	358	369	43.66	394
Barium	gamma	6	0	112	153	129.3	125.5	14.28	143
Chromium[b]	gamma	6	0	1	5.7	2.45	1.6	1.819	4.75
Iron	gamma	6	0	14900	23900	18317	16550	3825	22010
Lead[c]	lognormal	6	0	12.9	21.6	16.22	15.65	3.095	19.2
Manganese	nonparametric	6	0	8	249	57.73	10.7	95.73	118
Mercury[d]	gamma	6	0	0.04	0.198	0.1	0.0775	0.0582	0.172
Selenium	lognormal	6	0	2.8	3.8	3.267	3.2	0.378	3.62
Silver	gamma	6	0	8.2	29.4	14.38	10.05	8.491	24.1
Vanadium	gamma	6	0	2.4	11.2	5.317	4.05	3.362	9.43

Data distribution determined by ProUCL Goodness-of-Fit
Undetermined - Too few detected results to determine the data distribution or calculate a standard deviation
NA - Could not be calculated due to non-detected results

Table 13 - Preliminary Screening Criteria for Soil

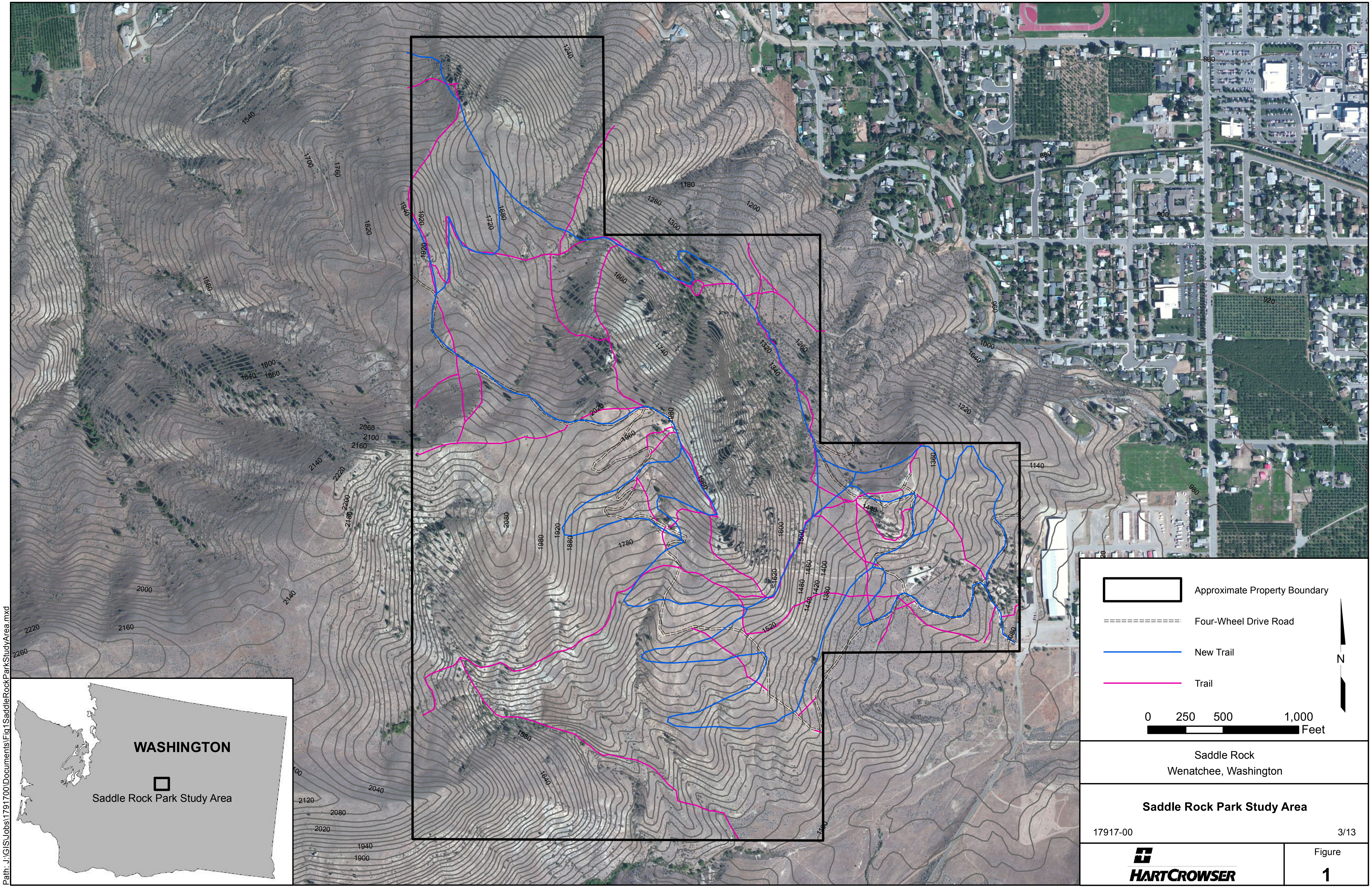
Constituents of Concern (mg/kg)	**Draft Screening Levels (not lower than background)**	Site-Specific Background Concentration	Ecology-Reported Natural Background[a]	Lowest Potential Soil ARAR[b]	MTCA Method A Soil Cleanup Levels[c]	MTCA Method B Soil Cleanup Levels		Ecological Indicator Screening Criteria[g]		
						Soil Ingestion[d]	Groundwater Protection[e]	Protection of Plants[f]	Protection of Soil[f]	Protection of Wildlife[f]
Aluminum (Al) - pH dependent	**22,524**	22,524	37200	50	--	80000	--	50	--	--
Antimony (Sb)	**5**	--	--	5	--	32	5.42[j]	5	--	--
Arsenic (As)	**14.4**	14.4	7	0.67	20	0.67	5.84[j]	-- / 10[h]	-- / 60[h]	7 / 132 (h)
Barium (Ba)	**160**	160	--	102	--	16,000	1650[j]	500	--	102
Chromium III (Cr III)	**42**	17.3	42 (i)	42	2,000	120,000	2000[j]	42[i]	42[i]	67 (i)
Chromium VI (Cr VI)	**19**	--		19	19	240	19.2[j]			
Iron (Fe)	**29,324**	29,324	42,100	91.2	--	56,000	91.2[j]	--	--	--
Lead (Pb)	**50**	17.4	50	17	250	--	--	50	500	118
Manganese (Mn)	**753**	753	1,100	522	--	11,200	522[j]	1,100	--	1,500
Mercury (Hg, inorganic)	**0.10**	0.048	0.07	0.10	2	--	2.09[j]	0.3	0.10	5.5
Selenium (Se)	**0.3**	--	--	0.3	--	400	5.2[j]	1	70	0.3
Silver (Ag)	**2**	0.33	--	2	--	400	13.6[j]	2	--	--
Vanadium (Va)	**44.9**	44.9	--	2	--	5.6	22.4[j]	2	--	--

Notes:
(a) Data from Natural Background Soil Metals Concentrations in Washington State (Ecology 1994).
(b) Shaded cells correspond to lowest potential chemical-specific ARAR.
(c) WAC 173-340-740(2), WAC 173-340-900 (Table 740-1), Model Toxics Control Act (MTCA) Method A
(d) WAC 173-340-740(3). MTCA Method B unrestricted land use soil cleanup standards. For carcinogenic constituents, the value presented is the lower of the non-carcinogenic and carcinogenic levels calculated using Equations 740-1 and 740-2 for ingestion only. Equations 740-4 and 740-5 are for ingestion and dermal contact. Information from CLARC 3.1 was used unless otherwise noted.
(e) WAC 173-340-740(3)(b)(iii)(A); MTCA Method B unrestricted land use soil cleanup standards, groundwater protection. Values calculated using the MTCA three-phase partitioning model WAC 173-340-747(4).
(f) MTCA 173-340-900 (Table 749-3)
(g) EPA Ecological Soil Screening Levels (ECO-SSL) are found at http://www.epa.gov/ecotox/ecossl/
(h) Based on Arsenic III / Arsenic V
(i) Based on total Chromium
(j) Based on drinking water MCL
-- Not established or not applicable

Table 14 - TCLP and SPLP Extraction Results

Sample ID			Waste Rock Pile SR02	Waste Rock Pile SR03	Waste Rock Pile SR06
	MTCA Groundwater Criteria	Dangerous Waste TCLP Criteria	Waste Rock Composite of SR02-D03, SR02-D04, SR02-D05, SR02-D07, and SR02-D09	Waste Rock Composite of SR03-D01, SR03-D02, SR03-D03, SR03-D07, and SR03-D08	Waste Rock Composite of SR06-D01, SR06-D02, SR06-D03, SR06-D04, and SR06-D05
Leachable Metals in mg/L (SPLP)					
Aluminum	16 *		0.07	5.81	
Arsenic	0.005 **		0.05 U	0.27	
Silver	0.08 *		0.003 U	0.005	
Leachable Metals in mg/L (TCLP)					
Arsenic		5	0.2 U	0.2 U	
Mercury		0.2			0.0002

U - Analyte not detected at the listed detection limit
* Groundwater Method B, Non-Carcinogen, Standard Formula
** Groundwater Method A, Table Value



Saddle Rock
Wenatchee, Washington

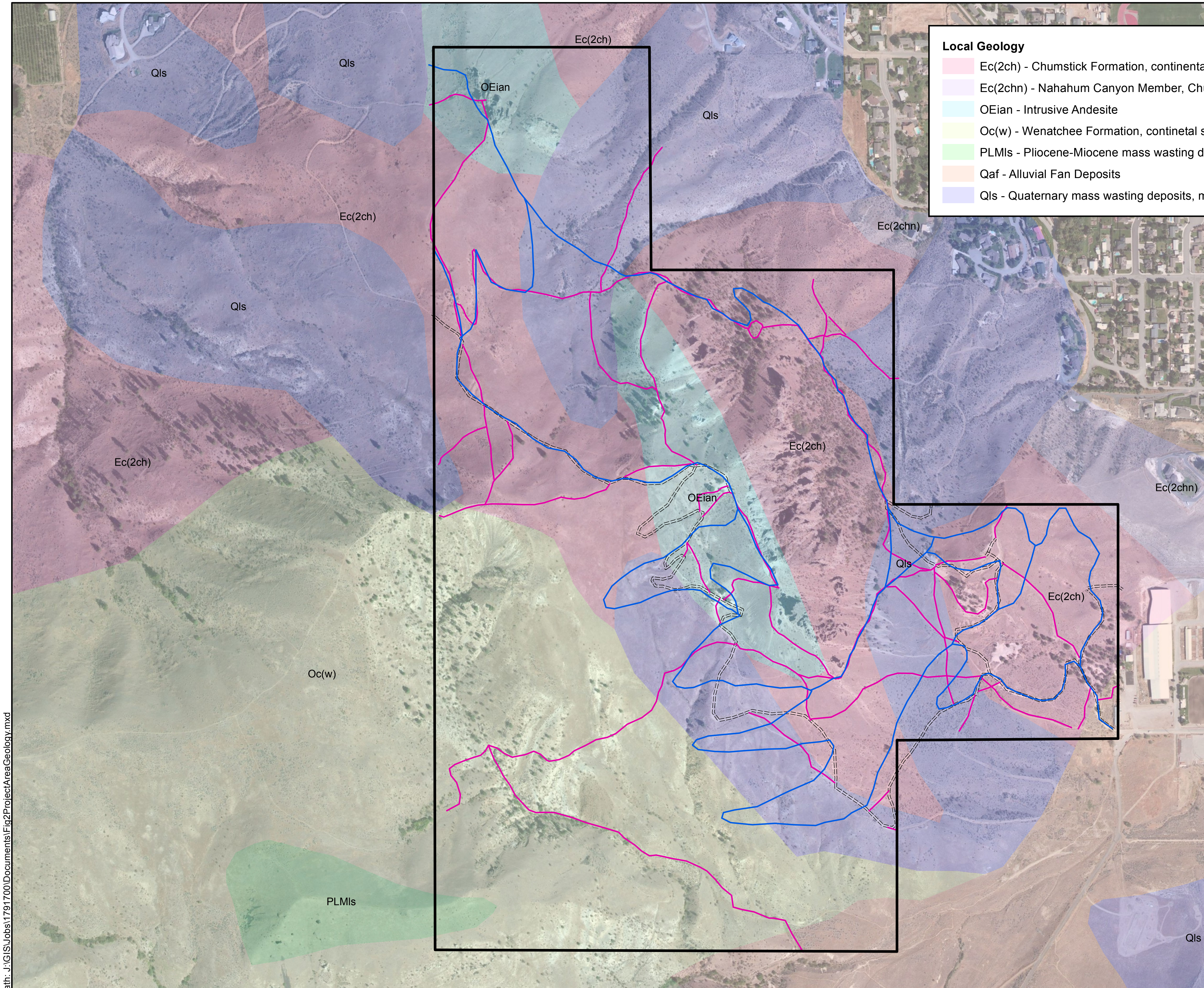
Saddle Rock Park Study Area

17917-00 3/13

HARTCROWSER

Figure 1

Path: J:\GIS\Jobs\1791700\Documents\Fig1SaddleRockParkStudyArea.mxd



Saddle Rock
Wenatchee, Washington

Project Area Geology

17917-00 3/13

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Figure 2

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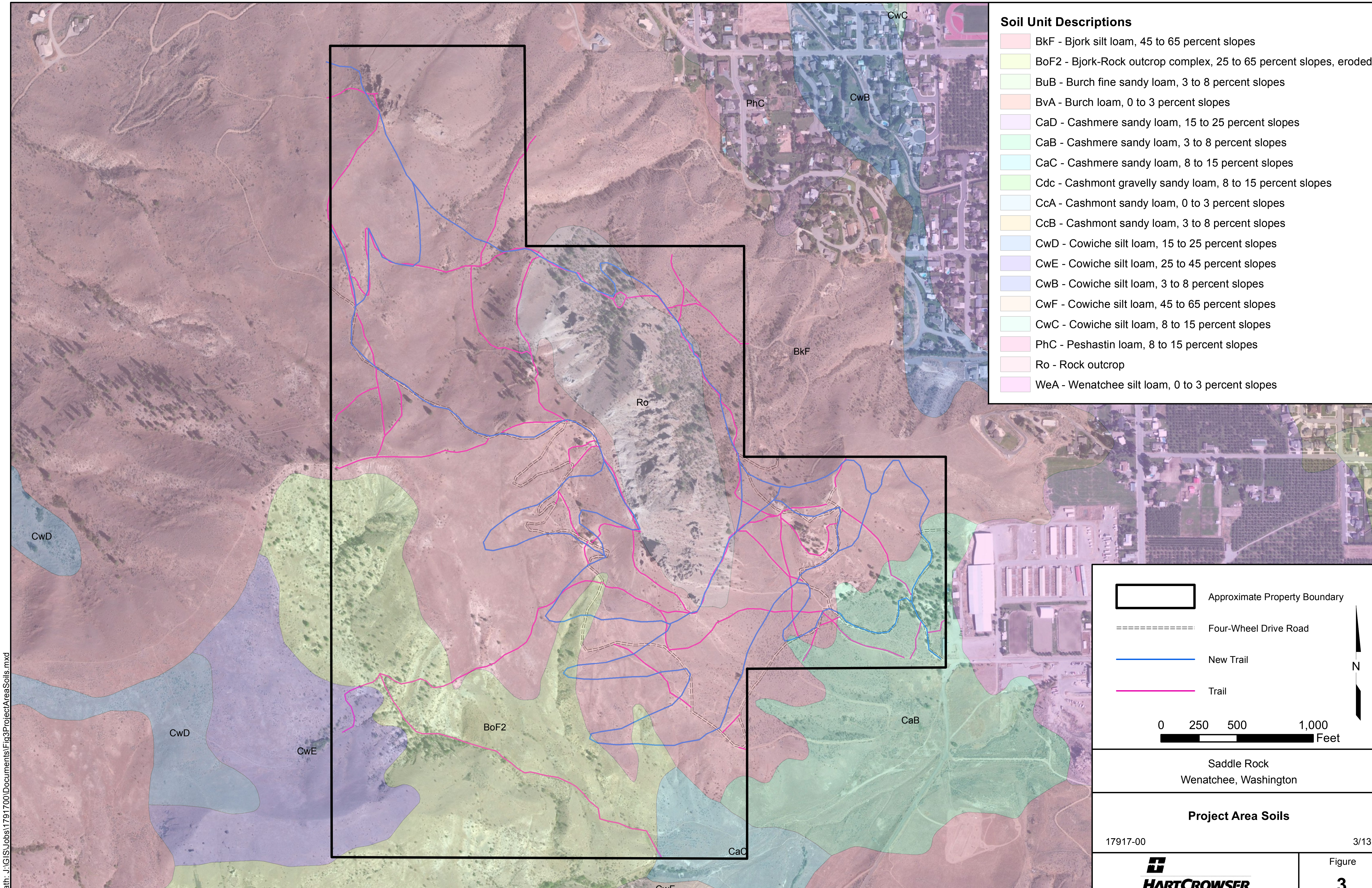
Soil Unit Descriptions
BkF - Bjork silt loam, 45 to 65 percent slopes
BoF2 - Bjork-Rock outcrop complex, 25 to 65 percent slopes, eroded
BuB - Burch fine sandy loam, 3 to 8 percent slopes
BvA - Burch loam, 0 to 3 percent slopes
CaD - Cashmere sandy loam, 15 to 25 percent slopes
CaB - Cashmere sandy loam, 3 to 8 percent slopes
CaC - Cashmere sandy loam, 8 to 15 percent slopes
Cdc - Cashmont gravelly sandy loam, 8 to 15 percent slopes
CcA - Cashmont sandy loam, 0 to 3 percent slopes
CcB - Cashmont sandy loam, 3 to 8 percent slopes
CwD - Cowiche silt loam, 15 to 25 percent slopes
CwE - Cowiche silt loam, 25 to 45 percent slopes
CwB - Cowiche silt loam, 3 to 8 percent slopes
CwF - Cowiche silt loam, 45 to 65 percent slopes
CwC - Cowiche silt loam, 8 to 15 percent slopes
PhC - Peshastin loam, 8 to 15 percent slopes
Ro - Rock outcrop
WeA - Wenatchee silt loam, 0 to 3 percent slopes
CwC
PhC
CwB
BkF
Ro
CwD
CwD
CwE
BoF2
CaB
CaC
CwF
Approximate Property Boundary
Four-Wheel Drive Road
New Trail
Trail
N
0 250 500 1,000
Feet
Saddle Rock
Wenatchee, Washington
Project Area Soils
17917-00
3/13
Figure
3
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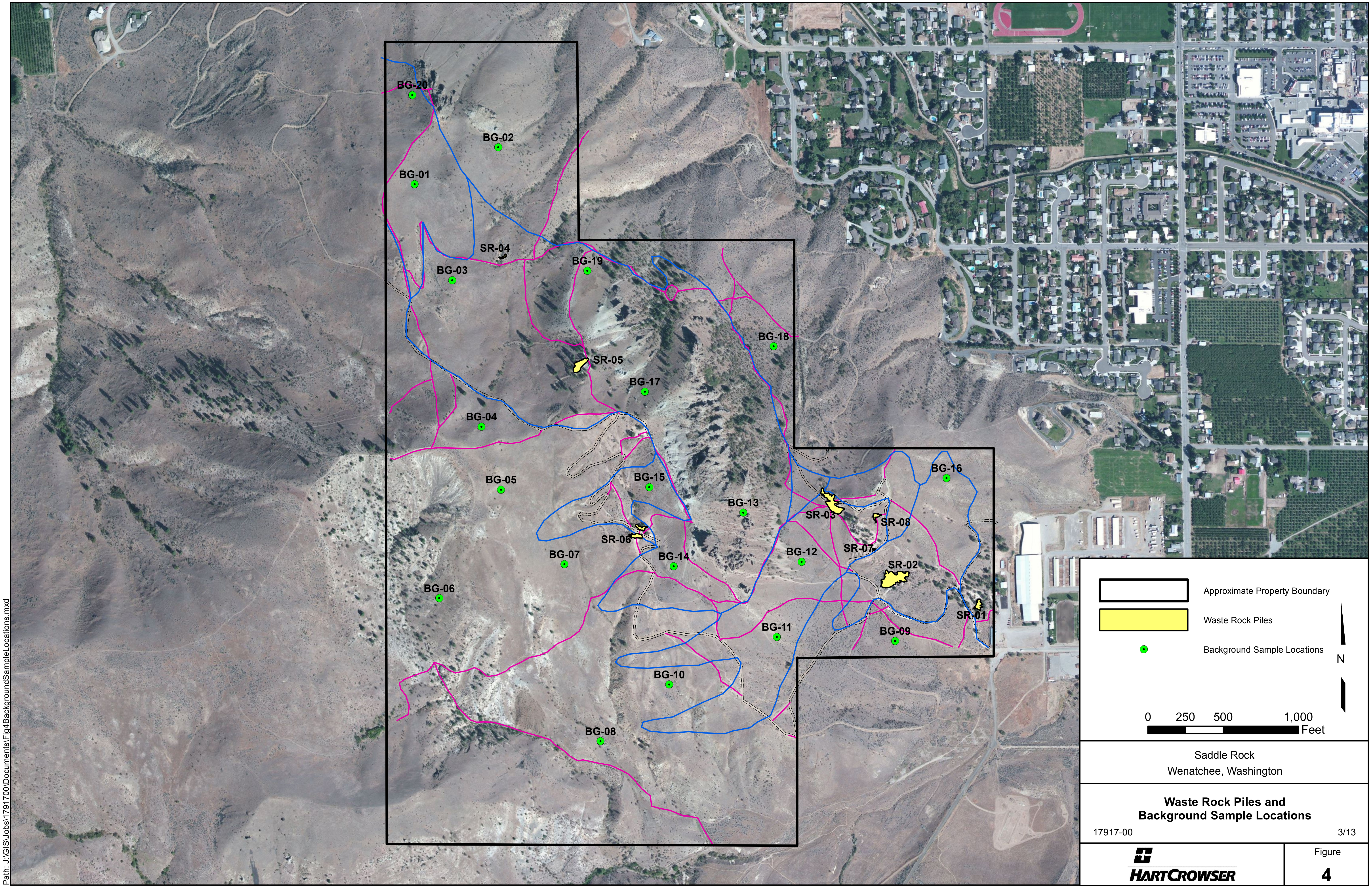

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Saddle Rock
Wenatchee, Washington

Waste Rock Piles and Background Sample Locations

17917-00 3/13

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Figure
4

Saddle Rock Park
Wenatchee, Washington

Waste Rock Pile SR-01

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Figure **5**

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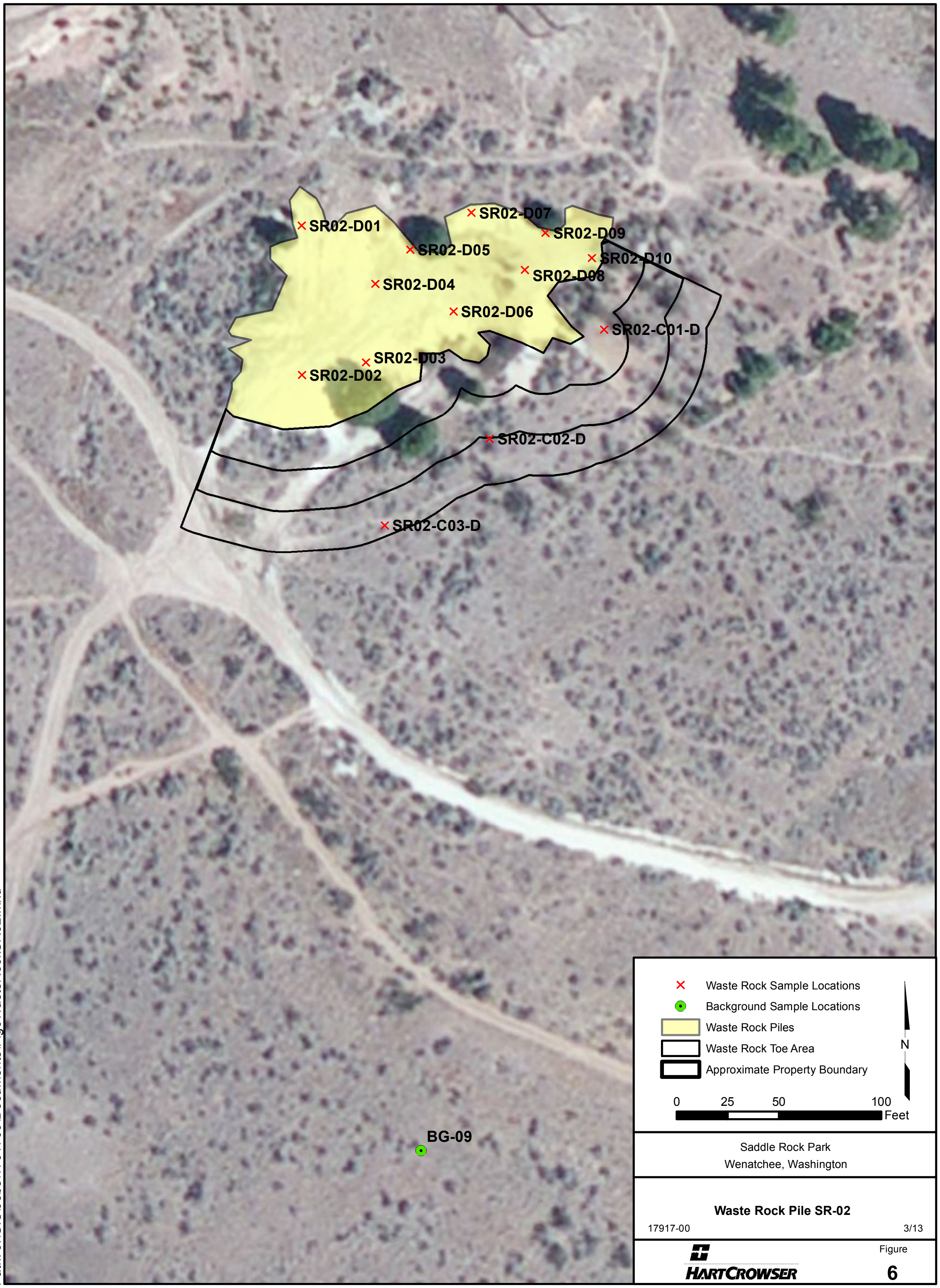

Saddle Rock Park
Wenatchee, Washington

Waste Rock Pile SR-02

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Figure
6

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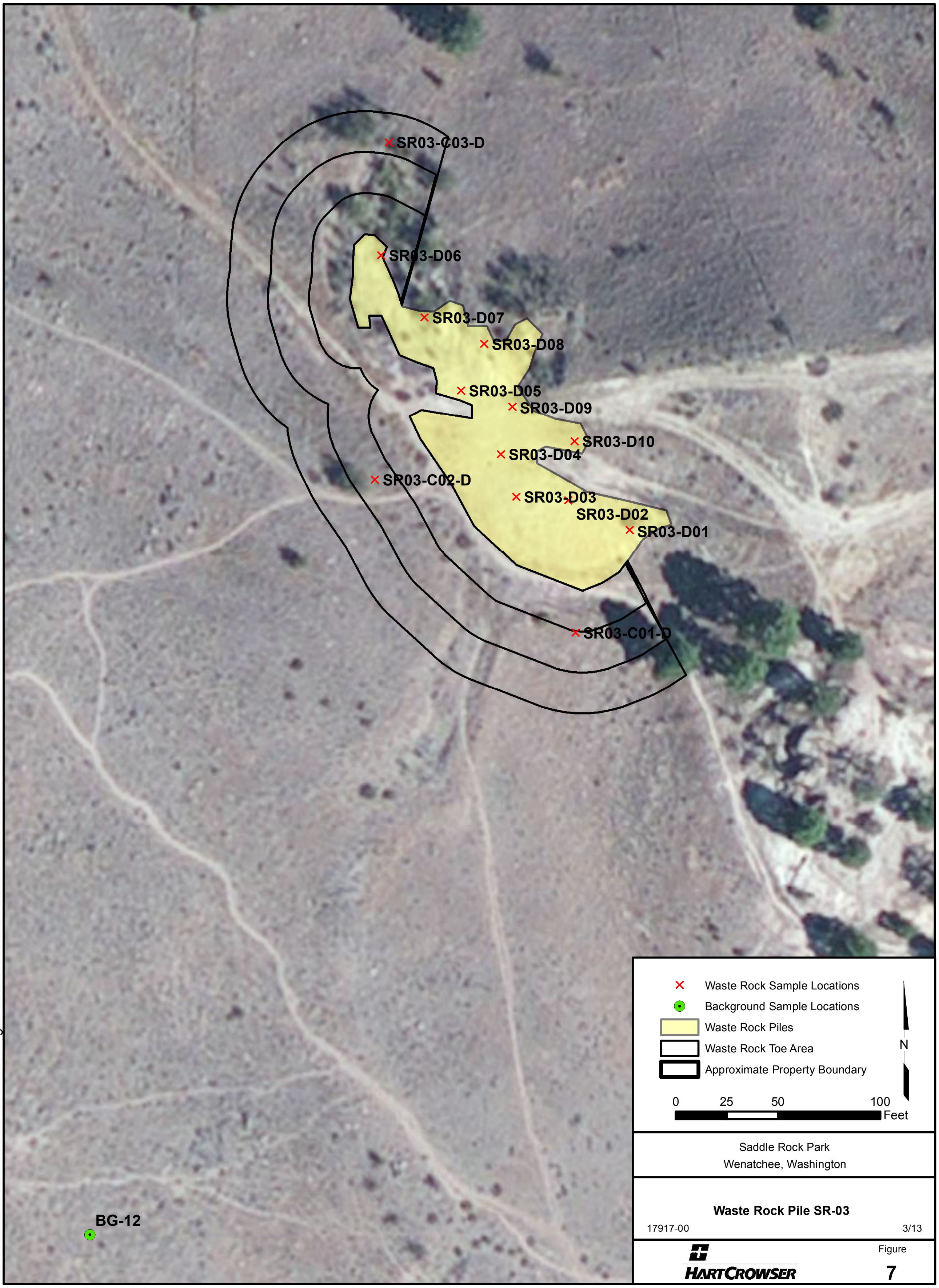

Saddle Rock Park
Wenatchee, Washington

Waste Rock Pile SR-03

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HARTCROWSER

Figure
7

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Saddle Rock Park
Wenatchee, Washington

Waste Rock Pile SR-04

17917-00 3/13

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Figure 8

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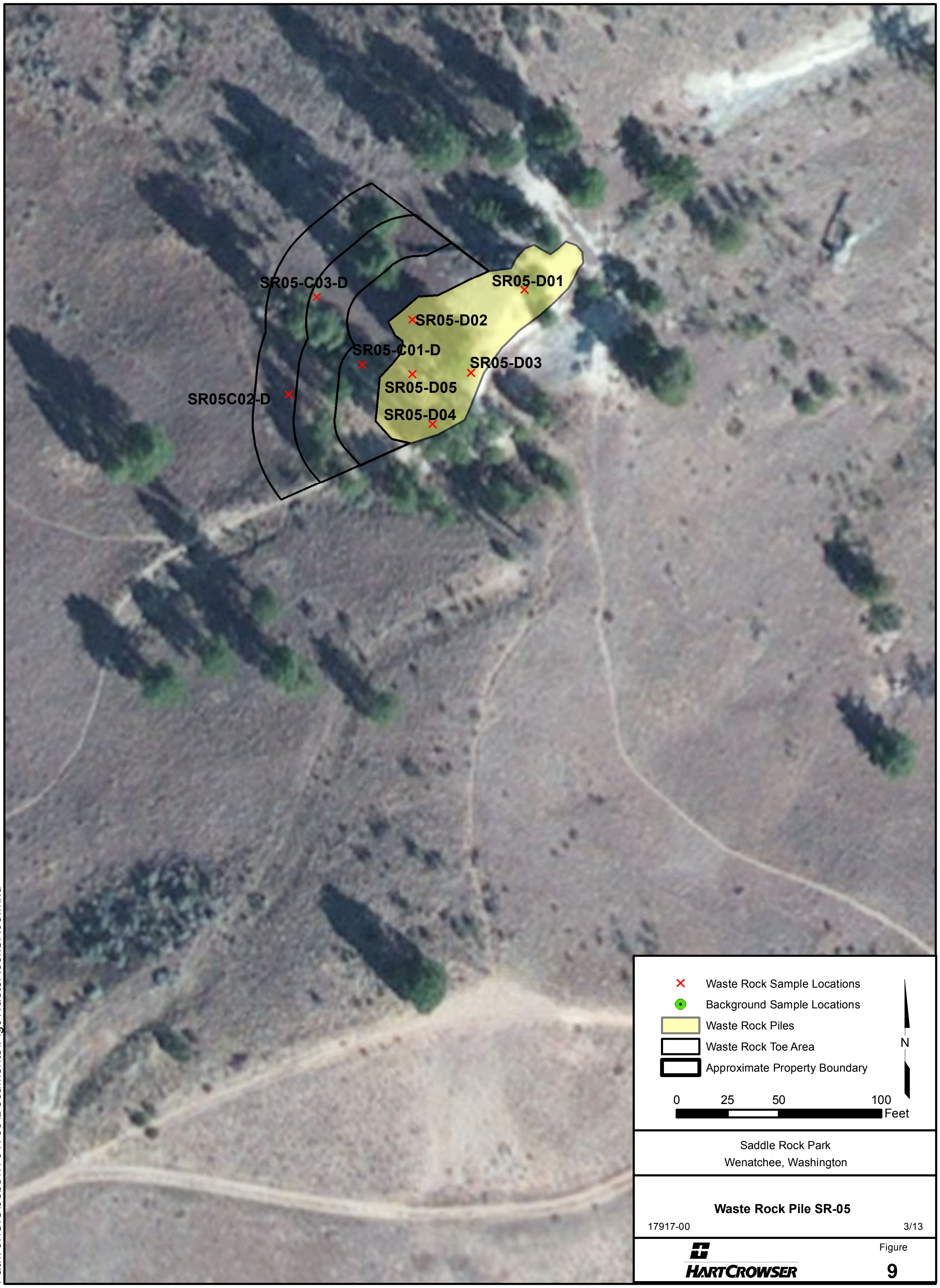

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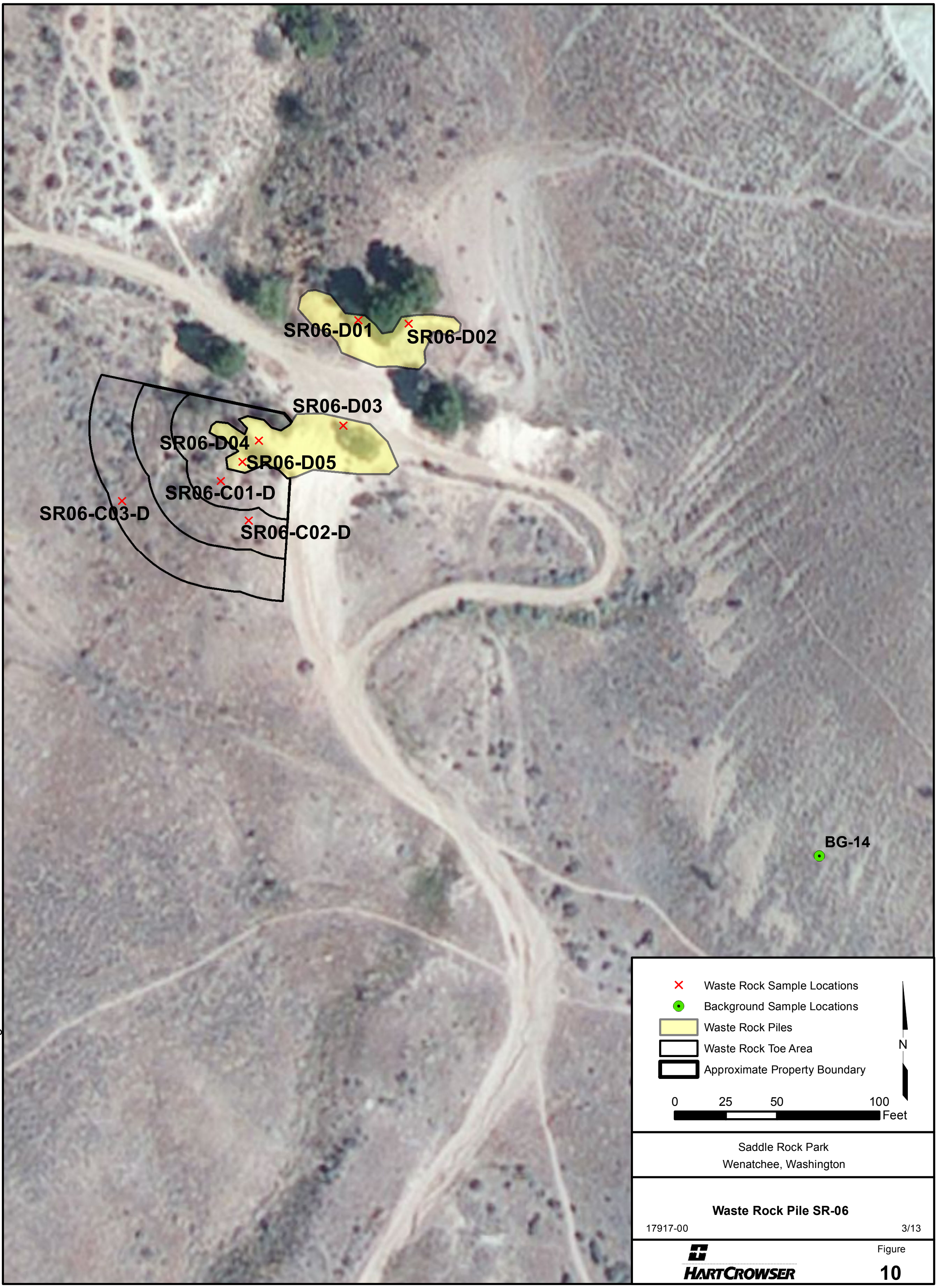

Saddle Rock Park
Wenatchee, Washington

Waste Rock Pile SR-06

17917-00 3/13

HARTCROWSER

Figure
10

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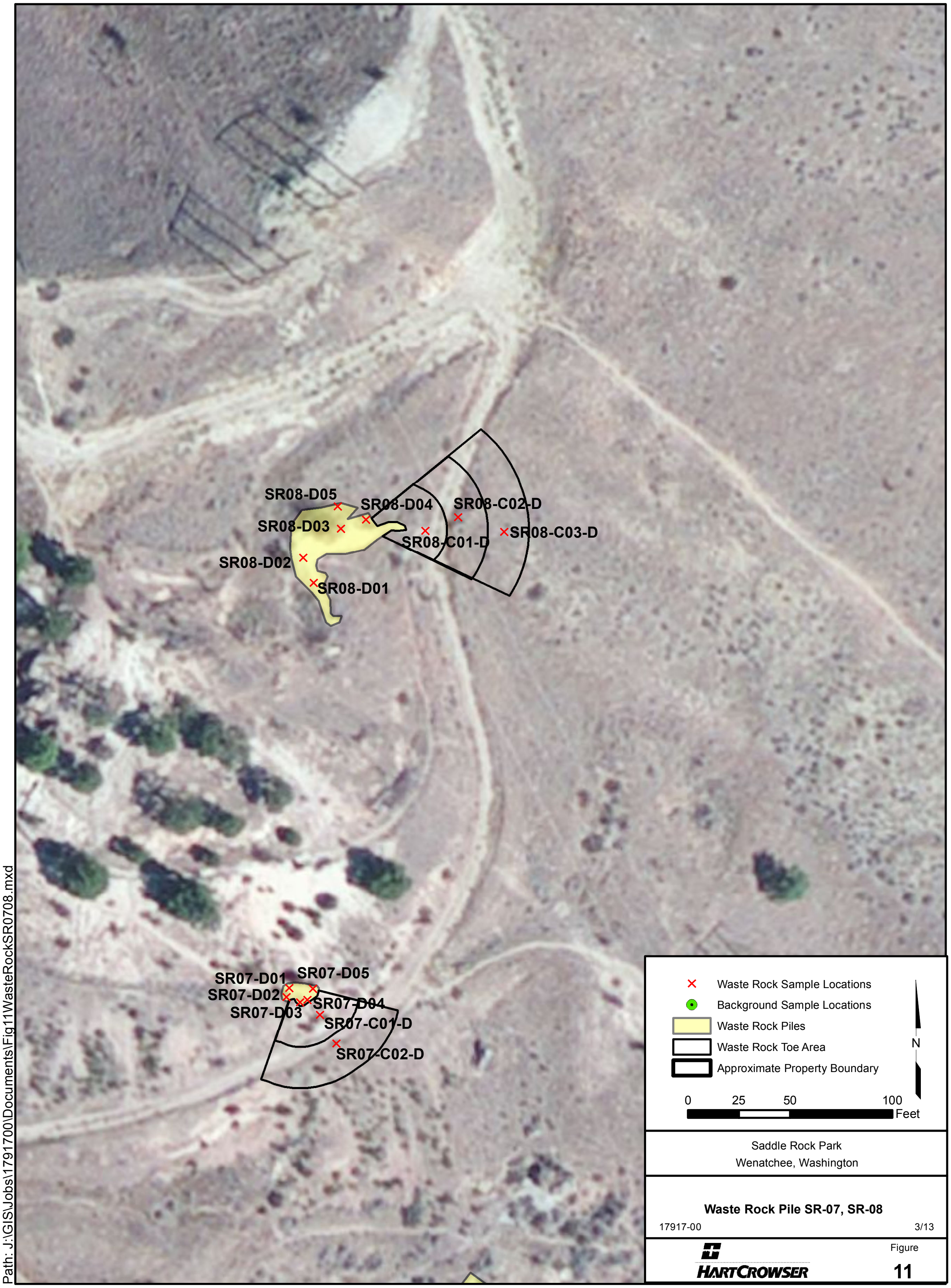

Saddle Rock Park
Wenatchee, Washington

Waste Rock Pile SR-07, SR-08

17917-00 3/13

HARTCROWSER

Figure 11

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APPENDIX A
ARCHAEOLOGICAL REVIEW AND CULTURAL RESOURCES REPORT

CULTURAL RESOURCES REPORT COVER SHEET

Author: William D. Schroeder, M.S., Lauren Walton, and Christopher Landreau, M.S.

Title of Report: An Archaeological Review and Inventory of the Saddle Rock Park Development Project, Chelan County, Washington

Date of Report: December 26, 2012

County: Chelan

Section: NW ¼ NW ¼, S ½ NW ¼, SW ¼, and NW ¼ SE ¼ Section 16
Township: 22N Range: 20E
Parcel: 222016300000 Property ID: 57419

Quad: Wenatchee 7.5' Acres: 325

PDF of report submitted (REQUIRED) **X** Yes

Historic Property Inventory Forms to be Approved Online? Yes **X** No

Archaeological Site(s)/Isolate(s) Found or Amended? **X** Yes No

TCP(s) found? **X** Yes No

Replace a draft? Yes **X** No

Satisfy a DAHP Archaeological Excavation Permit requirement? ☐ Yes # **X** No

Were Human Remains Found? ☐ Yes DAHP Case # **X** No

DAHP Archaeological Site #:

______
______
______
______
______
______
______
______

An Archaeological Review and Inventory of the Saddle Rock Park Development Project, Chelan County, Washington

January 2, 2013

RLR Report 2012-263-28

By

William Schroeder, M.S., Lauren Walton, and Christopher Landreau, M.S.

REISS-LANDREAU RESEARCH

PO Box 2215, Yakima, WA 98907

PH (509) 952-5130 Fax (509) 498-9818   E-Mail: chrislandreau@charter.net

Consultation Provided to:

City of Wenatchee, WA, Hart Crowser, Inc., and Chelan-Douglas Land Trust

Executive Summary

Reiss-Landreau Research (RLR) conducted a survey and inventory for a 325.24 (±0.12) acre parcel known as Saddle Rock Park in Wenatchee, Chelan County, Washington (Figures 1-3). This project was initiated after a sale of the property from Chelan-Douglas Land Trust, Washington State Department of Natural Resources, to the City of Wenatchee. The City of Wenatchee owns the property and it is permanently protected by a Conservation Easement held by the Chelan-Douglas Land Trust (CDLT). Through this partnership between the Land Trust and the City, restoration and stewardship dollars will ensure better maintenance of the area without the City incurring additional expenses. While the development of a trailhead is not part of initial plans, CDLT and the City will explore grant opportunities and partnerships for a public trailhead and maintenance.

As a result of the sale and stewardship agreement, Reiss-Landreau Research (RLR) was contacted to conduct an intensive cultural resources survey of the 325-acre parcel. Background research on the project site revealed seven cultural resources reports within one mile of the proposed project area. Two archaeological sites are recorded along the west bank of the Columbia River in Chelan County i.e., in Wenatchee, WA, and nine archaeological sites are recorded along the east bank of the Columbia River in Douglas County i.e., in East Wenatchee, WA. There are two cemeteries—technically one cemetery and one mausoleum—within a mile radius of the project area. Seven National Register properties exist within one mile of the project area, mostly in the Historic Downtown Wenatchee area. There are 23 Historic Properties indices in the WISAARD system on the eastern margin of the project area in Section 16. Only those properties which are adjacent or very close to the project area are discussed below; none of the aforementioned archaeological sites, National Register nor historic properties will be affected by the proposed action at Saddle Rock Park and are therefore not further discussed. Case in point, the Lanham Lateral irrigation ditch on the outskirt of the alluvial fan which emerges out of Dry Gulch has not yet been recorded to the DAHP HPI database and will not be affected by this project in any way; therefore it is not recorded here.

This report details the results of a pedestrian survey within the Area of Potential Effect (APE) of this project. During the course of inspection, RLR identified six historic mining sites, and one historic archaeological or historic properties, and have uncovered evidence of a Native American traditional cultural property associated with the site. The archaeological properties have been recorded to the Washington State Department of Archaeology and Historic Preservation's Washington Information System for Architectural and Archaeological Records Data (WISAARD) database as archaeological sites. Prior to development of the project area, **Reiss-Landreau Research recommends that the stakeholders consider putting forth a district nomination for the sites associated with Saddle Rock, as their historic relationship is clear and notable.**

Figure 1: Project locator map within Washington State.

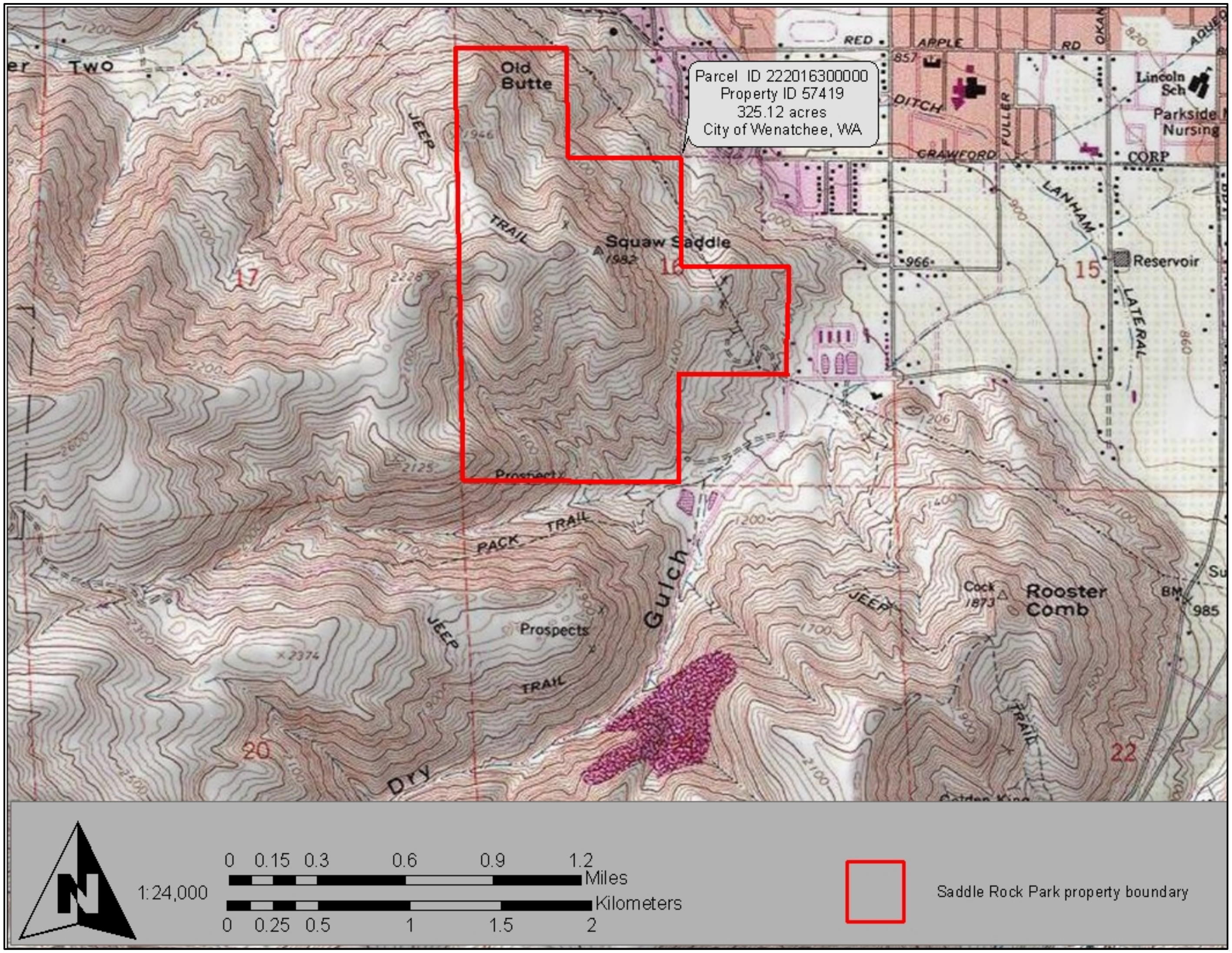

Figure 2: Project Area on a 1:24,000 scale topographic projection.

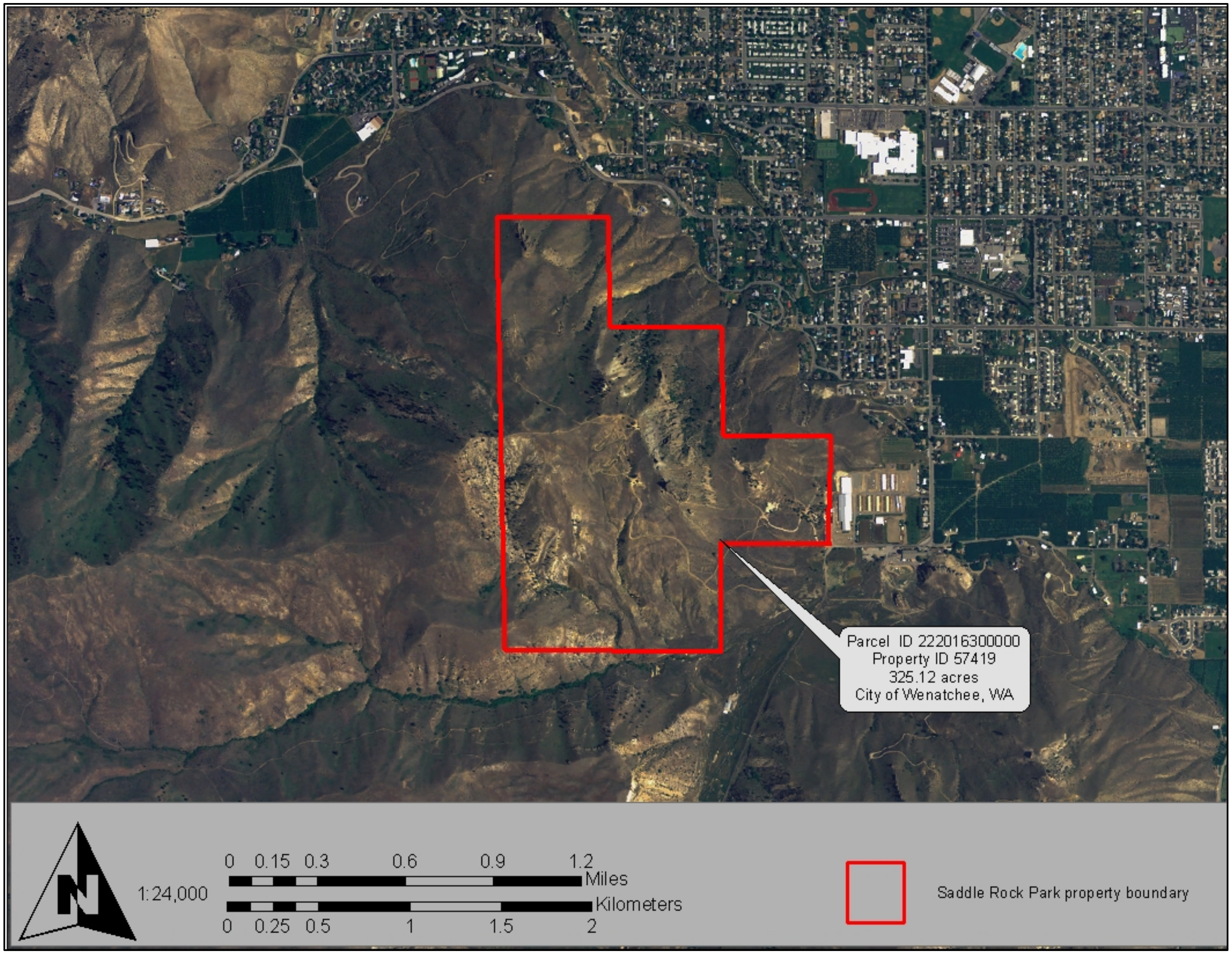

Figure 3: Project area on an orthographic projection.

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Project Description

A. Project Activities: The project proponent is proposing to improve a parcel of land in Wenatchee, WA as a public park (Figures 1-3).

B. Project Area of Potential Effect (APE): The project APE encompasses 325.24 (±0.12) acres of City of Wenatchee property formerly owned and managed by Washington State Department of Natural Resources (WADNR).

C. How the APE was determined: APE was determined by the property owner.

D. Location and size (in acres) of the survey area: The project area a ca. 325 acre parcel of City of Wenatchee property in Section 16, T 22 N, R 20 E in Chelan County, WA.

E. Project proponent, property owner, and agency: The City of Wenatchee owns the property and it is permanently protected by a Conservation Easement held by the Chelan-Douglas Land Trust (CDLT).

F. Regulatory:

G. Survey personnel: Wm. Schroeder, M.S. and L. Walton

H. What circumstances led to this survey: This project was a standard regulatory compliance project.

Legal Information:

USGS: Wenatchee 7.5' Quad
State Plane: T 22 N, R 20 E, NW ¼ NW ¼, S ½ NW ¼, SW ¼, and NW ¼ SE ¼ Sec. 16
UTM: 10T 0701508E 5252746N at SE corner property entrance;
1,982 ft. above mean sea level for highest point on Saddle Rock.

Environmental setting

This project is located on the western margin of the Columbia Plateau in Chelan County, Washington south of Wenatchee, WA. The subject property is south of the Wenatchee River and west of the Columbia River. The land surrounding this project was primarily used for mining purposes i.e., gold, silver, mercury. During the Pleistocene and Pliocene, the region was periodically covered by massive glaciers, some over 1km high, until the end of the Pleistocene. At the end of the Wisconsin glaciation, as the ice retreated, massive flooding and sedimentary depositional events occurred throughout this region. The influence of the glaciation in North-Central Washington State is manifest visually everywhere in the form of sandy loam soils, glacio-fluvial, landslide, and massive sand bar deposits, as well as erosion zones from the catastrophic flooding events associated with the Missoula Floods throughout the basin. This project area is in the extreme Northwest portion of the Columbia Basin Physiographic region and borders the lower Okanogan Highland region with aspects of both provinces visible here (Symposium on the Regional Geology of the State of Washington, Lasmanis, Cheney, & Geological Society of America. (1994), especially the stark contrast between olivine-rich Miocene flood basalts to the east and Swakane biotite-plagioclase-quartz gneiss of Eocene age to the west of the Columbia River (Tabor & Geologic Survey, 1982). Indeed, geothermal activity is believed to be responsible for the metamorphosis of Chumstick Formation sandstones into coarse-grained quartzite shot through with metals in the interstices.

There is considerable evidence of mass wasting on the northeast and southeast sides of Saddle Rock. Hummocks form the toeslope and can be seen in dramatic relief from the top of Saddle Rock. It is presumed that there was a period of excessive moisture which supersaturated the glacial and catastrophic flood event sediments as well as the native soils generated from the residuum from the weathering and erosion of the intrusive dacite dome which gave way under gravity and weight as mass wasting events. The time period of these events is unknown, but is likely in the Late Pleistocene or early Holocene.

McKee (1971) outlines tectonic events beginning 40 million years ago (Mya) involving a massive crustal plate—the Farallon plate—which subducted under the North American plate causing pressure to build up and deformation of the crust. Excessive pressure led to faulting and eventually flood-like eruptions of olivine-rich basalt. Subduction of the Farallon plate under the North American plate continued from 19 to 2 Mya, but at a slower rate. The Columbia River Basalt Group is the result of several sequential low-viscosity Miocene flood-basalt flows from approximately 17 to 2 Mya that covered an area of over 63,000 mi^2 and began in an unstable fault zone near the present borders of Washington, Idaho, and Oregon. Individual lava flows measure 27 to 100 ft. (8 to 30 m) thick, but when taken in aggregate—as one might at Vantage, Washington on the Columbia River—a total thickness of 2,000 to 5,000 ft. (600 to 1,550 m) can be attributed to this formation (Franklin, Blinn, & Dyrness, 1988, p. 29). Columbia River Basalt Group (CRBG) flows were malleable enough that they folded under pressure instead of faulting, though there are numerous faults within the Yakima Fold Belt. During the Pliocene and the Pleistocene, gravel, sand, silt, and clay were deposited in lakes or by aggrading streams and rivers in depressions. Glacial outwash during the Pleistocene produced huge volumes of wind-blown silt called loess. It blankets much of the Columbia Basin and in places is up to 200 feet thick (Symposium on the Regional Geology of the State of Washington et al., 1994).

The Cannon Mine, located outside the Saddle Rock Park boundaries, has been in operation since the mid-1980s, but was first claimed in 1885 as the Gold King mine in the B reef. It is situated within the Chiwakum graben, a north-east trending strike-slip graben, bounded by the Entiat and Leavenworth fault zones. Geothermal alteration as a result of porphyritic biotitic dacite dome intrusion has altered arkosic sandstones into quartz-chalcedony-adularia-calcite veins and veinlets (stockworks) within a brecciated unnamed sandstone and/or siltstone unit and overlying Eocene Chumstick Formation deposits. These veins and veinlets contain gold and silver ore and electrum (Figures 4 and 5). Saddle Rock contains porphyritic hypersthene basalt trending towards sodic hornblende-pyroxene andesite.

Lovitt Mines are part of the property controlled by the Cannon Mine, which is in joint operation with Asamera Minerals, Inc. and Breakwater Resources, Inc. as of the 1990s. Alternate names for Lovitt mines are: Golden King, Wenatchee, Squillchuck, Gold King, and L-D mines (Derkey, Joseph, & Lasmanis, 1990, pg. 14). Gold and silver ore and electrum are the main commodities. Sporadic production of ore occurred in 1894, 1910, 1938-39, 1944-46, while continuous production occurred from 1949 to 1967. This would place these mines within the historic era and associated mining debris, blasting cans, or refuse may be extant near mine entrances. These mines are outside the current project APE. Information on the Sunrise, Squaw Saddle, and Gold Knob (labeled “Prospect” on the Wenatchee USGS 7.5’ topographic quadrangle) mines and others may be found below. See Figure 6 below for a detailed, point-specific map of known mines; information retrieved from WADNR Geoscience Data and Collections, GIS Data and Databases at http://www.dnr.wa.gov/ResearchScience/Topics/GeosciencesData/Pages/geoscience_data.aspx.

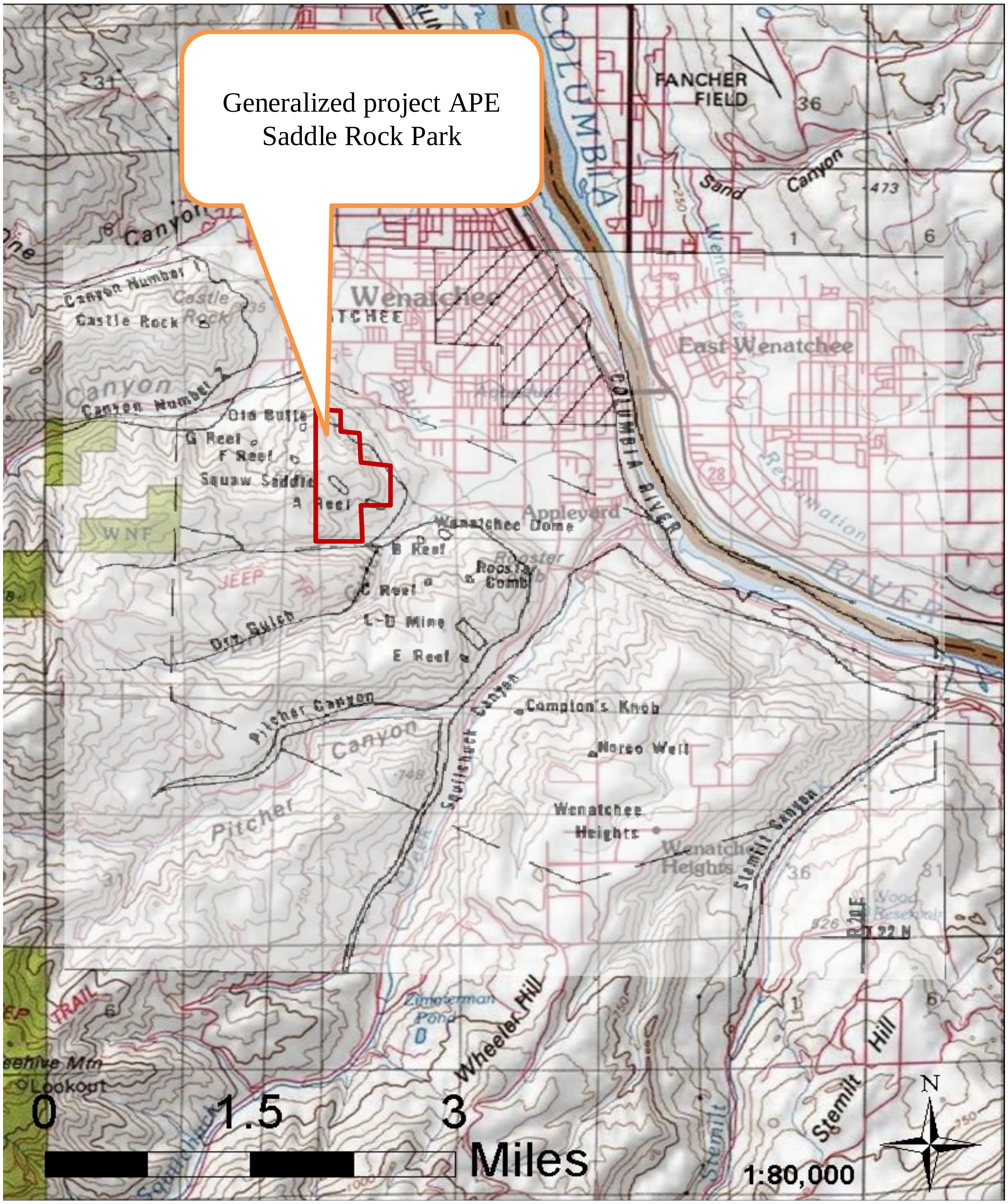

Figure 4: Detail map from 1:80,000 scale topographic quad with Figure 1 from Patton and Cheney (1971) superimposed and georeferenced, indicating reefs with Saddle Rock Park outlined in general in red.

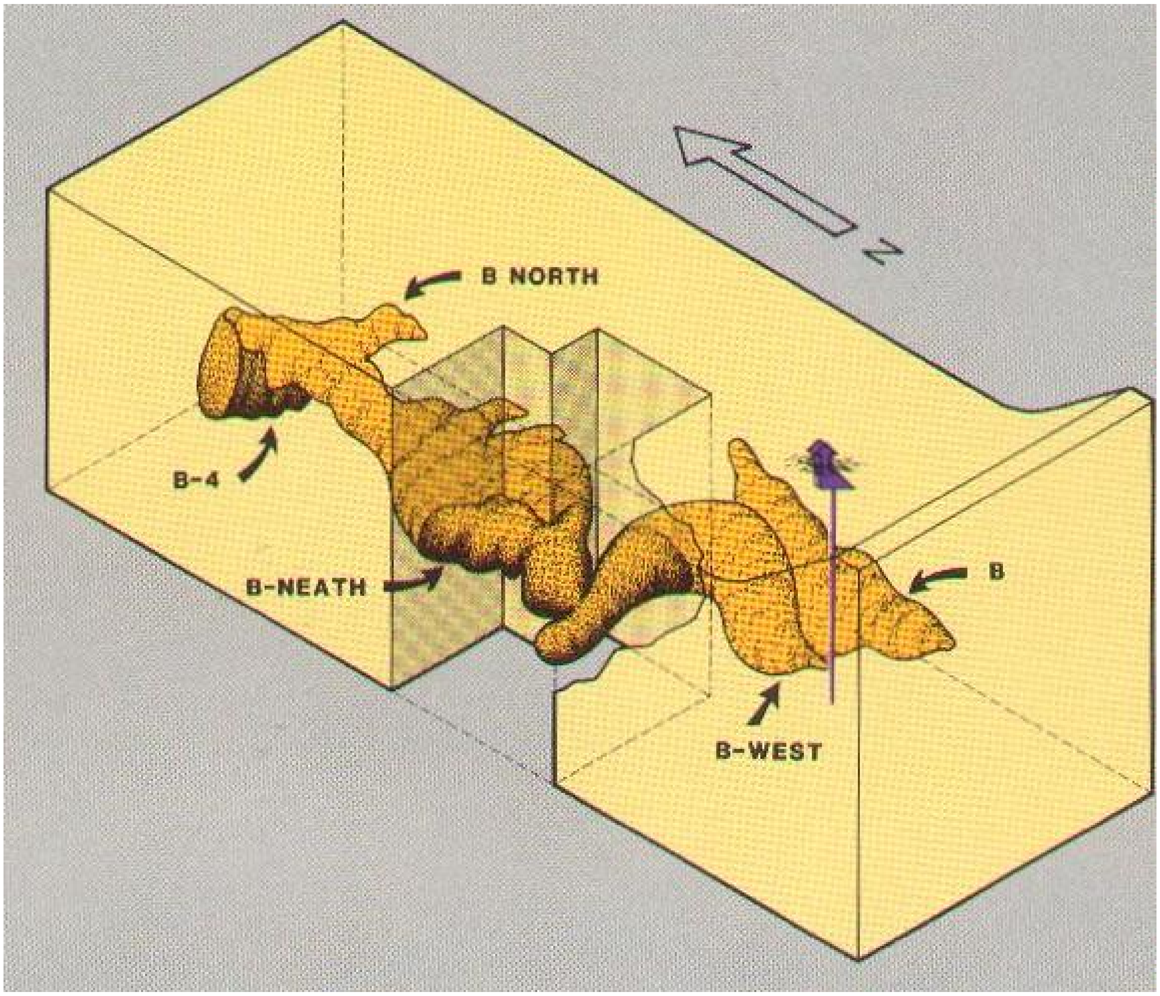

Figure 5: Diagram of isometric ore bodies within Cannon Mine minesite (genesbmx.com, 2012).

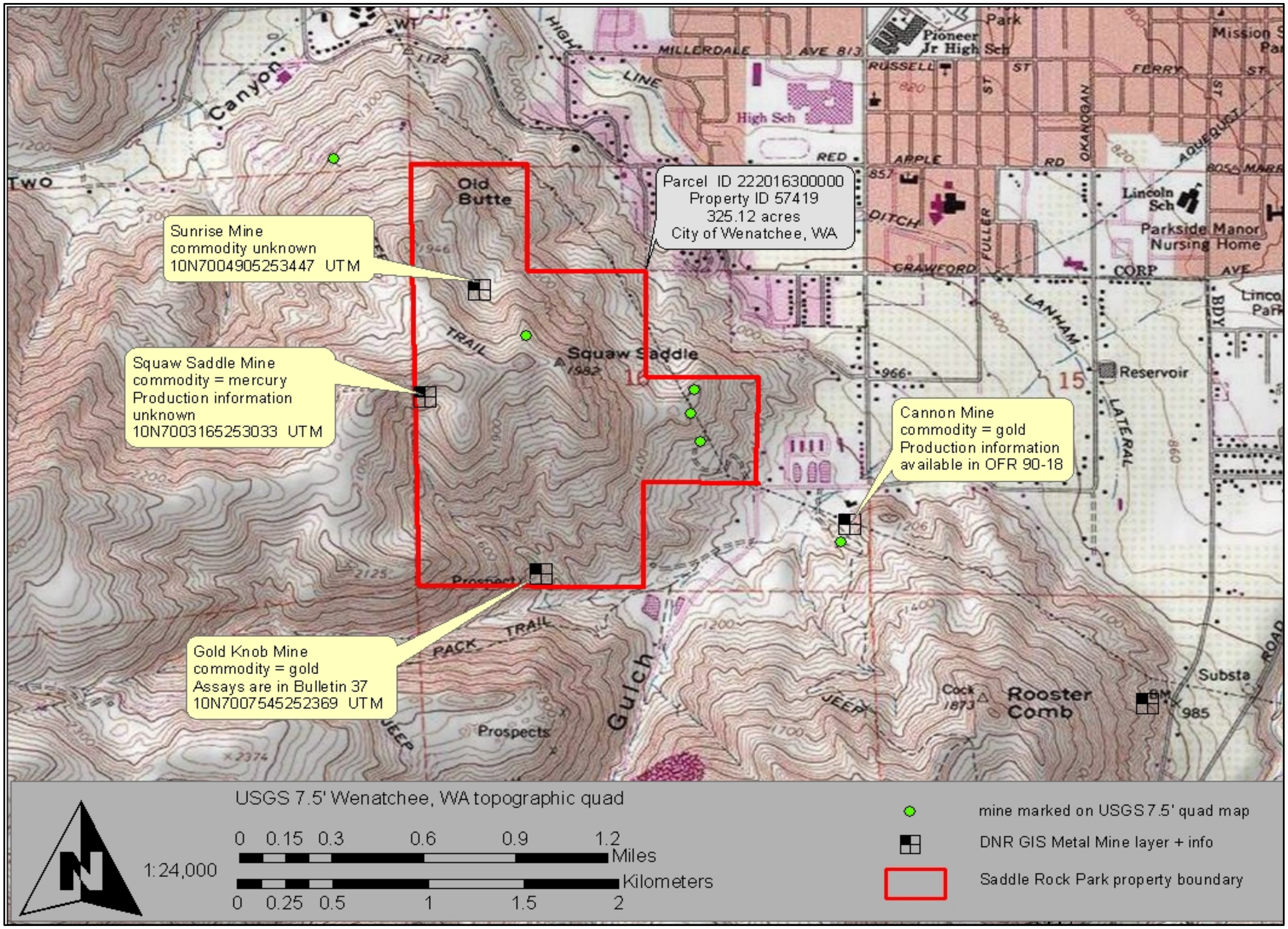

Figure 6: Point-specific mine data within and near Saddle Rock Park (www.dnr.wa.gov, 2012).

Cultural Setting

The subject property lies within Confederated Tribes and Bands of the Yakama Nation Ceded Land, a vast region of central Washington occupied historically by the constituent Bands and Tribes who are now through the Treaty of 1855 recognized as the Yakama Nation (Schuster, 1998) as well as the Confederated Tribes of the Colville Reservation Indian Land Area judicially established by the Indian Claim Commission (personal communication, Warren Hurley, 2012). The Presidential Executive Order issued on July 2, 1872 moved the Colville Indian Reservation to its present location on the west side of the Columbia River and diminished its size to less than three million acres.

Traditionally the Ichi-Shkiin Sin-Wit (Meninick, personal communication, 2008) have been a part of this landscape since the inception of time. Through the Creator's Law the resources of water, land, air, natural resources and human resources have been advocated by the Ichi-Shkiin Sin-Wit until a profound change was introduced in 1855. In this year the Ichi-Shkiin Sin-Wit signed a Treaty with the United States Government and it was declared that "The Treaty is the law of the land in perpetuity as long as the sun shall rise, as long as the mountain shall stand and as long as the waters shall flow" (Meninick, personal communication, 2003). Since this time it has been common for scientists and ethnographers to refer to the Ichi-Skiin Sin-Wit as the Yakama that speak Sahaptian language dialects.

Traditionally the land of the Ichi-Shkiin Sin-Wit was utilized and cared for by a seasonal round. This seasonal round would require cyclical movement through the landscape to best make use of the natural resources, both plant and animal (Hunn, 1990). Generally, the Native families would winter in large villages along major waterways and would move to higher elevations as the seasons warmed, utilizing the seasonal resources as they moved upslope.

From an ethnographic point of view, subsistence focused on seasonally-available plant and animal resources including salmon, river mussels, lomatium, bitterroot, berries, and ungulates. Documented archaeological sites within the Columbia Basin include fishing and village sites along the major waterways, stone quarrying sites, temporary camps, and plant processing locations (Bicchieri, 1991; Hodges, Miss, & Shea, 2003; Smith, 1910). Of interest to any archaeological or prehistoric/pre-contact discussion should be the importance and role of winter villages. Winter villages were integral to the seasonal round. They were generally occupied from mid-November until the beginning of March, depending on the weather. They were positioned within the landscape such that protection was afforded from the environment. They were also situated with respect to available and stored resources--resources acquired through the seasonal or yearly round. Archaeologically documented winter villages tend to occur at or below elevations of 2,500 ft. in the eastern Cascades.

The Columbia ethnographic group (Ray, 1939; Smith, 1977) embraced much of the Channeled Scablands, yet the general region is at an intersection of more than one ethnographic group. The Yakama, Columbia (Kawachen), Spokane, Methow, and

Wenatchi shared the upper Middle Columbia River. Salishan and Sahaptin dialect speakers are commonly separated ethnographically even though they intermarried and traded. Therefore, in a mixed-cultural landscape, it is not possible to determine without Tribal consultation which ethnographic group lays claim to a particular traditional cultural place or has patrimonial primacy over significant archaeological finds. Suffice it to say, people have been on the landscape of the Channeled Scablands and the Columbia Basin for upwards of 10,000 years.

Ethnographic place names for landforms and locations are given in Relander (1986) and are mentioned here because they are not often discussed in cultural resources reports. Generalized locational information is presented only and not specific coordinates of Traditional Cultural Properties (TCPs) as those areas remain under the purview of the Confederated Tribes of the Colville Reservation.

The project area lies within the Columbia Plateau physiographic province as defined by Walker (1998). Pokotylo and Mitchell (1998) include the project area within the Northern Plateau Physiographic Province and more specifically within the South Okanogan Valley. Culturally, the project area lies within the traditional territory of the Wenatchi Tribe and borders traditional territory of the Columbia (Kawachen).

Cultural history of this region begins with the Paleo-Indian period dating to 11,500 years before the present (hereafter B.P.). The Richey-Roberts Clovis Cache is the only known site to contain intact cultural deposits of this age and was found southeast of the proposed project area nearer to East Wenatchee, WA (Mierendorf, 1987). Other artifacts attributed to the Clovis period have been found across the landscape but are entirely limited to surface finds where chronological placement is limited to artifact typology association (Ames, Dumond, Galm, & Minor, 1998). Those cultural materials that predate 8,500 B.P. are often limited to fluted projectile points that have been found on the surface. Interpretation of these surface finds is difficult except to say that a variety of these point styles have been found (Pokotylo & Mitchell, 1998).

Using the Cultural Chronology developed by Grabert (1974) the next major technological shift observed in the archaeological record dates to 6,000-3,000 B.P. and is characterized by people who utilized basal-notched stemmed points, leaf shaped points, and milling stones which have been found in rock shelters or open locations (Pokotylo & Mitchell).

Using the Cultural Chronology developed by Ames et al. (1998) the next major technological shift seen in the archaeological record dates to 11,000-5,000/4,400 B.P. and is characterized by people who utilized a broad-spectrum hunter-gatherer subsistence economy. These people would have moved across the landscape according to seasonal changes in low population densities which were highly adaptable (Ames et al.). No evidence of pit houses or permanent structures has been found from this era. Technologies inferred from artifacts and features indicate that these people were highly mobile and likely had no use for a permanent structure. This period also predates the eruption of Mount Mazama in southern Oregon, a chronological marker used to date archaeological sites based on their position above or below the lens of ash. Mt. Mazama tephra is often absent from the depositional record (or reworked/incorporated into the soil solum) the further from the eruptive zone one is and cannot therefore be used ubiquitously as a temporal marker.

After the eruption of Mount Mazama, Ames et al. (1998) identify the next major technological shift at 5,000/4,400-1,900 B.P. This shift in technology is marked by the decline in frequency of projectile points and an increase in milling stone size and evidence of intensified natural resource exploitation including certain roots and salmon. This period also marks the first appearance of pit houses. The climate during this period was cooler relative to the climate observed during Period 1B. Timberlines descended in elevation and moisture increased (Chatters, 1998).

The next period of technological shift identified by Ames et al. (1998) spans from 1,900 years ago to A.D. 1720 (ca. 300 B.P.). Within this period the climate continued to cool until around 800 B.P. when temperatures begin to warm and glaciers receded as a result (Chatters, 1998), often referred to as the Hypsithermal. This fluctuation in temperature is reflected in the observable tree lines in the archaeological record. Between A.D. 1400 and 1850 a "Little Ice Age" occurred, and while evident in the higher mountain ranges, this event had little effect on the flora of the Northwest (Chatters, 1998). At the beginning of this period use of pit houses became widespread. Evidence of a heavy reliance on fishing, storage, and intensive exploitation of camas can be found in the archaeological record from this period. Land use patterns observed by Euro-American explorers during their first arrivals corroborate archaeological findings. The period ends with the arrival of the horse and European explorers i.e., Contact Period.

During this late period projectile points become smaller and a greater reliance on aquatic resources is apparent. During this period, Southern Okanogan Cultures differ from their neighbors to the north through an abundance of ornamental objects found within Northern Okanogan Valley assemblages (Pokotylo & Mitchell). At the time of Euro-American contact the people living near the project area where the Wenatchi People.

The Middle Columbia Salish, the Sinkayuse, Wenatchee, and Southern Okanogan, Sanpoil, and Nespelem (Miller, 1998) are often grouped together in ethnographies. Villages and food procurement followed the seasonal round. Winter months were spent in the river valleys in villages or in small hunting camps. Camps were established for harvesting roots and berries in the higher elevations. May through August was the fishing season and the people would move from their higher elevations to villages in the river valley (Miller).

Contact period overview

In 1807 the first trading post was established on the Columbia River and in 1820 the famous trading center of Colville tribes' ancestors, Kettle Falls, was occupied by the Hudson Bay Company. The era of trade began with indigenous native people and was often conducted by non-Indians from the northern territories which became Canada. Euro-Americans did not settle in Chelan/Grant County area in earnest until after 1860.

Prior to the 1860s the territorial dispute between the United States and Great Britain discouraged homesteading and settlement. The Treaty of 1846 ended British claims in north central Washington and established the Canadian border as well as the Oregon Territory (and later the Washington Territory). U.S. Army orders prohibited white settlement in most of eastern Washington between 1846 and 1859 until a treaty between the United States and the Yakima Confederacy signed at Walla Walla in 1855 was ratified by Congress (in 1859). Large reservations such as the Yakima and Colville were established for the Indians. The Columbia or Chief Moses Indian Reservation, established by two executive orders in 1879 and 1880 signed by then President Rutherford B. Hayes, originally extended from Lake Chelan and the Chelan River on the south, to the Columbia and the Okanogan rivers on the eastern side, to the Canadian border on the north, and to the 44^{th} Parallel from Washington, D.C. on the western margin.

On February 23, 1883, President Chester A. Arthur signed an executive order which restored a strip of land fifteen miles wide along the Canadian border to the public domain, effectively re-opening that area for mining claims. Indeed, almost the entirety of the Columbia or Moses Reservation was restored to the public domain, subject to the limitations as to disposition imposed by the Act of Congress approved July 4, 1884 (23 Stats., §79-80), which ratified and confirmed the agreement entered into on July 7, 1883, between the Secretary of the Interior and the Commissioner of Indian Affairs and Chief Moses and other Indians of the Columbia and Colville Reservations in Washington Territory. And it was thereby further ordered that the tracts of land in Washington Territory surveyed for and allotted to Sar-sarp-kin and other Indians in accordance with the provisions of the Act of July 4, 1884--allotments approved by the Acting Secretary of the Interior April 12, 1886—be set apart for the exclusive use and occupation of said Indians.

From the History of the Colvilles from the Tribe's website at www.colvilletribes.com (2012), the following block quote is taken to preserve the meaning and intent of the Colville's perspective:

> Twenty years after the Colville Indian Reservation was moved to its present location, the north half of the reservation was ceded to the United States by an act of Congress (27 Stat. §62). At that time 660 Colville Indians were allotted 51,653 acres located in the ceded area. In that same year, the United States negotiated an agreement with our tribal forefathers for the purchase of the unallotted acreage located in the north half and paid them $1.5 million dollars for 1.5 million acres, priced at $1.00 an acre.
>
> The Colville tribal leaders of 1892 were able to reserve the right for members of the Confederated Tribes of the Colville Reservation to hunt and fish on the former north half of the reservation for time immemorial. Later, a Presidential Proclamation on October 10, 1900, opened the south half of the Colville Indian Reservation, totaling 1,449,268 acres, to homesteading which began six years later in 1916.

> The Reservation Allotment Act of 1887 was finally implemented on December 1, 1905 when two-thirds of the estimated number of Colville Indians available on that date, signed the McLaughlin Agreement that ceded the south half of the Colville Indian Reservation for an 80-acre allotment to each Indian. By 1914, 2,505 Colville Indians had been allotted 333,275 acres of reservation lands.
>
> A Presidential Proclamation of May 3, 1916 opened the remaining 417,841 acres of unallotted and unreserved reservation lands to settlement.
>
> In 1934, Congress began ending the federal allotment policy and an order issued by the Secretary of the Interior on November 5, 1935. This halted the withdrawal status of the reservation lands belonging to the Confederated Tribes of the Colville Reservation. Twenty two years later, in 1956, in recognition of the federal government's past failed policies, about 800,000 acres of Colville Reservation lands were returned to tribal ownership.
>
> Today, the Colville Indian Reservation consists of acreage held in trust for the Colville Confederation and individual tribal members and land owned by others in non-trust or fee land status. The Colville Business Council has set in place a policy to purchase lands put up for sale that are located with the boundaries of the reservation and unallotted lands outside the reservation based on funds available through yearly tribal fiscal budgets. One of monumental goals of the Colville tribal government is to own all Colville Indian Reservation lands. Presently, over 200,000 acres are not owned by the Colville Confederation and thousands of those acres are in agricultural production by non-Colville tribal members.

Colville, Chelan, Entiat, Methow, Okanogan, Lake, San Poil, Nespelem, Moses, Nez Perce, Palouse, Sinkayuse, and Wenatchee tribes and bands comprise the members of the Colville Confederated Tribes. The current project area is in the traditional territory of the Wenatchi, Methow, Entiat, Chelan, Columbia (Kawachen), Yakama, and Kittitas bands.

Early Euro-American contact was with fur traders representing several companies, specifically the American Pacific Fur Company, the Canadian-based North West Company, and the Hudson's Bay Company (Beckham, 1998). These companies sent employees out into the areas surrounding the Columbia River, but this contact between fur traders and native people was likely sporadic except along the trails the companies used. Significant contact did not occur until the discovery of gold in northeast Washington and British Columbia in the later 1850s. Would-be gold miners came through the Methow Valley on their way further north and inspected the valley for its mining potential as they passed through. By the 1870s, the federal government was no longer negotiating treaties with the Indians, but reservations were created by Executive Order for numerous Indian groups such as the Colville. For example, the Methow band was assigned to the Colville Reservation, while the land in the Methow Valley became part of the Moses or Columbia Reservation in 1879 (Miller, 1998). Soon after, miners pressed to have the land reopened for mining, and the Moses Reservation was canceled in

1883. Subsequently in 1884, gold was discovered in the Twisp River headwaters. With the influx of miners into the area, settlement increased while some miners squatted on land and continued to mine through the season of good weather, others new to the valley chose to settle and began agricultural ventures.

Euro-Americans did not settle in Chelan County in earnest until after 1860. Prior to the 1860s the territorial dispute between the United States and Great Britain discouraged homesteading and settlement. The Treaty of 1846 ended British claims in north central Washington and established the Canadian border as well as the Oregon Territory (and later the Washington Territory). U.S. Army orders prohibited white settlement in most of eastern Washington between 1846 and 1859 until a treaty between the United States and the Yakima Confederacy signed at Walla Walla in 1855 was ratified by Congress (in 1859). Large reservations such as the Yakima and Colville were established for the Indians. The Columbia or Chief Moses Indian Reservation, established by two executive orders in 1879 and 1880 signed by then President Rutherford B. Hayes, originally extended from Lake Chelan and the Chelan River on the south, to the Columbia and the Okanogan rivers on the eastern side, to the Canadian border on the north, and to the 44th Parallel from Washington, D.C. on the western margin.

From the Wapatopoint.com website (2012) this following block quote is taken:

> Members of the Wapato Family were among those who claimed allotments. This family, whose patriarch at the time was Nekquelekin (Enkawhakekum) or Wapato John (sometimes misspelled Wapato), had previously lived along the Columbia River above Ribbon Cliff in the Entiat vicinity. In 1884, Peter Wapato, son of John, obtained the Wapato Point area as part of the Moses Agreement allotment No. 10, and his descendants still retain his interest.
>
> Later, the Point became a gathering place for local Indians, who played the stick game, ran their horses on a half-mile racetrack, and staged rodeos. A grandstand was erected at the racetrack, which was located on the west side of the neck of land leading to Wapato Point itself. Nearby, on this neck, family members operated a dance hall from the late 1920s into the 1940s.
>
> They also planted fruit trees on the east side of the neck. Nothing is left standing of the early structures. In the 1950s and 1960s, the family maintained facilities for camping, swimming, and boating.
>
> In the early 1900s, the local settlers, through the Wapato Irrigation Company, convinced Congress to reduce the size of the allotments previously awarded the Indians. In March 1911, Congress did diminish the allotments to only 160 acres. In the 1930s, the water level of Lake Chelan was raised 22 feet, causing approximately 50 acres of the final 160 acres to be under water, when the lake is at high water, 1,100 ft. elevation.

The recent Ninth Circuit decision in United States v. Confederated Tribes of the Colville Indian Reservation (Colville) (2010) challenges the decisions made in 1855 and 1894. It decided that the Wenatchi Tribe, a sub-group of the Colville Indian Tribe with members living on both the Colville and the Yakama Indian reservations, holds treaty fishing rights in common with the Yakama Nation and the citizens of Washington State at their traditional fishing grounds, the Wenatshapam fishery at the confluence of Icicle Creek and the Wenatchee River, near present day Leavenworth, WA. The Wenatchi have waited more than 150 years for protection of their fishing rights at their ancestral fishery (Shutler, 2011).

Indeed, Scheuerman, Clement, Trafzer, and the Wenatchee Valley Museum and Cultural Center (2005) found that:

> [i]n the pivotal decade of the 1850s, five distinct bands comprised the Wenatchi with closely related neighboring tribes upstream including the Entiat, Chelan, and Methow. Unlike the Plains Indians, however, the Wenatchi were a "tribe" less in a political sense than linguistic and geographic. . . . Rather, each band was autonomous under the leadership of its own headmen and was known by a distinctive name. The westernmost band, the Sinpusq'ísoh, was generally headquartered in the vicinity of their famous fishery. . . .

The Treaty with the Yakima (June 9, 1855; 12 Stat., §951; United States, 1975) ratified on March 8, 1859 and proclaimed April 18, 1859, states in Article X [10]:

> [t]hat there is also reserved and set apart from the lands ceded by this treaty, for the use and benefit of the aforesaid confederated tribes and bands, a tract of land not exceeding in quantity one township of six miles square, situated at the forks of the Pisquouse or Wenatshapam River, and known as the "Wenatshapam fishery," which said reservation shall be surveyed and marked out whenever the president may direct, and be subject to the same provisions and restrictions as other Indian reservations.

According to A. J. Splawn's account, at the end of the negotiations, the Yakama were persuaded to surrender its interest in 29,000 square miles in return for a reservation of less than 2,000 square miles and $650,000 (Splawn & Washington State Library, 1944). Shutler (2011) found that in 1856 Chief Skamow of the Wenatchi met with US Army Col. George Wright, who actually marked boundaries for a six-mile reservation around the fishery and that Wright reiterated that the United States would honor the Treaty (Ninth Judicial Circuit Historical Society, 2000), then two years later Captain J. J Archer stated his intention to make sure an eight square mile reservation was marked out. By the late summer of 1858, the Army had instead subdued the Indians through destruction of their villages (Scheuerman et al., 2005). Nonetheless, the Wenatchi continued to fish at their fishery, believing that eventually the government would survey their reservation as promised. According to Richard Hart and Ninth Judicial Circuit Historical Society (2000), US Government officials marked boundaries for the reservation between 1856 and 1858. The Wenatchi almost got their reservation surveyed in 1892, when President

Benjamin Harrison signed an executive order, but his successor, President Grover Cleveland, took office the next year and the new administration stopped the process.

Tate (2005) found that tracks for the Great Northern Railroad were laid directly through what was supposed to be the P'squosa reservation in 1892. Led by Chief John Harmelt, the P'squosa protested. They were promised individual allotments of up to 160 acres. They were also promised perpetual rights to their ancestral fishing grounds, yet not one acre of land was ever actually allotted to the tribe. The land and the fishing rights were instead sold in 1894 for a total of $20,000. The Bureau of Indian Affairs negotiated the sale with the Yakama Nation not with the P'squosa themselves. By 1896, only 180 P'squosas were still living in the Wenatchee Valley in their traditional lands. They were offered $9.30 each for their rights to the ceded land and none accepted.

Heffter (2003) found that:

> Harmelt spent the rest of his life fighting for the lost reservation. He traveled to Washington, D.C., twice to ask federal agents for his tribe's land. Finally, in the early 1900s, destitute tribal members began to move 100 miles northeast to the Colville Reservation.

Pratt (2010) and Mehaffy (2010) reported that the 9th Circuit found that both the Yakama Indian Nation and the Wenatchi band of the Colville Tribes both retain “non-exclusive” fishing rights at Icicle Creek near Leavenworth, WA. Indeed, Pratt found that

> …Judge Richard Tallman of the U.S. Court of Appeals, ninth circuit, in Portland, wrote that the court’s three judges relied on expert anthropological opinions, century-old documents, including a transcript of treaty talks, and “reliable hearsay” to establish that “more than any other place, the Wenatshapam Fishery was the hub around which the Wenatchi’s cycle of life rotated.”

Chief Moses and the Moses Columbia Reservation

Sulktalthscosum, also known as Half-Sun, was a powerful leader of the Sinkiuse people in the early 19th Century. He was the son of Slukpostaglanna, or Wolf with Chain of Hearts. Sulktalthscosum is believed to have been born at the time of the eclipse of 1800 (Ruby & Brown, 1965, Pg. 3). He was killed on a buffalo hunt ca. 1850 by Plains Indians (Ruby & Brown, 1992, pg. 205). Sulktalthscosum’s eldest son, Quiltenenock (Quiltomee), led the Sinkiuse until he, too, was killed, this time at the hands of white miners below the mouth of the Wenatchee River in 1858. Quiltenenock’s brother, Moses—a Christianized given name acquired at the American Board of Commissioners of Foreign Missions at present-day Lapwai, ID—assumed his role as the leader of the Sinkiuse or Kawachen people. Moses was born about 1829 on the Flat near the Wenatchee River and what is now known as Moses Coulee (Ruby & Brown, 1965, Pg. 6) and after his first solid food meal, he received the name Loolowkin (the Head Band). Loolowkin spent some of his early years in the Columbia Plateau and some of it in the Missouri River watershed. He traveled with Theodor Winthrop as a guide to The Dalles.

Loolowkin had come under the tutelage of Chief Owhi, the father of Loolowkin's two wives, after Sulktalthscosum's death. Owhi considered Loolowkin his "son".

After the debacle created by McClellan and the usurpation of lands cared for by the many tribes of the Columbia Plateau for thousands of years and the deaths of the Whitmans which resulted in the Yakama Wars of 1855-1858, Loolowkin changed his name to a warrior name—Quetalican or One Blue Horn. Quetalican roamed the Spokane and Colville country stalking intruders, namely white men. Qualchan, Quetalican's brother-in-law, one of Owhi's sons, was believed by Col. Wright to have been Agent Bolon's killer. Qualchan missed a warning and rode directly into Wright's camp and was killed by hanging about 15 minutes after his arrival. Quetalican went into hiding in the lower Spokane until the soldiers left the middle Columbia region and things quieted down. Quetalican then took his wives to the San Poil country near Keller Mountain for a year. The US Army was still bent on revenge.

Quetalican returned to the mid-Columbia in 1859 when some of the hostility had subsided. Quetalican's wife, Quemollah, died soon after their return. Meanwhile, Quetalican gathered scattered warriors and remnants of the Columbia bands who had managed to escape or avoid confinement on a reservation at the behest of white men. Quiltenenock's death at the hands of white men in 1858 paved the way for Quetalican to assume his father's name—Sulktalthscosum—and his father's role as a leader of his people. Thus Quetalican became Half-Sun.

At about the same time, the US Army established Fort Colville approximately 15 miles east of the Columbia River. The Hudson's Bay Company fort of the same name became a bastion of protection for the white settlers. Additionally, Indian Affairs Portland, Oregon Superintendent Edward R. Geary recommended to A. B. Greenwood, Commissioner of Indian Affairs in Washington, D.C., that non-treaty Indians of the Columbia be placed on the Yakima or Simcoe Reservation. Indeed, the Okanogans and the Sinkiuse or Columbia Indians had signed no treaty with the US at Walla Walla in 1855. The Columbia Indians showed no signs of being persuaded by gifts or bribes into exchanging or ceding their lands.

After a meeting with A.J. Splawn and Major John Thorp concerning the movement of a large herd of cattle through the mid-Columbia, Chief Moses was informed that a small band of braves were plotting to kill the white men intruders. Moses personally rode between the hostile band and the white men and prevented a massacre from happening. Because of his decisive and quick action, Moses' leadership strengthened and respect for him increased. Moses became a respected leader of his people, yet some were drawn to Smohalla and the Wanapum way of life.

Through until 1870, Moses remained aloof with regard to white men—sometimes assisting, sometimes resisting. Case in point, Moses resisted telling the US Government officials information about his tribe such as population, stating that G-d already knew their numbers and that the only authority they recognized was [their] God.

Near the end of the Civil War, President Lincoln signed a charter which created the Union Pacific, Northern Pacific, and Southern Pacific railroad systems. The original planned route of the Northern Pacific from Clark Fork, ID to the Puget Sound fairly followed the 48^{th} Parallel. The railroad withdrew its Right of Way along the proposed northern route and reverted control to the US Government. Out of this territory the Colville Reservation of July 2, 1872 was established by Executive Order. Later that same year, Moses and some of this people travelled down Crab Creek and watched as surveyors staked a proposed route which passed right through their ancestral lands. Without a Treaty or an Executive Order, Moses and his people were unable to argue or stop the progress of the white men and their “chick-chick wagons” through their homeland.

Kershner (historylink.org, 2008) says that:

> In 1877, Moses had to make the difficult choice about whether to join Chief Joseph's Nez Perce in war or to remain peaceful. His ties with the Nez Perce were particularly strong, dating from his days at Lapwai, but he eventually realized it would be futile to join in the war, since the Nez Perce were already retreating across the Rockies. Moses apparently did what he could to prevent his warriors from joining in a number of attacks that erupted across the Northwest during the Nez Perce crisis,

and

> a suitable reservation settlement seemed more crucial than ever to Moses. The government was pushing him to accept removal to the Yakama Reservation -- which was south of his tribe's homeland and already filled with other tribes -- or to the newly established Colville Reservation, which was north of the Columbia and farther east than the tribe's homeland. Moses made clear his displeasure with either idea by staying away entirely from the 1877 treaty council.

Unfortunately, two white settlers, Lorenzo and Blanche Bunting Perkins, were murdered by seven renegade Umatilla tribal members in 1878 near White Bluffs. The people responsible for the murders were purportedly on their way to Moses’s camp when they encountered the white settlers, and the nervous white people of the Yakima accused Chief Moses of complicity in the murders. Chief Moses offered to apprehend the renegades, but was himself apprehended by the posse he created. Moses was imprisoned in Yakima, W.T. He was guarded at the Yakama Reservation until February, 1879. President Hayes invited Moses to come to a council in Washington, D.C., but was skeptical—President Hayes had decided that there would be no Columbia Reservation during the time Moses spent in jail.

Kershner (2008) goes on to say that,

> In a series of meetings over the next week, Moses must have been persuasive. E. A. Hayt, the Commissioner of Indian Affairs, agreed to the new, vast reservation west of the Colville Reservation for Moses's people and "other friendly Indians."

> On April 19, President Rutherford B. Hayes (1822-1893) signed an executive order establishing the reservation, which would become the Columbia Reservation, more commonly known as simply Moses's Reservation.

Unfortunately, the news was bittersweet in that

> Moses had trouble convincing many Indians, most of whom lived south of the reservation on the Columbia, to move up there. And white miners and ranchers [had begun] to raise a ruckus about the loss of so much prime land. They began agitating for the abolition of the Moses Reservation almost before Moses or any other Indians had moved onto it. It didn't help matters that when Moses finally established his home camp in 1880, it was in the Nespelem Valley on the Colville Reservation, not on the Moses Reservation.

Ultimately, Kershner (ibid.) points out that

> Moses and the related tribes cede[d] the entire Moses Reservation and move[d] to the Colville Reservation. In exchange, the government [gave] them various improvements, including a sawmill, a grist mill, cows, wagons, and plows. Moses himself was offered an annuity of $600 a year if he and his people kept to the agreement. Moses bargained only one significant change; He asked for $1,000 a year, and got it. Moses signed with an X and when the treaty was ratified in 1884, the Moses Reservation was no more.

Chief Moses died at his house in Nespelem on March 15, 1899—nearly 100 years old. Sadly, grave robbers/looters dug up his grave in 1904. Not only did they disturb his grave, they took his watch and a Presidential medal given to him on his trip to Washington, D.C. This indignity is in part the reason for the extensive environmental and cultural background sections in this report—respect and honor is due to the people who cared for the land in pre-contact and contact times which was part of this survey and inventory presently.

Traditional Cultural Places of the Wenatchi

There were many permanent Wenatchi villages along the Columbia near present-day Wenatchee. The construction of dams on the Columbia River flooded many of these villages. The village of "*kultαktcín*," meaning "delta," was a permanent village at the mouth of the Wenatchee River. Approximately 40 people lived there. The villagers had a spear fishing station on the east side of the river. "*Nakumchín*" or *nk'əmcín,* translated as "place at the mouth" was a small summer camp located near the intersection of old U.S. Highways 97 and 10 near the mouth of the Wenatchee River. People of this village gathered edible roots and berries in the area, and fished in the Wenatchee River. Camp population varied from 20 to 60 people. Upriver from the confluence a large, permanent village associated with *nk'əmcín* was on the north bank of the Wenatchee River. The village was/is called *alotœs* and had a population of 200. A small summer camp whose name translates as "purplish rock" was on the Columbia River near the south end of the present-day Wenatchee business district (Miller, 1998; Ray, 1974, ppg. 424–425). The village of "*stóxpas*" was on the east bank of the Columbia, opposite the mouth of the Wenatchee River. A small summer settlement was also on the east side of the Columbia called "*xaxátqw*," which Ray (1974, pg. 427) translates as "dragon jaws."

One of the largest Wenatchi villages was at the mouth of Squilchuck Creek. This village is called "Rocks Scattered All Over" by Miller (1998, pg. 254) and "Two Owls" by Ray (1974, pg. 426). This village had a population of 400. The large village of "*skiłkatín*," which translates as "Warm Shore," was at the mouth of Stemilt Creek. This was an important fishing village with a population of about 300 (ibid.). The village of "*tcama.s*" was on the Wenatchee River at the mouth of Icicle Creek, just south of the present town of Leavenworth. This village was the Wenatchi's main salmon fishing grounds. Up to 3,000 people gathered at the village during the peak fishing season, including visitors from across the Plateau. Another small fishing camp was on the north side of the Wenatchee River near present-day Leavenworth. Other villages and camps were located along the Columbia and Wenatchee rivers (Miller, pg. 254; Ray, 1936, pg.142; 1974, pg. 424–426) outside of the 2-mile radius required by WA DAHP to be included in an archaeological/ethnographic review (see *WA DAHP Data* below for a summary of previously recorded archaeological sites in the near of the project area).

Wenatchi-P'squosa Legend

A publicized version of the Weantchi-P'squosa legend of Grizzly Bear and Black Bear, as told by Celia Ann Dick and used by permission of the Dick family in Wm. Layman's *Native river: The Columbia remembered: Priest Rapids to the international boundary* (2002, pg. 63) is re-presented here, with permission of the Confederated Tribes of the Colville Indian Reservation:

> Grizzly Bear was a disagreeable wife. She had a reputation of being grouchy and was prone to outbursts of anger. Black Bear, on the other hand, was hardworking and conscientious. She cooked good meals, took care of the children, and tended her duties at home. This earned her the respect of the husband the two bears shared in common. Grizzly Bear was very jealous of Black Bear.
>
> One morning Black Bear needed to go dig some camas so she set out from the hills above the river to Badger Mountain. She rose early, took off her digging pouch and flung its belt across the river at Rock Island, forming a bridge that she could then cross. By the time Grizzly Bear finally caught up, Black Bear was on the other side with her belt back by her side. This made Grizzly Bear very mad and in a temper she tore up trees and brush before traveling downriver in search of another place to cross.
>
> One on Badger Mountain, Grizzly Bear neglected her digging by spending the day spying on Black Bear who went about her business of root digging. By day's end Black Bear's basket was filled with camas, but Grizzly had little to take home. Hurrying to get something in her basket, Grizzly broke what roots she dug.

> When Grizzly Bear arrived home to feed her husband, he would not ear because her camas was inferior.
>
> Black Bear took care in digging her roots and upon returning home, she prepared them well. Their husband of course preferred Black Bear's camas. This infuriated Grizzly Bear all the more. Soon she even began having thoughts that Black Bear must be more sexually attractive to her husband. Such thinking only made Grizzly Bear all the madder at Black Bear and the fighting continued.
>
> As time went on, the two bears' quarreling got worse. One day Coyote grew tired of their ceaseless bickering and turned them into stone, which is where they stand today.

Additionally, the rocks at the base and to the sides of Saddle Rock are said to be the bears' children (cubs). It is not difficult to envision in the presence of chaotic geologic formations that they are the result of a great and powerful force which ripped up the landscape during their formation.

Sincayuse/Sinciuse/Sin-ki-use/Isle de Pierres/Kawachkins/Moses Indians/Columbia Indians

According to the *Report of the Commissioner of Indian Affairs For the Territories of Washington & Idaho, And The State of Oregon, for the Year of 1870* (United States, 1981, pg. 15), [t]he Isle de Pierres, whose tribal name is Sin-ki-use, are located on the east and south side of the Columbia River, from Grand Coulée down to Priest's Rapids, which includes the peninsula made by the great bend of the Columbia to the west." Later on the same page, the Report mentions that there are three major fisheries on the Spokane River and the first is about 10 miles above the mouth of the river (to the Columbia, presumably). "The Lower Spokanes, part of the Sanpoils, Isle d'Pierres, and Palouzes collect to catch their annual supply of salmon" there (ibid.). The Isle de Pierres/Sin-ki-use are listed under Parties to no Treaties—East of Cascade Mountains (pg. 9).

Remarks made in the Report are condescending to the modern reader and are not reproduced here except to say that the Report describes the collection of roots and gives a preparation method which has been noted in other regions e.g., the Willamette Valley (*viz.* White, 1980).

Ruby, Brown, and Kinkade (1992, pg. 204-205) report that the name Isle de Pierres, or "people of the island of rocks" was given to the people living on the Columbia River near Wenatchee by the French Canadian fur traders in the early contact period. The people who occupied the Rock Island area of the Columbia called themselves Kawachens, or 'living on the banks.' They reportedly had a village near present-day Beverly, WA known in translation as 'roasting place', presumably a place where root vegetables were prepared. Their traditional territory, at least in the Late Period, extended from the rich root grounds of Badger Mountain east of the Columbia River and south of Waterville, WA, thence northeast towards modern-day Grand Coulee Dam, thence south following the eastern slopes of Grand Coulee towards Soap Lake, Ephrata, and Moses Lake. From Moses Lake, their territory continued south to approximately the cadastral 47th Parallel, thence southwest towards the river near present-day Beverly, WA. Swanton (1952) after Spier (1936) found that the "Sīnkaqaī'ī'ūs" were a "new" band composed of intermarried members of the Moses Columbia and the Tukoratum Band of the Sinkiaetk from the Okanogan region.

Historic-era overview

According to Wenatcheevalley.org (2012), the first Euro-American settlers were gold prospectors, cattlemen, and missionaries. Cattlemen used routes through modern-day Chelan County, historically, the Okanogan Territory to drive cattle to the gold fields of Canada and northern Washington. An important early arrival in 1863 was the Catholic missionary, Father Respari. He was followed in 1883 by Father DeGrassi who is credited with starting irrigation practices at Cashmere and reportedly taught agriculture to Indians of that district.

The Great Northern Railway through the Wenatchee Valley in 1892-93 spurred agricultural settlement. Before the railroad, only a limited amount of wheat and livestock moved on the upper Columbia River by stern-wheel steamers. When the Great Northern line was built Wenatchee became an important point of trans-shipment from river vessel to rail transportation. Most homesteaders grew field crops of grain and hay for local markets and some livestock was driven overland to railroad points. None of the aforementioned cultural values will be impacted by the proposed action on the Saddle Rock Park property.

Largely by trial and error homesteaders in north central Washington discovered how well fruit trees such as apples and pears grew in the valley in irrigated plots. During the 1890s a few farmers in the Wenatchee Valley began selling apples commercially to buyers who shipped them by rail to Seattle. Apples of this early period were of varieties now largely obsolete such as Spitzenburg, Baldwin, Pearmain, Ben Davis, Wolf River, and Arkansas Black.

In part due to the agricultural production of the Valley, the population of Chelan County quintupled in the first decade of the 20th Century. Population increased in the newly created Chelan County as it was previously part of Kittitas and Okanogan counties' census records. The Washington State legislature created Chelan County in 1899, carving it out of the existing Kittitas and Okanogan Counties. The first decade of the 20th Century saw a boom in irrigation facilities, organizing fruit growers, and expanding fruit markets along with its population increase. By 1930, the population reached 31,634 people. Improved rail service and highway transportations across the Cascade Mountains improved marketing conditions. The economic base of the county began to expand after 1940 to include new types of employment in lumber, mining, hydroelectric construction, food processing, and electrical refining of metal such as at the Alcoa plant situated ca. 11 miles south of Wenatchee which opened in 1952. The Wenatchee Works was the first smelter to be built in the Pacific Northwest in the post-World War II period and the first plant of its type built with private capital in the area since before the war in part due to the construction of the Rock Island Dam, the first large hydroelectric dam built on the Columbia River and the electricity it provided.

Chelan County history

Chelan County encompasses 2,920 mi^2 in North-Central Washington, including the Wenatchee, Entiat, and Chelan River watersheds, and Lake Chelan. Almost 90% of the county is managed by State and Federal agencies (Wilma, 2006).

In 1888, Wenatchee Valley was in Kittitas County; Kittitas County was formed out of the former Ferguson County in 1882. Thus the project area was technically part of Kittitas County until 1899, when Judge Thomas Burke offered to clear title and land for a brick hotel and a courthouse, if the State would consider Wenatchee a county seat. The Washington State Legislature approved a measure and created Chelan County out of parts of former Okanogan and Kittitas counties on March 13, 1899. Early land title and mining records before 1899 can be found in the Kittitas County Assessor's Office while records after March, 1899 can be found in the Chelan County Assessor's Office.

Title 30—Mineral Lands and Mining; Chapter 2—Mineral Lands and Regulations in General (30 USC §22-47) as amended.

The Act of May 10, 1872, also known as the General Mining Act of 1872, authorizes and governs prospecting and mining for economic minerals including gold, silver, and platinum on Federal public lands. It is not specific with regard to State public lands. The mining claims claimed in Section 16, Township 22 N, Range 20 E in Kittitas and Chelan counties were on State School Grant lands as of November 11, 1889. It is not clear whether State public lands were considered Federal public lands at that time.

The General Mining Act of 1872 allows for three types of claims: a mining claim, a lode claim, or a placer claim. Mining claims allow a prospector the right to explore for and to extract minerals from a tract of land, once the claim has been staked; sometimes referred to as a prospecting claim. Marking of claim boundaries with stakes or piles of rocks and the requisite forms are required to make a claim official. A lode claim is a claim over a hard rock deposit, while a placer claim is a claim over economic mineral-bearing sand or gravels. At least $100 worth of labor in improvements is required to obtain a patent on a claim. Many of the mining records in the Chelan County Assessor's Office are Notice of Location and Proof of Labor documents. To wit:

> A mining claim located after the 10th day of May 1872, whether located by one or more persons, may equal, but shall not exceed, one thousand five hundred feet in length along the vein or lode; but no location of a mining claim shall be made until the discovery of the vein or lode within the limits of the claim located. No claim shall extend more than three hundred feet on each side of the middle of the vein at the surface, nor shall any claim be limited by any mining regulation to less than twenty-five feet on each side of the middle of the vein at the surface, except

> where adverse rights existing on the 10th day of May 1872 render such limitation necessary. The end lines of each claim shall be parallel to each other.

Thus, the early mining claims on Saddle Rock measured approximately 1,500 ft. long by 600 ft. wide, or roughly 20 acres in area. Some variation is seen in the records, but not exceeding the claim dimensions i.e., some claims are smaller, but are generally the same dimensions and orientation. Some of the original claim stakes are extant across the subject property and will be recorded as historic-era archaeological sites. See Figure 7 below for a generalized historic mining claim map of the project area.

Mining history

From the Lovitt Resources, Inc. website at http://lovittresources.com/properties/lovitt-gold-mine/, the following block quote regarding gold mining and the company history is taken:

> Chinese working on the US transcontinental railway discovered gold on the Lovitt Mine property in 1865. They made ladders to reach the veins in the cliffs, then panned their rock chippings for gold in Squilchuk Creek in the valley below. Apparently they did well, because there are hundreds of pits in the cliffs of D reef as silent witness to their activity.
>
> The mine property was first staked in the 1890s and a small gold operation was run for about three years prior to 1900, about one thousand feet from the main ore body.
>
> The property changed hands several times prior to Ed Lovitt appearing on the scene in 1949. Lovitt immediately recognized the potential of the property and in 1950 he raised the financing required to take the property to production. For eight years the company shipped ore grade rock averaging 0.5 to 0.9 oz of gold per ton to the Asarco smelter in Tacoma.
>
> Lovitt employed contract miners who shared in the profits. In 1959, the miners discovered "Nellie's Room" a very rich pocket of ore in a room of 15x15x20 feet. In today's dollars, about $ 40 million in gold and silver was recovered and the company was raided by the IRS before any payouts could be paid out to the miners to make sure the proper federal tax was deducted.
>
> The Lovitt Mine mineralization is mostly epithermal micron gold, much like that found in the Carlin trend in Nevada, and a local Wenatchee World newspaper article quotes Ed Lovitt saying "the gold is so fine that it can't be seen, even at

100 oz. per ton". However, there were occasional zones of very high grade like Nellie's Room where the gold was visible and Lovitt made a side business of selling the gold and electrum specimens discovered in the mine.

In 1960 Lovitt entered into a joint venture agreement with the Day brothers of Idaho, who were experienced mill operators. Lovitt felt that he could do better by milling the ore, then delivering the resulting concentrate to a smelter. The partnership was known as L-D Mines and the partnership was in effect until the mine suspended operations in 1967, with gold fixed at 34.00 per oz. and expenses rising.

Historic records show production of 410,480 oz of gold and 625,850 oz of silver between 1951 and 1967. At today's gold price of 1,700 per oz, this would be equivalent to a gross revenue of over $ 700,000,000.

After the mine suspended operations, Cypress Anvil optioned the property, and spent about three years exploring for gold in the area. They were interested in developing the open pit potential of the Lovitt Mine, and they completely missed the potential of the Cannon Mine adjoining the Lovitt Mine to the north with product ion of 1.1 million ounces of gold in the late 1980s early 90s. Taken together, the Lovitt and Cannon Mines has production in excess of $2,500,000,000 in today's dollars and gold price.

The Cannon Mine was optioned by a Vancouver mining promoter in 1982 as a proximity play to the Lovitt Gold Mine. By 1984 diamond drill results were achieved with gold intersections and grades that the world mining community recognized the potential of a world class gold camp. One diamond drill hole intersected 60 feet of over 1 oz gold per ton and the gold rush was on. Prior to the news release, Breakwater's stock had closed at around 3.50, and after release of the news of the spectacular drill intersection, it opened around $16.00. Breakwater, a junior exploration company, had brought in Asamera Minerals Inc., a more senior company with deep pockets to finance the investment required to explore and take the mine to production. Ultimately Breakwater owned 49% of the Cannon Mine, and Asamera owned 51%.

The Squaw Saddle Mining & Milling Co. history

Linda Barta, Librarian and News Assistant at The Wenatchee World reported that:

> [a] large deposit of gypsum was recently discovered in the Squaw Saddle area west of Wenatchee. The Squaw Saddle Mining & Milling Co. has been incorporated to explore the area. Officers are Pat Heley, president; John Keegan, vice president; Henry Sommers, secretary; and R.S. Ludington, treasurer

in her article, Old News, on December 16, 2009, the 100 year anniversary of the founding of the Squaw Saddle Mining & Milling Co. It is not clear from the original records, located in the Chelan County Assessor's Office that gypsum was the mineral claimed by the newly-formed company in 1909, but rather numerous Lode Claim records suggest gold was the economic mineral claimed by Heley and Keegan. Oddly, findthedata.org lists the Squaw Saddle mine as containing mercury and not gold or gypsum (http://www.mineral-resources.findthedata.org/l/39487/Squaw-Saddle, 2012).

The Cannon Mine

From the Cannon Gold Mine website at http://www.genesbmx.com/cannon-gold-mine/#[-002-], the following long block quote is taken with a slightly different timeline than what is presented above:

> The Cannon Mine was located southwest of the town of Wenatchee, Washington at the corner of Miller and Circle Streets. … The Cannon Mine project area comprises some 5,000 acres located in Chelan County, Washington. The Cannon Mine site is located at the 1,000 foot elevation in Dry Gulch at the base of the Cascade Mountains.
>
> …
>
> The discovery of gold in the Wenatchee area dates back to the 1880s, when early prospectors staked gold bearing quartz veins and silicified sandstone outcrops, known at the time as "reefs". Initial gold production occurred in 1894 from a stamp mill, but processing of the fine material proved difficult and production did not resume until 1910, continuing for only a short time. Mining occurred intermittently in the 1930s and 1940s until 1949 when Mr. E. H. (Ed) Lovitt began mining in earnest what is commonly referred to as the D reef mine.
>
> In the early 1950s, Anaconda Copper Company explored the area known as the B reef. During the 1960s, Mr. Lovitt did some exploratory drifting and metallurgical test work on the B reef and adjacent outcropping of reef type materials. Unfortunately, low gold prices and operating difficulties combined to make these orebodies subeconomic. Additional exploration was conducted in the area of the B reef by Cyprus Mines Corp. in the mid-1970s leading to the discovery of the B west reef.

Saddle Rock Park history

According to an article in the Wenatchee World newspaper (Mehaffey, January 6, 2011), the Department of Natural Resources (WADNR) property transfer stipulates that the property must continue as a public use area for recreation, open space, or wildlife habitat. The City of Wenatchee initiated discussion about acquiring Saddle Rock Park in 1909. A more formal effort was begun in the 1940s, but failed. Another attempt to address the property as a county park in the 1960s, but it, too, failed. More recent discussions in 2007 moved the property sale/transfer forward. Anonymous donors contributed $500,000. The Community Foundation of North Central Washington fund was used to purchase the 325 acre property in 2011. A coalition of groups is starting to explore the establishment of trailhead facilities at the base of Saddle Rock, but no decisions have been made. This survey and inventory project will help gather information necessary to make recommendations for the property and the Wenatchee Foothills Community Strategy.

Literature Review

A Review of BLM General Land Office Cadastral Survey Records shows one prominent survey with mapping of the area. This survey was conducted in 1884 by Charles Holcomb (Figure 7). The map shows little in the way of topographic features. What appears like a trail network along both sides of the Wenatchee and Columbia rivers may only be a dashed line representing the margins of the floodplains of both rivers—flat areas suitable for farming or establishing orchards. It is possible that trails paralleled both rivers. Miller & Freer's store and a ditch system are labeled in the vicinity of present-day historic downtown Wenatchee in Section 33, Township 23 N, Range 20 E and continue through Sections 4, 5, 9, 15, 16, and 22, Township 22 N, Range 20 E—including the area NE of the mouth of Dry Gulch, currently labeled Highline Ditch—Lanham Lateral on the USGS Wenatchee 7.5' topographic quad. Likewise, a series of three irrigation ditches and a House are labeled in the NE quarter of Section 16 and in the SE ¼ Section 9 respectively. No other historic-era features are labeled in this map near the project area, but a solid parallel line is drawn indicating a road which formerly paralleled the west bank of the Columbia River to the House depicted and labeled in Section 9; thereafter the road is indicated by a dashed line. The Highline Ditch or Lanham Lateral outside of the subject property will not be affected in any way by the proposed project and is therefore not discussed further in this report.

All of Section 16 was vested to the State of Washington via School Grant Patent #11111889 as of November 11, 1889. The GLO records also indicate that by an Act of Congress an action was taken on January 25, 1927 and again on November 2, 1973 as document #46740026. It is not clear from these indices what action was taken other than a possible release of land for sale to the public.

Appendix A is a thorough property history. Property records and or mining records before 1899 are located in the Kittitas County Assessor's Office, while records dated 1899 to the present are located in the Chelan County Assessor's Office. The earliest mining or prospecting records were located in hand-written, un-automated ledgers on December 1, 4, and 5, 2012 in Ellensburg, WA. Automated records search at the Chelan County Assessor's Office returned roughly 40 records dated before 1963 in the database in Wenatchee, WA. Book, page, and document numbers were cross-referenced with microfilm records for accuracy and were tabulated. The property history presented in Appendix A combines both counties' records for the NW ¼ NW ¼, S ½ NW ¼, SW ¼, and NW ¼ SE ¼ Section 16, Township 22 North, Range 20 E, East of the Willamette Meridian in Washington State and a few mining claims which border the project APE.

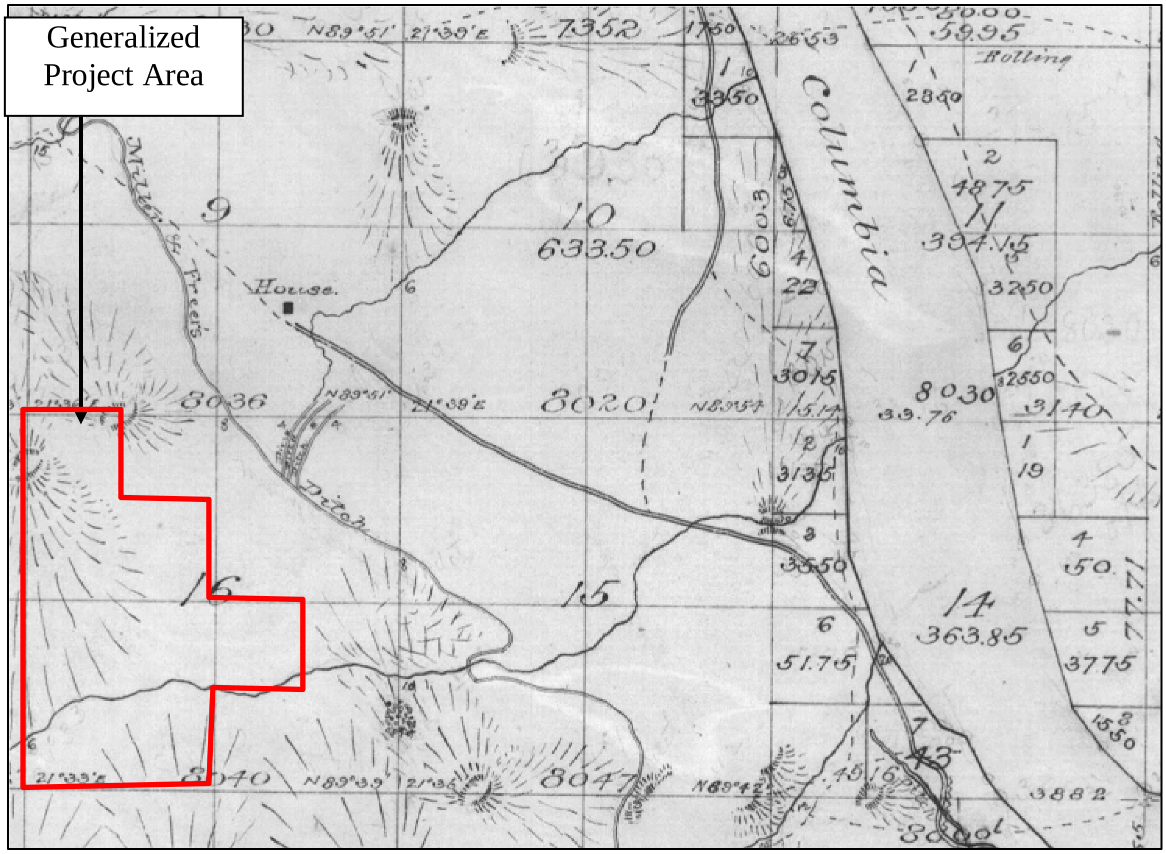

Figure 7: 1884 Cadastral Survey with generalized project area in red (GLO, 2012).

WA DAHP Data

Sites on, adjacent to, or near the APE are considered to be confidentially located. Files pertaining to these sites are found at the Washington Department of Archaeological and Historic Preservation's WISAARD database.

Cultural Resources Survey Reports

To date seven cultural resource surveys have been completed within 2 miles of the proposed project area. These surveys are described below.

WA Survey # 1330060. Chapter 14. *Asamera Minerals' Cannon Mine Development.* This chapter, prepared ostensibly by Asamera Minerals, author unknown, summarizes what was known in 1984 about the cultural resources near the proposed Cannon Mine tailings dam and impoundment area and three potential borrow pit areas within Dry Gulch canyon.

This report found an early newspaper article in *The Pioneer and Democrat* of Olympia, Washington Territory in 1859 which encouraged an organized party of miners to collect in Portland and from there, go to the "Wenatchee Country" as it was known then. "By

1893 every foot of the Wenatchee river bed from three miles above Leavenworth to Mission Creek was staked with placer mining claims" (Unknown, 1984, pg. 14-8).

Furthermore, the author of the report contacted informants about the Appleatchee area and Dry Gulch. The informants could recall no homesteads within the Cannon Mine area. Informants also reported that,

> [a] ranch was reportedly located about 1.5 miles up a trail or road that ran up the "lefthand side" of the "righthand fork" of Dry Gulch which is probably the valley just north of the one currently called Dry Gulch. The surrounding area was farmed and it is reported that approximately 15 "arrowheads" were collected in the course of this farming (Unknown, pg. 14-9).

In the 1950s, a quarry began operations on the top of Dry Gulch, south of Saddle Rock, just northeast of the tailings and dam area. A rock-slicing machine was installed which cut sandstone into building-sized blocks (Wenatchee Daily World, 1951). The Wenatchee Silica Company, as of 1984, still operated a facility near the mouth of Dry Gulch. They had been in operation for at least 10 years at the time of the writing of the report. Informants also remarked upon a small, short-lived coal mine up Dry Gulch, the whereabouts no one could ascertain with certainty.

WA Survey # 1350010. *2007 Archaeological monitoring survey of the Rock Island hydroelectric project, Chelan and Douglas counties, Washington*. This report prepared by James Schumacher of CRC for the Public Utility District No.1 of Chelan County concerns sites listed or determined/recommended eligible for the National Register of Historic Places (NRHP), as well as those surveyed or tested, but not yet evaluated for the NRHP within the Rock Island hydroelectric project APE. Sites not recommended eligible were not included in the monitoring plan. No new archaeological sites were recorded as a result of this survey, and the locations of recorded sites appear generally stable. No substantive changes in landform integrity since the 2004 monitoring survey were observed.

WA Survey # 1681390. *Cultural resources survey for the proposed Squilchuck Reservoir project, Chelan County, Washington.* This report, prepared by Ron Adams and Terry Ozbun of Archaeological Investigations Northwest, Inc. in 2011 for Chelan County Public Utility District No. 1, concerns a proposal to construct a new reservoir [Squilchuck 1427 Reservoir] on a ridge directly southeast of Squilchuck Creek. Additionally, a new water transmission main would need to be installed. No archaeological or historical resources were identified within the project area by AINW.

WA Survey # 1352444. *Archaeological survey for Squilchuck lift station replacement, Wenatchee, Washington.* This report, prepared by Jim Schumacher and Glenn Hartmann of Cultural Resource Consultants, Inc. in 2009, concerns proposed improvements to a sewage lift station located in South Wenatchee. The survey did not result in the identification of any potentially significant cultural materials at the project area.

WA Survey # 1349623. *Historic resources survey—Inventory; Orondo Avenue, Wenatchee, Washington.* This report, prepared by Flo Lentz of Cultural Resource Consulting in 2001, concerns recent commercial development and infill construction which had begun to alter the character of Orondo Ave., as well as that of older residential blocks to the northwest, all part of a proposed local historic district. This survey/inventory sought to identify and evaluate that early character. 83 individual properties along Orondo Avenue and Cherry Street, ranging in date from the early 1900s through the 1960s, were recorded to the Historic Property Inventory database.

WA Survey # 1349629. *Survey of historic resources in the Grand View Addition and Jackson Place Addition, Wenatchee, Washington.* This report, , prepared by Flo Lentz of Cultural Resource Consulting in 2003, represents Phase Three of a three-year effort by the City of. Wenatchee to compile documentation on a potential residential historic district. Phase One of this effort, completed in 2001, examined residential properties along Orondo Avenue, an early arterial leading southwest from downtown. Phase Two, completed in 2002, recorded properties on blocks bounded by Douglas, Delaware, Washington and Alaska streets, northwest of Orondo Avenue. With the conclusion of this project, a total of nine full blocks and three partial blocks were added to the state and local Historic Property Inventory.

WA Survey # 1350125. *Downtown Wenatchee cultural resource survey report.* This report, prepared by Michael Sullivan of Artifacts Consulting, Inc. in 2007, concerns a Certified Local Government grant to conduct a cultural resource survey of downtown Wenatchee's historic resources in 2006-2007. The first goal was a comprehensive cultural resource survey and inventory data for the City of Wenatchee and the Washington State Department of Archaeology's (DAHP) Statewide Historic Property Inventory Database. The second goal was to identify those properties that are forty years old or older and evaluate them for potential inclusion in a National Register and/or Wenatchee Register historic district. 113 properties in the downtown commercial core were surveyed.

WA Survey # 1346144. *Draft—cultural resources discipline report SR 285—Wenatchee (south end).* This report, prepared by Michael Sullivan of ENTRANCO, Inc. and Archaeological and Historical Services, Inc. for the City of Wenatchee in 2004, concerns a review of previous contextual work done in the near of SR 285—Wenatchee (south end). 140 structures were found to be at least 50 years old or older and the proposed right-of-way would have impacted 44 of them. 25 structures were inventoried for potential inclusion in the National Register of Historic Places; five properties were considered eligible. Ultimately, the project alignment was shifted to avoid one structure significant to the City of Wenatchee.

Cemeteries

Saddlerock Evangelical Presbyterian Church Memorial Garden (45CH829). Officially established in 2000 and owned by the former First Presbyterian Church, this property needs field verification of age and other pertinent cultural resource qualities.

This property also contains the Home of Peace Mausoleum.

Previously recorded archaeological sites

45CH207--The site was originally recorded during the Rock Island Dam survey and reported in Cleveland & Rice (1974). Separately recorded by Merola, Clevland, and WARC (Washington Archaeological Research Center) in 1973, this site is "apparently a camp site" exposed by recent cut and fill operations and dozing. This site is composed of "very scattered cryptocrystalline chips" and was badly disturbed by GNRR (Great Northern railroad) cut and fill, a sewage lagoon, and various orchards and roads in the vicinity. Informants believed that the site may have been washed away by a flood in 1925 which washed down Squilchuck Canyon. In 2007, Cultural Resource Consultants, Inc. found the landform stable, yet no further archaeological materials were discovered then. Additional monitoring in 2010 found the landform stable and no further archaeological materials were discovered then either. The same for a monitoring report filed in 2011.

45CH282—The Boat Launch site. This site, at the foot of Orondo Street, Wenatchee, on the edge of the Columbia River, is recorded as a historic midden, composed of commercial and residential refuse and serves as a boat launch. The thick midden contains assorted metal, coal, charcoal, ash, glass, brick, ceramics, and miscellaneous trash dating to the early 1900s to 1930s. The location of the site is known to have been a commercial dock for the Great Northern railroad in 1893. There was a known cable ferry at that location also. The area is also known colloquially in Wenatchee, WA as the center of "Shacktown", a community of racial and cultural minorities, mainly fruit pickers and other transients, which "camped" along the Columbia River. "Shacktown" covered ca. 60 acres and had ca. 200 structures at one point before it was burned by the City in 1945.

45DO182—This site, like 45CH207, was recorded by the Rock Island Dam Reservoir Survey of 1974. It was re-visited in 2005 by Ryan Ives and Josh Keene of Archaeological and Historical Services of EWU. The site presently is below the southwest corner of the Fred Meyer parking lot in E. Wenatchee, WA, near the banks of the Columbia River. Formerly, this site was associated with Eddie May's Motel. There, in an arroyo, lithic flakes, shell, bone, and fire cracked rock are exposed ca. 50cm below the surface. Informants mentioned that European trade beads had been found at the site, also. This precontact camp site measures 55m by 17 m.

45DO694—Recorded by Ryan Ives and Josh Keene of Archaeological and Historical Services of EWU in 2005, this historic-era isolate is a body of a burnt out car made ca. 1930.

45DO695—Recorded by Ryan Ives and Josh Keene of Archaeological and Historical Services of EWU in 2005, this site is a precontact temporary camp composed of 45 lithic flakes, five bifaces, five modified flakes, two cores, one cobble tool, and two groundstone artifacts, 256 non-modified bone fragments, and some shell, but lacking intact buried features. The presence of diagnostic artifacts in a buried context led AHS to find this site eligible to the NRHP.

45DO701—Recorded in 2006 by Ann Sharley of AHS, this isolated find is recognized as a precontact flaked cobble found on the steep eastern bank of the Columbia River in E. Wenatchee near the Columbia River footbridge.

45DO702—Recorded in 2006 by Ann Sharley of AHS, this site is composed of ca. 1,000 items of ca. 1940-1950-era domestic refuse including crimp-sealed cans, Mason-type jars, various glass vessel shards, sherds of ceramics and earthenware, pressed glass dishware, tobacco tins car seat springs, red brick fragments, paint cans, and oyster shells, dumped over the edge of the riverside terrace. Two concentrations were recorded, each is 15m apart from the other and overall measures 45m by 25 m near the Columbia River footbridge.

45DO703— Recorded in 2006 by Ann Sharley of AHS, this site is composed of ca. 500 items of ca. 1940-1950-era domestic refuse including crimp-sealed cans, Mason-type jars, various glass vessel shards, sherds of ceramics and earthenware, sawed bone, older style lightbulbs, and barbed wire near the Columbia River footbridge.

45DO704—Recorded in 2006 by Ann Sharley of AHS, this site is composed of ca. 300-400 items of ca. 1940-1950-era domestic refuse including crimp-sealed cans, Mason-type jars, various glass vessel shards, sherds of ceramics and earthenware in three discreet loci near the Columbia River footbridge.

45DO891—This site, recorded by Dave Cox and Amy Foutch of Archaeological Investigations Northwest, Inc. in 2010, is another historic-era debris concentration along the Columbia River with artifacts dating to ca. 1940-50. The site is composed of approximately fifty sanitary tin cans including hole-in-top evaporated milk cans, syrup cans, large juice cans, and square tins that are generally opened by a church key or can opener. Also included in the scatter are colorless glass bottles with screw caps, colorless glass bottle bases, amber glass bottle bases, window glass, an older vehicle fender and running board, a vehicle door and other miscellaneous metal pieces, and non-diagnostic whiteware sherds.

45DO892— This precontact isolated find, recorded by Dave Cox and Ron Adams of Archaeological Investigations Northwest, Inc. in 2010, is identified as very small red and black CCS flake that was found in the upper 20 centimeters of a shovel test near the Columbia River.

Historic Property Inventory indices within or bordering Section 16, T 22 N, R 20 E.

There are ca. 25 historic properties dating 50 years old or older beyond the northeast, east, and southeast border of the Saddle Rock Park, none of which will be impacted by the proposed action, the sale of Saddle Rock Park. The only property of potential significance is Tax Parcel 57425, a building on Circle Street, Wenatchee, WA built in

1937 with an unknown use near the Lovitt Mining Company's Cannon Mine. Structures and facilities related to the mine have not yet been recorded to the state-wide HPI database; those properties are technically outside this project's scope of work and will not be recorded here either.

National Register properties within a 1-mile radius of the property.

Downtown Wenatchee Historic District (45DT?220) Roughly bounded by Columbia, Mission, North 1st, and Kittitas streets, this district has 55 commercial structures dating between 1902 and 1955 of local importance and significance, eligible under NHPA Criteria A and C.

Wenatchee Fire Station #1 (45CH649) This Beaux Arts style structure was constructed in 1929 and was designed by Ludwig O. Solberg. It is eligible under NHPA Criteria A and C.

U.S. Post Office and Annex (45CH239) The old U. S. Post Office and Post Office Annex in Wenatchee, Washington are two separate buildings completed in 1938 and 1918 respectively. They are located at the corner of Mission and Yakima Streets on adjoining lots divided by a service driveway. Each represents a different architectural style, although the design of the new building is skillfully planned to compliment the neighboring structure in scale, setback, materials and surface detailing.

The older Post Office, now referred to as the annex, is a box-like building light grey pressed brick with dimensioned sandstone architectural features elements include a water table and base course, a classical entablature and pilaster capitals and window sills.

Measuring a total of 101 by 64 feet in plan (long dimension in front), the forward two thirds of the building is two stories in height, while the remaining rearward portion is a single story. This one story attachment is shorter in overall length so that its end walls are set back four and a half feet from the ends of the main structure.

St. Joseph Church and Rectory (45CH579) This Gothic/Gothic Revival style church was constructed between 1908 and 1921. The architects were the Beezer Brothers. This property has local significance, and was nominated to the National Register in 1985.

Wenatchee Carnegie Library (45CH297) The City applied for a Carnegie grant of $10,000, which was awarded in 1909. The architect, Blackwell and Baker, was required by Carnegie to revise the plans because too much space was devoted to the lobby, vestibules and stairways. Construction took place in 1911 by the contractor Bird and Hobsen, and the building formally opened on January 1, 1912. By 1918, it was already being criticized for being too small, and Carnegie was asked for money to build an addition. None was granted, however, because the program was being discontinued. In 1939 the library moved to a new building across the street. For some years the building was a museum, and it is now used for various city offices.

Centennial Flour Mill (45CH241H) The Centennial Flour Mill in Wenatchee is a complex of related industrial structures built between 1907 and 1947 near the south edge of town at the intersection of Skagit Street and Wenatchee Avenue. The mill consists of three brick masonry buildings and two grain elevators, one frame and the other reinforced concrete. Oldest and largest of the buildings is the combination flour and feed mill built by the Bea1 Grain and Milling Company. It was completed and first put into operation in 1907 with a daily production capacity of 300 barrels. The Mill Complex was nominated to the NRHP in 1976.

Columbia River Bridge at Wenatchee (45CH581) Completed in 1950, the Columbia River Bridge at Wenatchee connects the cities of Wenatchee and East Wenatchee, Washington. The structure consists of concrete T-beam approach spans; steel deck truss anchor arm spans; steel, half-through, cantilever truss spans; and a steel suspended, through tied arch span. The Department of Highways' Biennial Report for 1946-1948 described the bridge as the most important structure of all those bridges being constructed at that time.

Research Design

RLR developed a hypothesis for this project, based upon the goal of cultural resources management in a rural agricultural context in areas where there is extensive previous contextual work. The immediate goal is to evaluate the potential of this project area for the presence or absence of cultural resources.

Hypothesis: The cultural survey will provide discovery of aspects of the built environment from the mining past of the project area. Given that pre-contact sites are found locally on surrounding landforms, a reasonable expectation is that Native American peoples would have utilized resources at Saddle Rock as well, but may not have utilized all upland areas unless significant resources were available.

To evaluate the potential of this project area for traces of the past, RLR prepared a field survey in conjunction with archival research. This study can potentially aid in the reconstruction of past landscapes by identifying and recording elements of the archaeological record. Special attention will be paid to the surface especially in the ephemeral drainages which characterize the eastern portion of the subject property as there may be evidence of historic-era debris.

Expected Results

The confluence of the Wenatchee and Columbia rivers has been utilized since the last glacial recession, as it is a watered and fertile place with access to natural resources. Given the location of sites along the Wenatchee and Columbia rivers within ten miles of the project area, pre-contact land utilization in the upland terraces or slopes is possible—see WA Survey # 1330060. Chapter 14. *Asamera Minerals' Cannon Mine Development* above regarding precontact Native American artifacts discovered near the project area. It is much more likely, however, that historic mining in the area predisposes this area to structural and infrastructural remains as well as debris scatters or concentrations. Mining may have physically obliterated intact subsurface archaeological deposits which might have been present within the subject property if any. Overall, given its geographic and topographic profile, as well as distance from natural water sources, pre-contact cultural resources are not expected and potential for recovery of any intact precontact sites is very slight.

Inventory Methodology

Assuming good surface visibility, Reiss-Landreau Research planned a two person visual survey within the APE of the project. This assessment was geared toward a preliminary inventory of historic properties directly or indirectly impacted by the APE of this project.

Survey Results

A. Date of survey, Weather Conditions: Pedestrian survey was conducted on November 28 and 29, 2012 as well as December 14, 2012. The weather was fair and sunny, ~40°F on November 28th, but began snowing on November 29th. There was less than an inch of snow on December 14th already on the ground; ~30°F. RLR archaeologists felt that they had adequate visibility to determine if there were any concentrations of historic-era or more recent debris at or near the surface—more recent debris was noted, but not recorded as it did not meet the minimum requirement of 50 years in age. One isolated historic-era object—a ca.30 ft. segment of iron irrigation pipe—was located on November 29, 2012, re-visited December 14, 2012, and recorded. Two days were spent in the Chelan County Assessor's Office—November 30 and December 13, 2012. Additionally, two days were spent in the Kittitas County Assessor's Office—December 4 and 5, 2012 doing archival research in the Book of Mining and General Index of said county looking for the original mining claims and any other land use actions in the historic period. The results are presented below as Appendix C—Property History.

B. Field personnel: Wm. Schroeder, M.S. and L. Walton

C. Actual methodology employed: Reiss-Landreau Research conducted a 3 meter visual transect survey as planned for the project APE where slopes were surveyable; mainly stayed on established trails throughout park property (Figure 8).

D. Shovel probe: RLR excavated no shovel test probes or auger probes as this was a visual reconnaissance survey.

E. Depositional Environment: See Appendix B for a soil parent material distribution map (USDI, 2012). The dominant soil series is Bjork. Bjork soils are moderately deep, well drained soils formed in loess and colluvium and residuum from schist, sandstone, or conglomerate. Bjork soils are on hillsides and mountainsides. Slopes are 8 to 75 percent. They are fine-loamy, mixed, superactive, mesic Aridic Argixerolls—clayey dry mollisols. Cashmere soils are very deep or deep to cemented pan well drained soils that formed in mixed alluvium over glaciofluvial material. They are on glacial outwash terraces. Slope ranges from 0 to 65 percent. Cashmere soils are coarse-loamy, mixed, superactive, mesic Aridic Haploxerolls—somewhat typical dry mollisols on the sides of glacial valleys in the Wenatchee region. Cowiche soils are present in the Saddle Rock Park. Cowiche soils are deep, well drained soils formed in loess and residuum on uplands. Slopes are 0 to 70 percent. Cowiche soils are fine-loamy, mixed, superactive, mesic Aridic Argixerolls—clayey dry mollisols used as orchard or crop land when irrigated. See Figure 8 and Appendix B for a soil parent material distribution map.

Generally, the soils in Saddle Rock Park are clayey mollisols mostly composed of residuum from the intrusive porphyritic biotitic dacite which has altered arkosic sandstones into quartz-chalcedony-adularia-calcite veins and veinlets (stockworks) within a brecciated unnamed sandstone and/or siltstone unit and overlying Eocene Chumstick Formation deposits. The soil is coarse and sandy, sticky, and plastic when moist. It has been placer mined in the past for metals such as gold and silver. Unfortunately, early mining exposed arsenic-laden minerals and residuum which have weathered to produce and leach arsenic in discrete areas of Saddle Rock Park.

E. Findings: The first objective was to visit the property with Washington State Department of Ecology (DOE), The City of Wenatchee, Chelan-Douglas Land Trust, and Hart Crowser personnel on November 27, 2012 to see the areas DOE had identified as having concentrations of arsenic. RLR was unable to determine from the surface expression of the prospects and tailings whether or not the sites constituted historic-era archaeological sites. A day was set aside for archival research in the Chelan County Assessor's Office to locate mining records. This proved to be worthwhile.

The second day of field reconnaissance, November 28, 2012, was spent in the project APE investigating areas not seen in the initial visit; areas to the east and northeast of the park entrance at the foot of the east slope of Saddle Rock. One new historic mining property was located and locational information was given to Hart Crowser for future reference. A historic-era isolate—a ca. 30 ft. segment of iron pipe—was identified on November 28, 2012 near SR1. Because of increasingly snowy weather conditions on November 28, 2012, field work was halted until a future date could be secured for further investigation. In sum, five of the six previously-identified mine sites were re-visited on November 28, 2012; SR4, the most remote and furthest north location was not re-visited on November 28th. SR4 was visited by RLR on December 14, 2012 as were the other five previously visited sites. Three additional historic mining properties were located on December 14, 2012—two are outside the APE. The ca. 30 ft. segment of irrigation pipe noted on November 28th was recorded as a historic era isolated object based on irrigation easement records located in the Chelan Co. Assessor's Office on December 13, 2012. See figures 8-36 and Appendix C for site forms of all historic-era mining properties and irrigation features recorded during this reconnaissance of the project APE.

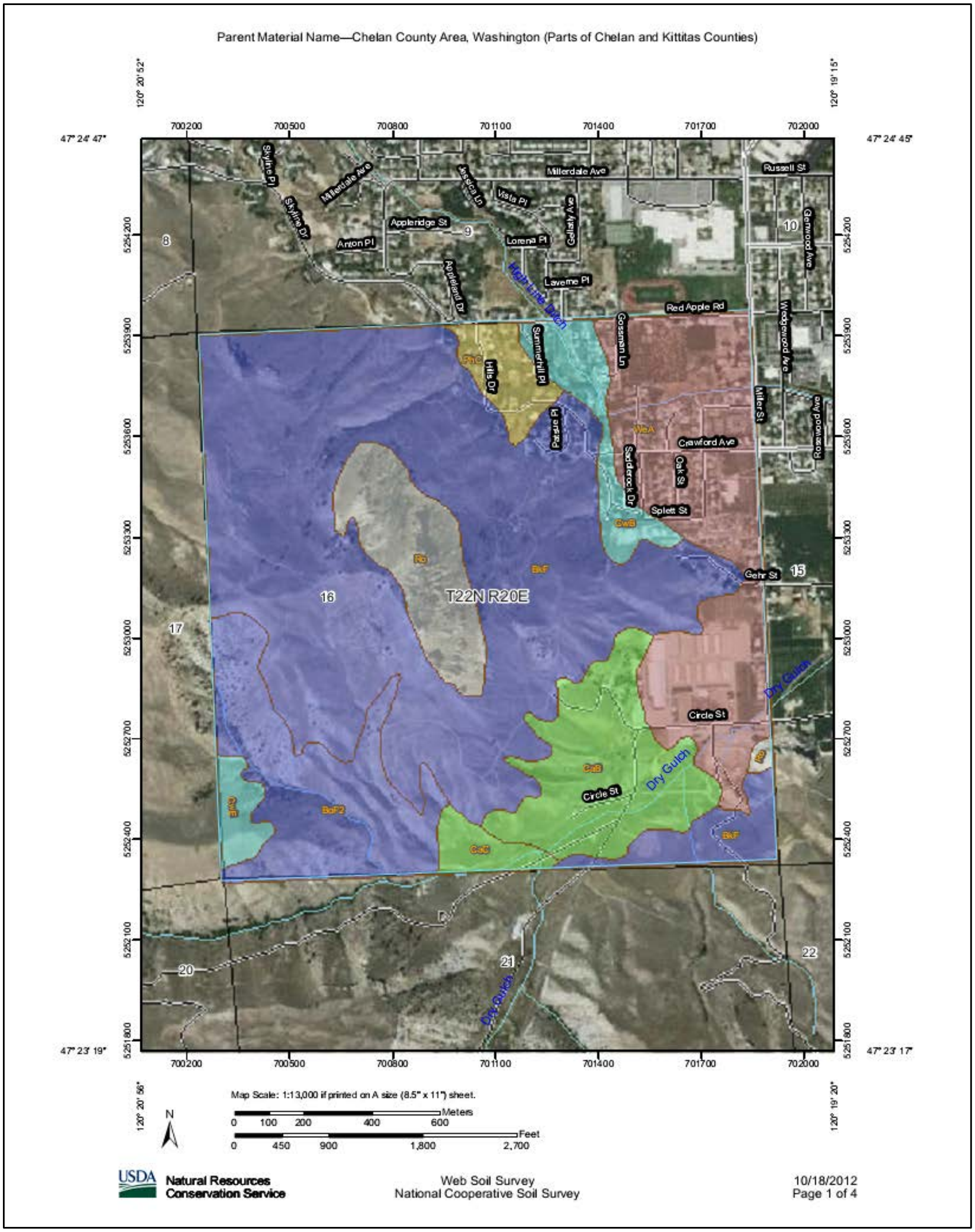

Figure 8: Soil parent material distribution map (NRCS, 2012).

SR1

Saddle Rock 1 (SR1) is the first and nearest historic-era mining claim within Saddle Rock Park from the main entrance on Circle St. It is located ca. 500 ft. NNW of the entrance. Chelan County General Index records trace this mining claim or prospect to either the Squaw Saddle Mining & Milling Company's (SSMMC) Keegan #4 Lode, a placer mining claim under the name Charles Robert Browne, or both (Appendix A—Property History; Figure 10). A cavity in the exposed bedrock, backfilled with rocky debris, and rock debris piles within a ca. 240 ft. (ca. 820 ft^2) diameter circular area around a rock outcrop define the site. The Keegan #4 is described as follows:

> 3,318 ft. N 65° 10' W of SE corner Section 19, T 22 N R 20 E. Commencing at this discovery post; being the center of vein, thence 300 ft. S 8° 35' E (SW corner), thence 1,500 ft N 81° 25' E (SW corner), thence 300 ft N 8° 35' W (E center end); thence 300 ft N 8° 35' W to NE corner, thence 1,500 ft S 81° 25' W (NW corner), thence 300 ft S 8° 35' E to west center end.

SR2

Saddle Rock 2 (SR2) is the next nearest historic-era mining claim within Saddle Rock Park from the main entrance on Circle St. It is located ca. 800 ft. NW of the main entrance along the main foot trail. Chelan County General Index records trace this mining claim or prospect to either the Squaw Saddle Mining & Milling Company's (SSMMC) Keegan #4 Lode, a placer mining claim under the name Charles Robert Browne, or both (Appendix A—Property History; Figure 10), though it is more likely a part of the SSMMC's Keegan #4 Lode given the amount of rocky debris surrounding the center of the site and the number of years the SSMMC was in operation. Indeed, a segment of narrow gage rail is exposed in one tailings pile and various-sized lumber is exposed in another tailings pile at the base of the bedrock outcrop near a small cavity within the site boundaries. This site measures ca. 200 ft. SW/NE by ca. 150 ft. SE/NW and is oval in shape with a bedrock outcrop in the middle.

SR3

Saddle Rock 3 (SR3) is the next nearest historic-era mining claim within Saddle Rock Park from the main entrance on Circle St. It is located ca. 1,150 ft. NW of the main entrance along the main foot trail. Chelan County General Index records trace this mining claim or prospect to either the Squaw Saddle Mining & Milling Company's (SSMMC) Keegan #4 Lode, a placer mining claim under the name Charles Robert Browne, or both (Appendix A—Property History; Figure 10), though it is more likely a part of the SSMMC's Keegan #4 Lode given the amount of rocky debris surrounding the center of the site and the number of years the SSMMC was in operation. This site measures ca. 180 ft. SW/NE by ca. 500 ft. SE/NW and is a "lazy 8" in shape with the long axis being SE/NW-oriented with bedrock outcrops in the middle. For Department of Ecology concerns, only the northwesternmost portion of the SR3 archaeological site was tested for arsenic; for DAHP concerns, the entire 90,000 ft^2 (2 acre 2,880 ft^2) area should be considered an archaeological site.

SRs 1-3 may also have been worked as the E. H. Lovitt "Public" mine after a Proof of Labor record filed on 3/11/1957. Mr. Lovitt had seven days to "improve" the land by building roads, cutting timber, and had the permission to blast, but it appears likely that that permission was not used. It seems likely that the main trail and other more substantial and relatively flat trails throughout the southeastern portion of Saddle Rock Park were made under this Proof of Labor in 1957 (Figure 12). It is also possible that segments of iron pipe and drill holes in exposed bedrock near SR3 were in preparation to blast the bedrock under the 1957 Proof of Labor, but it is not self-evident that the physical evidence on the ground is proof of any preparations to blast the bedrock (Figure 25).

SR4

Saddle Rock 4 (SR4) is the furthest historic-era mining claim within Saddle Rock Park from the entrance visited for the purposes of this investigation. It is located ca. 4,250 ft. NW of the main entrance and beyond the main foot trail which "ends" near SR5 (discussed below). Chelan County General Index records trace this mining claim or prospect to either Martin Keegan's "Little Wonder" Lode, an Indenture and Prospecting Lease given to J. J. Keegan from the State of Washington, or both (Appendix A—Property History; Figures 10 and 12), though it is more likely a part of the "Little Wonder" Lode given the amount of rocky debris surrounding the center of the site and the number of years the SSMMC was in operation. The Notice of Location reads as follows:

> The NE corner is 3,953 ft S 78° 54' W of NE corner of Section 16, T 22 N, R 20 E. Commencing 350 ft N 4° 56' W, thence 300 ft. W to NW corner, thence 1, 500 ft S 4 ° 56' E to SW corner, thence 300 ft E to South Center, thence 300 ft E to SW corner, thence 1,500 ft N 4° 56' W to NE corner, thence 300 ft W to North Center.

J. J. Keegan's Indenture and Prospecting Lease goes as follows (Appendix A—Property History):

> N ½ of NW ¼ of Section 16, containing 80 acres +/-; the NE ¼ NW ¼ has been sold by the State and the permittee herein may not enter upon the land until a waiver has been secured from the owner thereof…for 2 years of prospecting…may cut and use timber on said premises for fuel and construction thereon of building required in the operation of any mine on said premises and drains, tramways, and supports of said mines but for no other purpose; cannot remove more than 5 tons of ore therefrom for assaying and testing purposes, shall remove no ore for any other purpose within 60 days of the expiration of this lease.

This site measures ca. 200 ft. SW/NE by ca. 150 ft. SE/NW and is ovoid in shape with the long axis being SW/NE-oriented with a weathered bedrock outcrop in the middle. For Department of Ecology concerns, the northeasternmost portion of the SR4 archaeological site tested strongly for arsenic along a SW/NE axis; for DAHP concerns, the entire 30,000 ft^2 area should be considered an archaeological site as should a linear excavated feature ca. 300 ft. SSE of the SR4 site locus. This trench-like feature is on the hill slope to the SE of SR4 ca. 300 ft. It is approximately 30 ft. wide by ca. 100 ft. long and is up to 10 ft. in height at the NE end where rock and soil is piled highest. It may represent the southern boundary of the "Little Wonder" claim and will be considered part of the SR4 site boundaries.

SR5

Saddle Rock 5 (SR5) is located ca. 3,290 ft. northwest of the main entrance to Saddle Rock Park on Circle St. SR5 appears as a road cut on the SW slope of Saddle Rock until one notices that the material on either side of the road or trail is composed of mine tailings and debris. Based on Chelan County mining records, this property can be linked to the SSMMC "Shamrock" Lode. Patrick Heley and Thomas Keegan are listed as the original locators on 5/24/1908 and filed for record on 1/11/1909 (Appendix A—Property History; Figure 10). The SSMMC Notice of Location for this mining lode goes as follows:

> Post No.1, located 4,203 ft S 63° 45' W of NE corner of Section 16, T 22 N, R 20 E. Commencing at this discovery post, being 300 ft N 52° E to post No. 2, thence 300 S 38° E to post No. 3, thence 1.500 ft S 52° W to post No. 4, thence 300 ft. N 38° W to post No. 5, thence 300 ft. N 38° W to Post No. 6, thence1,500 ft N 52° E to post No.1, thence S 38° E to post No. 2.

Additionally, The SSMMC filed a Deed and an Indenture with the State of Washington on 3/18 and 4/29, 1910 respectively. Therein, a Notice of Location gave the SSMMC permission for 30 years (Appendix A—Property History):

> The E ½ SW ¼ Section 16, T 22 N, R 20 E, 80 acres +/- which premises are leased to the second party for no other purpose than the purpose of exploring for, mining, taking out and removing therefrom the merchantable shipping or containing copper, lead, silver, gold, gypsum, and other valuable metals or minerals, except coal…and use the timber found upon said premises for fuel and for the construction of buildings required in the operation of mines on the premises…drains, tramways, and supports for such mines, provided however State of WA reserves the right to terminate.

Later, long after the 30 years had expired for the previous Deed, James A O'Connor filed a Real Estate Contract with the State of Washington, a Contract for Mining, and an Indenture in 1962 for a term of 20 years starting 3/7/1961 for the:

> N ½ of SW ¼ Section 16, T 22 N, R 20 E, 80 acres +/-; permitted to build roads,

> remove ore except coal, cut and use timber (Figure 12; Appendix A—Property History).

It appears likely that the SSMMC is responsible for the mining spoils piles near SR5, but it is also possible that J. A. O'Connor contributed to the mining spoils piles within the historic period. Nonetheless, the site measures ca. 200 ft. E/W by ca. 180 ft. N/S in an oval-shaped area containing ca. 36,000 ft^2. For DOE concerns, the site was tested for arsenic and the highest concentrations were discovered within SR5 site boundaries in the SW portion (Figure 13). For DAHP concerns, given the number of years the SSMMC was in operation and the similarity to the weathering of bedrock exposed and general orientation of mining spoils near the site locus, the entire 36,000 ft^2 area is considered one historic-era archaeological site by RLR.

SR6

Saddle Rock 6 (SR6) is located ca. 2,730 ft. NW of the Saddle Rock Park entrance on Circle St. This location is characterized by what appears to be a road cut on the SW slope of Saddle Rock, adjacent to a relatively flat trail (road) which effectively dead ends nearby to the NE.

Based on Chelan County General Index records, it is most likely that this site is the SSMMC "Washington" Lode. To wit:

> Commencing at this discovery post, being the center of the vein or claim, thence 112 ft N 52° E to a post marked #2, being east center end; thence 300 ft. S 38° E to a post marked #3 (a corner); thence 1.500 ft s 52° W to a post marked #4; 5 being west center and thence 200 ft N 38°W to a post marked #6 (a corner), thence 1,500 ft N 52° E to a post marked #1, thence 300 ft. S 38°E to #2 post, center end. Post #1 being 4,124 ft S 55° W of NE corner of Section 16, on southern slope of Squaw Saddle Mountain, on the SW side of City of Wenatchee, and extends along the SE side of Shamrock Lode.

This site may also be the result of road work performed in 1957 under a Proof of Labor document issued to E. H. Lovitt on 3/11/1957 as the "Public" mine. Mr. Lovitt had seven days to "improve" the land by building roads, cutting timber, and had the permission to blast, but it appears likely that that permission was not used. It seems likely that the main trail and other more substantial and relatively flat trails throughout the southeastern portion of Saddle Rock Park were made under this Proof of Labor in 1957 (Figure 12). It is also possible that segments of iron pipe and drill holes in exposed bedrock near SR3 were in preparation to blast the bedrock under the 1957 Proof of Labor, but it is not self-evident that the physical evidence on the ground is proof of any preparations to blast the bedrock (Figure 26). This site does not contain an self-evident mine adit or collar, indeed it is difficult to discern if any formal mining occurred at this locale, though ore-bearing rock may have been removed in the road building process and could have been sent away for processing. Furthermore, the SSMMC had a Notice of Location and permission for 30 years (Appendix A—Property History) for:

> [t]he E ½ SW ¼ Section 16, T 22 N, R 20 E, 80 acres +/- which premises are leased to the second party for no other purpose than the purpose of exploring for, mining, taking out and removing therefrom the merchantable shipping or containing copper, lead, silver, gold, gypsum, and other valuable metals or minerals, except coal…and use the timber found upon said premises for fuel and for the construction of buildings required in the operation of mines on the premises…drains, tramways, and supports for such mines, provided however State of WA reserves the right to terminate.

In either or both events, the land use actions which ostensibly created the trail or road on the SW face of Saddle Rock occurred in the historic period, therefore this location will be treated as a historic-era mining property archaeological site. For the purposes of DOE, this site was tested for arsenic and higher concentrations were found in the SW portion of the site (Figure 13). The site is defined as an oval-shaped area measuring ca. 200 ft. E/W by 110 ft. N/S and is bisected by a road or trail. For DAHP concerns, given the number of years the SSMMC was in operation and the similarity to the weathering of bedrock exposed near the site locus, the entire 36,000 ft^2 area is considered one historic-era archaeological site—The "Washington" Lode site--by RLR.

Analysis

When evaluated in context, all six archaeological sites recorded by RLR for this project in specific meet Criterion A of the National Register of Historic Places (NRHP). Specifically, these historic-era mining property archaeological sites are significant to the local, regional, and state mining history—a broad pattern of events which defined an era in Washington history from the 1870s to the 1990s. Together with the other mines in SW Wenatchee, the area can be characterized as a Historic Mining District even if all the records, names, and information related to all the mines has not yet been completely gathered from archival records; it is evident that mining was important and significant to the Wenatchee area economy and history. Criterion B may be substantiated as well if the Squaw Saddle Mining & Milling Company's president, Patrick Heley, or the Keegan family members can be found to have been important figures in Wenatchee's history. Criterion C does not appear to be substantiated as there are no extant and no known structures built on the property save flumes or other mine appurtenances which were dismantled at some point. Criterion D, normally reserved for intact buried archaeological deposits, is not likely applicable. However, it should be noted that for the Saddle Rock Park property in the sense that Kittitas and Chelan County Assessor's Office records of mining, irrigation, labor, and real estate actions are a form of data, of which only a portion of the records have been recovered. Indeed, many more records for the Wenatchee Mining District or Saddle Mountain Mining District exist for properties and claims outside of the present project APE, yet are in adjacent parcels or Sections and could be considered part and parcel the same mining district given the geologic setting. The isolated segment of 3 in. diameter iron pipe ostensibly used by D. O. Leavers' irrigation easement is not considered a NRHP-eligible historic property by any account. It has been recorded as a Historic Mining Property isolated find as 45CH ZZZZ.

Three photodocuments were generated chronicling the various agencies' protocols and needs to record field data for this project including Jason Shira's XRF field data images, Hart Crowser's field data images, and RLR's field data images. Good representative images are used below to provide visual perspective to the sites under investigation across the subject property. The image which visually represents best the historic or landscape context from the three photodocuments generated was selected for this report. Case in point, Jason Shira's images have boxes drawn around the locations under investigation within a landscape setting. Some RLR images are of details important to the understanding of the land use history of the property such as stakes, rail or pipe segments, and areas of disturbed ground associated with individual sites. Additional images and maps may be found in the individual site or isolate forms generated for this report in Appendix C. Images from the two agencies other than RLR are used with permission for illustrative purposes. Maps were generated using Kittitas and Chelan County Assessor's Office records on file translated and plotted to 1:24,000 scale orthographic representations so that the relationship to landscape features can be more easily seen as opposed to a topographic projection, which appears chaotic. Additional 1:24,000 scale topographic maps of the historic-era mining and other land use actions can be found in Appendix D and in individual site or isolate forms in Appendix C. A 1:12,500 scale map of systematic archaeological pedestrian survey is presented in figure 14 as is the same map in an orthographic projection for visual reference so that better detail of the trails and paths taken to survey and reach the individual sites and the isolate can be seen more clearly than on a 1:24,000 scale topographic projection. For the sake of completeness, a 1:24,000 scale topographic projection of the transects performed by RLR is presented with the other topographic maps in Appendix D as the last image.

Special note: Mining/Prospect claims, Notices of Location, or Proofs of Labor descriptions which have been drawn on 1:12,500 and 1:24,000 scale orthographic and topographic projections contain call outs which are light blue or light green in color. These records are either incomplete in their legal description or the action to which the record refers is unclear where on the ground surface that action took place (if at all). Those historic-era land use actions which are unclear have been colored differently so that the distinction can be made compared to those entries which RLR is certain occurred or is in the proper location on the landscape in reference to the legal property description summarily depicted on the orthographic map images. Some of the mining/prospecting records located in the Chelan County Assessor's Office refer to areas which were not visited during this investigation. This suggests that there are more historic mining properties across the landscape within the Saddle Rock Park property boundaries which have not yet been tested for arsenic concentrations or recorded as archaeological sites. This is the case. Additional investigations in more remote corners of the Saddle Rock Park property are warranted when the weather permits.

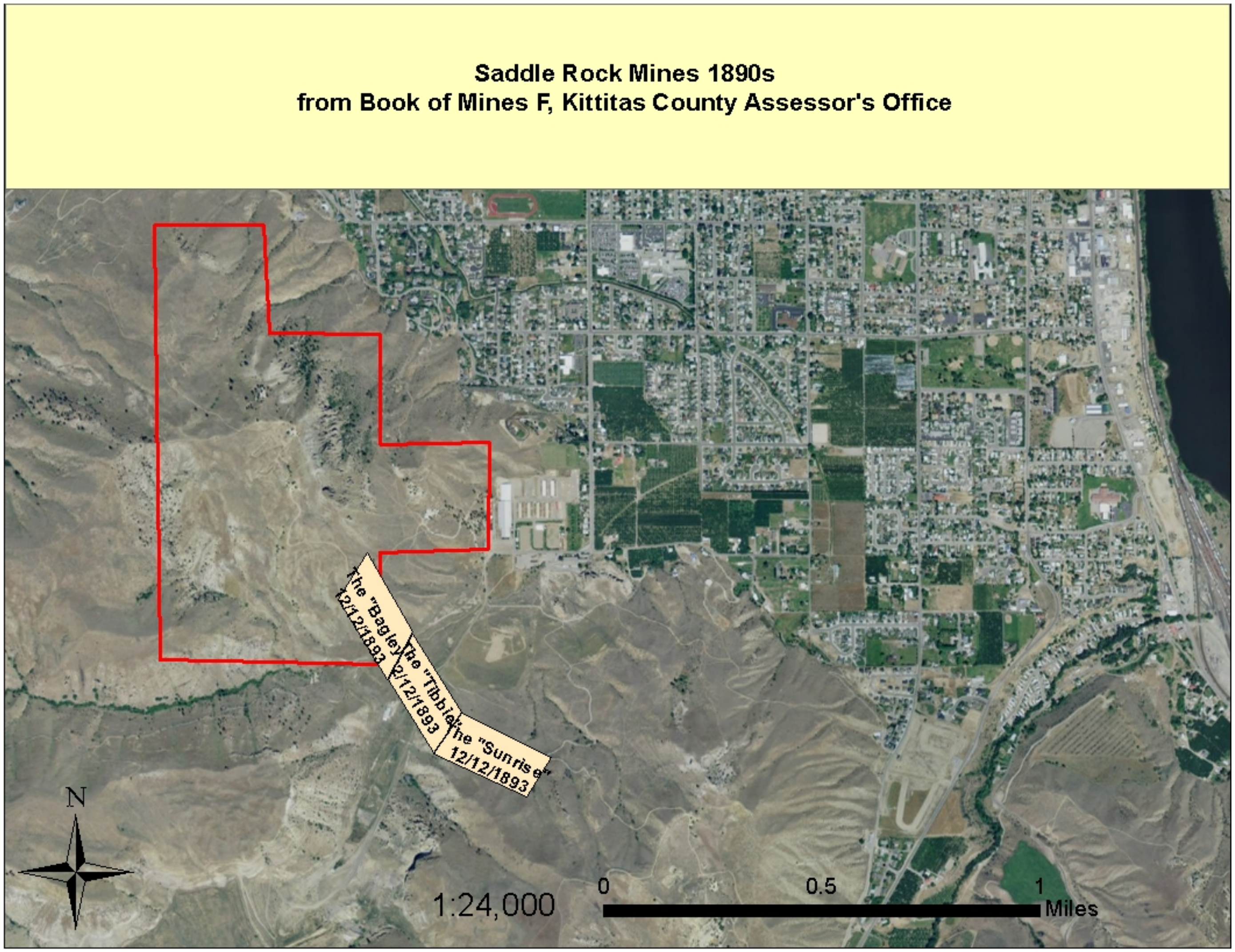

Figure 9: Earliest mining claims and lode names within project APE gathered from Kittitas County Assessors' Office records drawn on a 1:24,000 scale orthographic projection.

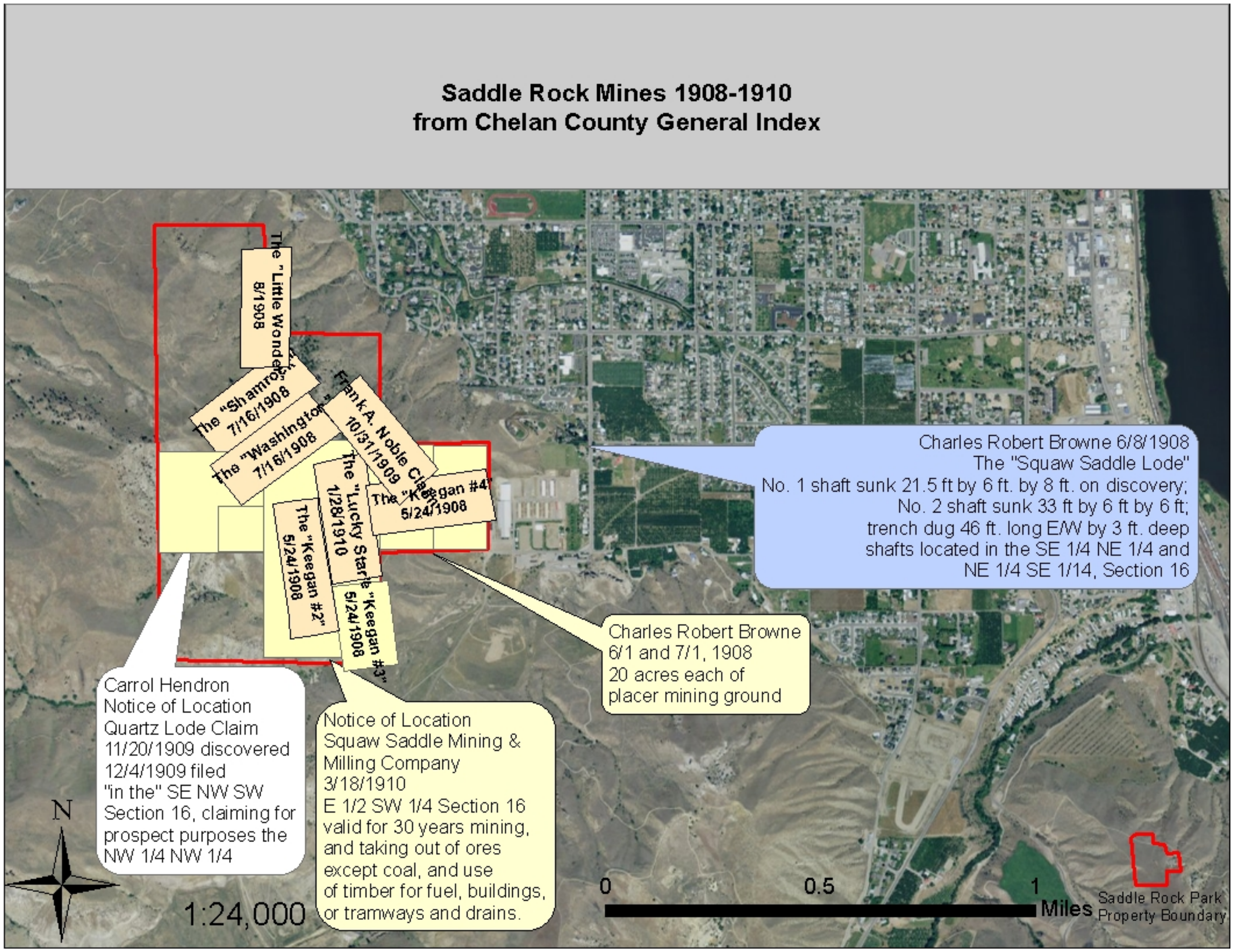

Figure 10: 1900-1910 mining claims and lode names gathered from Chelan County Assessors' Office records drawn on a 1:24,000 scale orthographic projection.

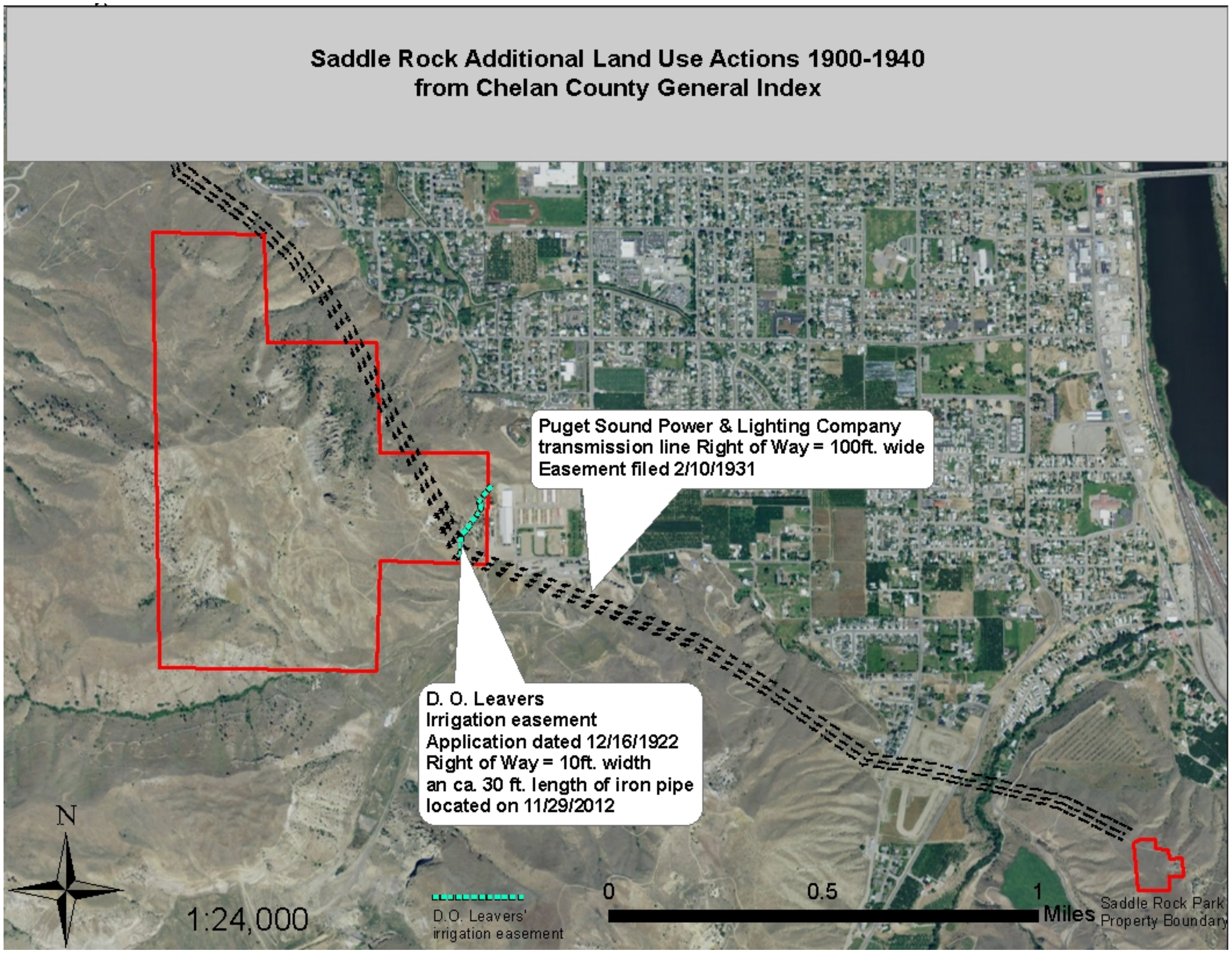

Figure 11: 1900-1940 additional land use actions gathered from Chelan County Assessors' Office records drawn on a 1:24,000 scale orthographic projection.

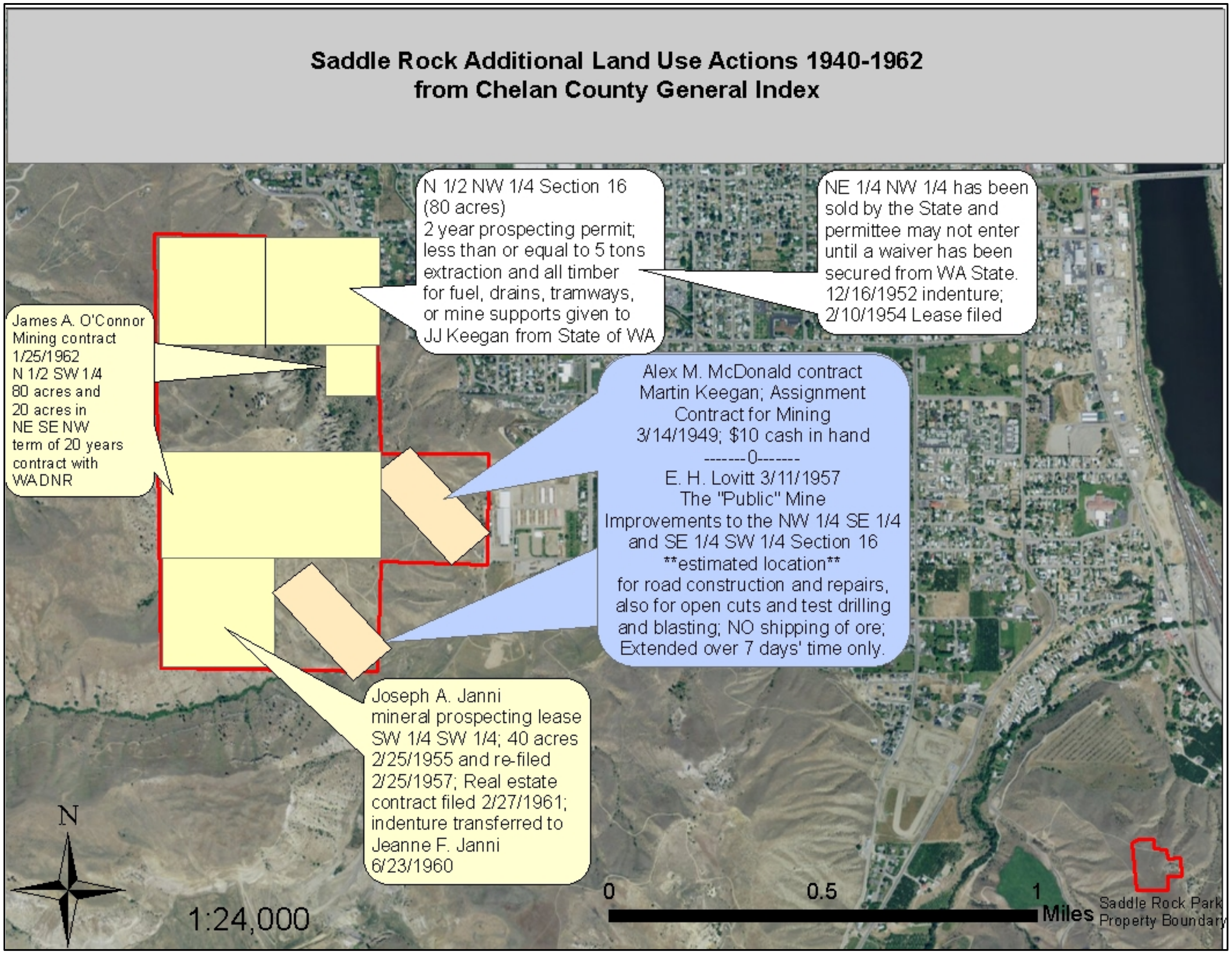

Figure 12: 1940-1962 additional land use actions gathered from Chelan County Assessors' Office records drawn on a 1:24,000 scale orthographic projection.

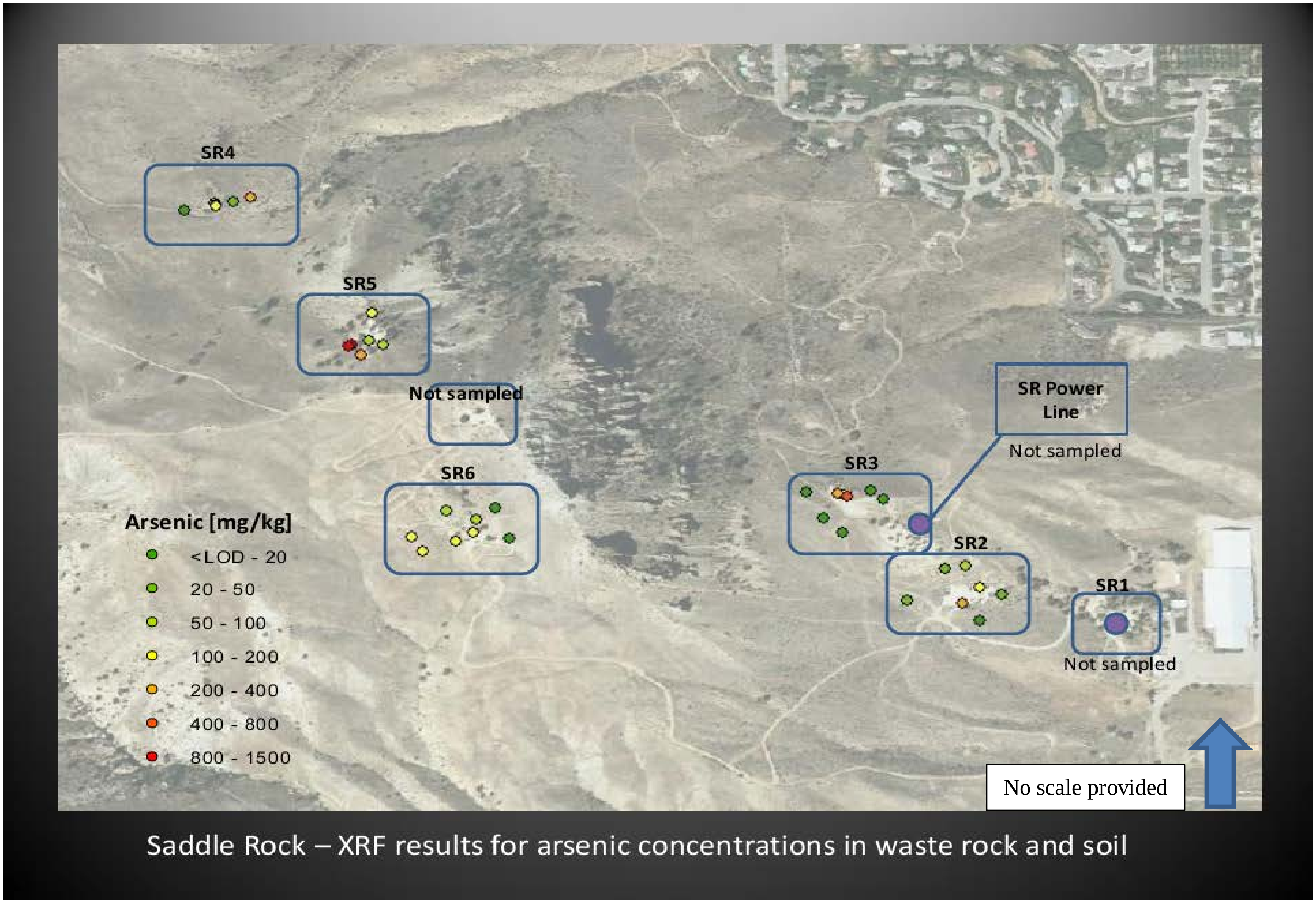

Figure 13: Department of Ecology Saddle Rock arsenic concentration locations on an orthographic projection. Each location is near a former prospecting claim and in an area the Park would like to develop trails.

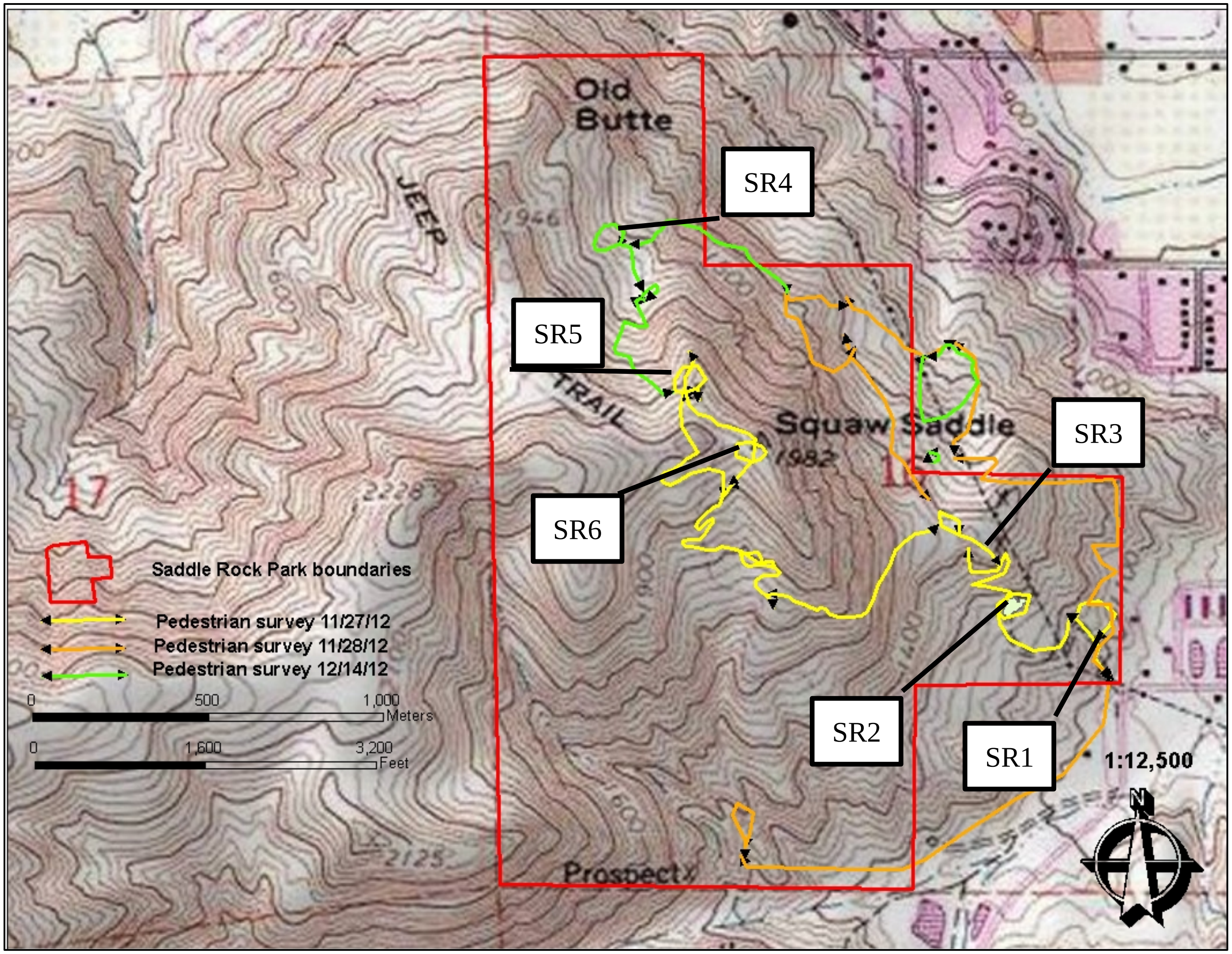

Figure 14: Systematic visual reconnaissance and pedestrian survey on a 1:12,500 scale orthographic projection.

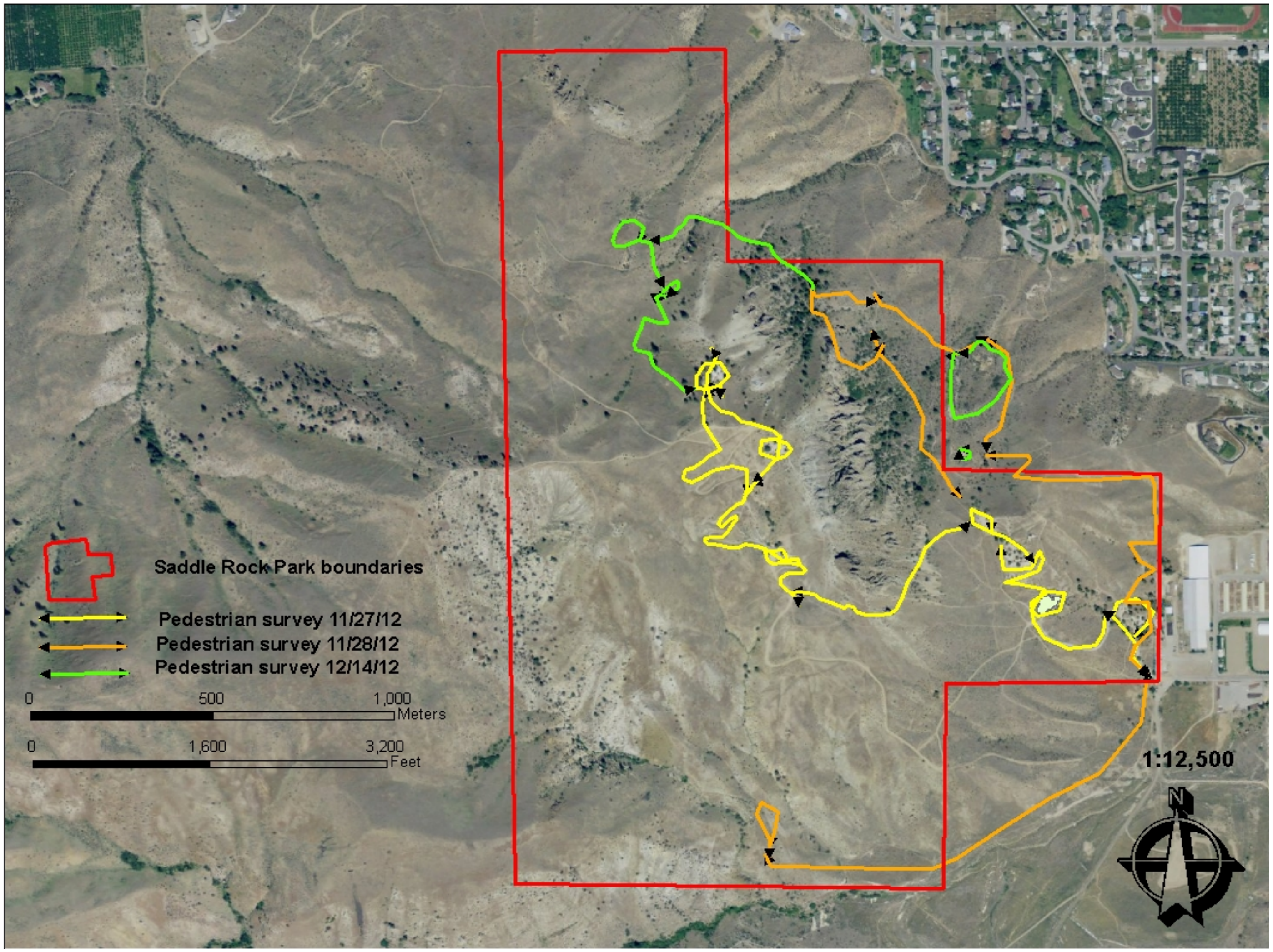

Figure 15: Systematic visual reconnaissance and pedestrian survey on a 1:12,500 scale orthographic projection.

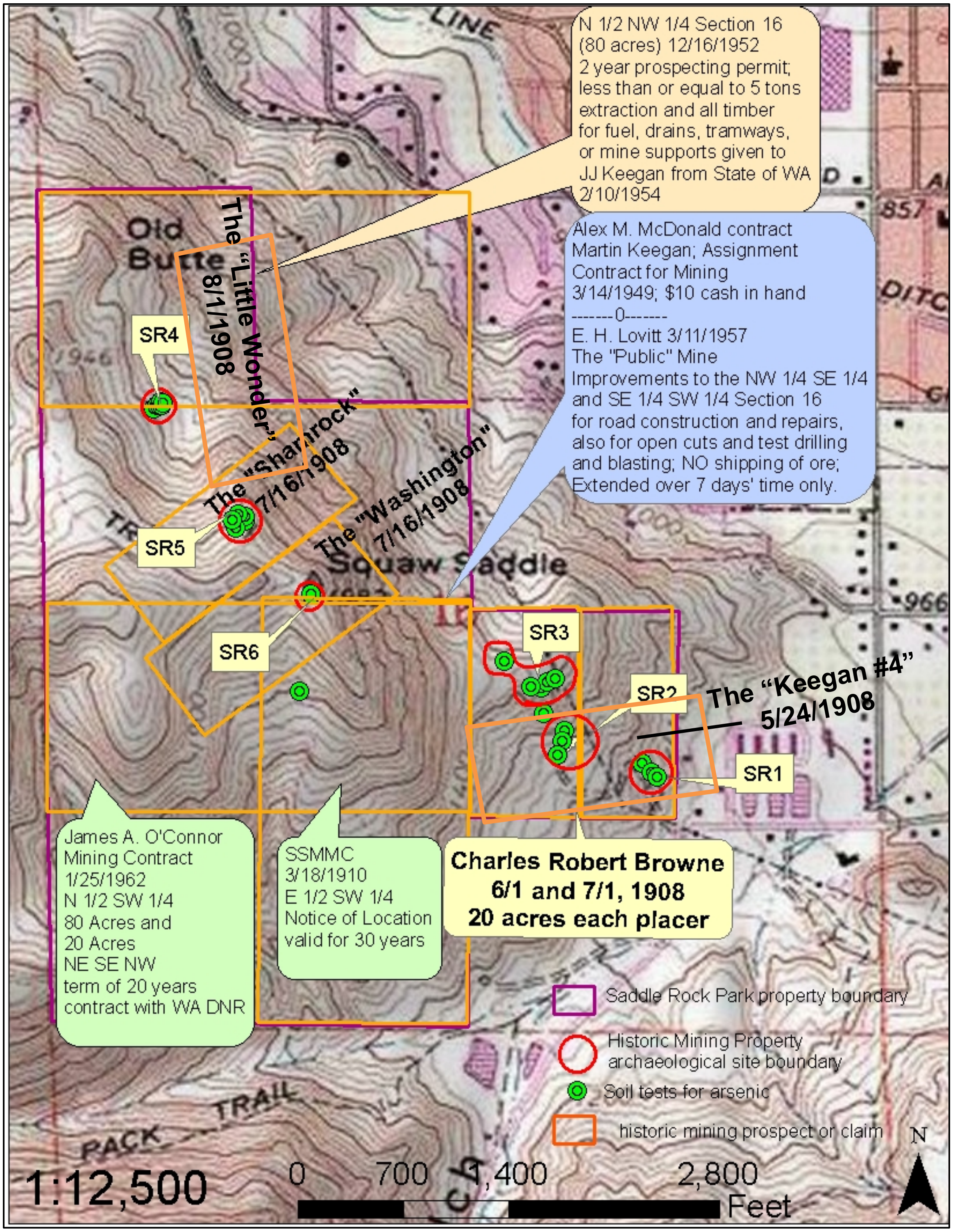

Figure 16: Soil sampling, pedestrian survey reconnaissance, and Chelan County Assessor's Office records depicted on a 1:12,500 scale topographic projection

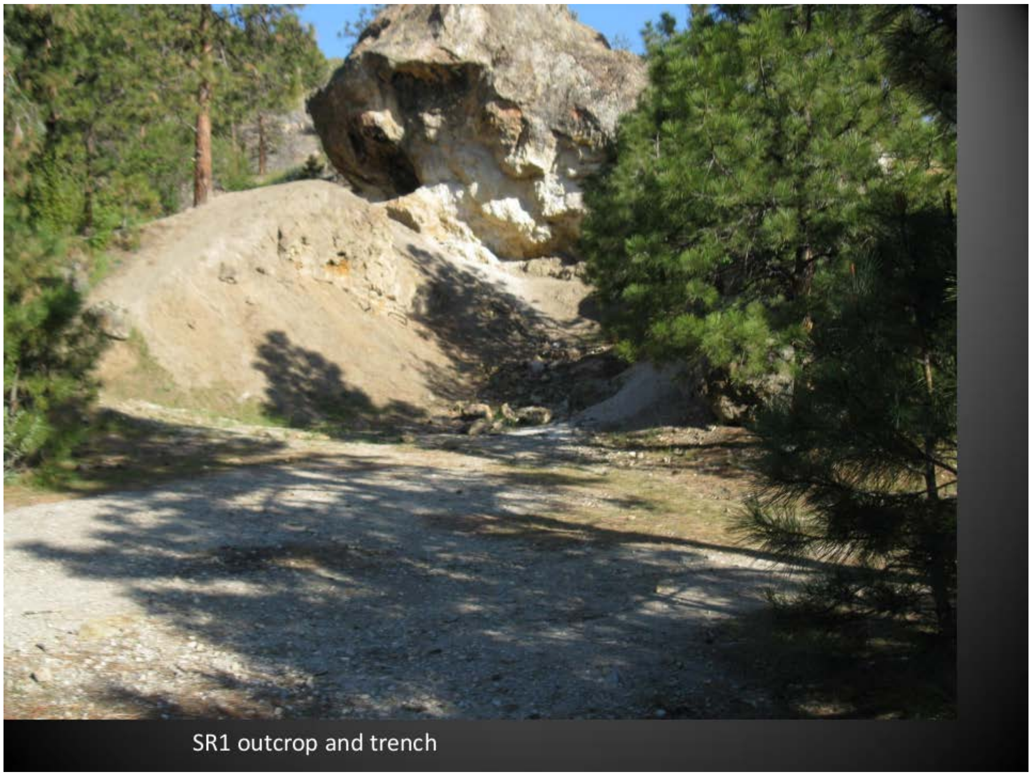

Figure 17: Systematic XRF survey of Saddle Rock property; SR 1.
Jason Shira, Department of Ecology, 5/4-5/2012.

Figure 18: Small void in backfill at base of rock outcrop; systematic soil testing survey of Saddle Rock property; SR1. Image courtesy Hart Crowser, Inc. 2012.

Figure 19: Systematic XRF survey of Saddle Rock property; SR2.
Jason Shira, Department of Ecology, 5/4-5/2012.

Figure 20: Systematic pedestrian archaeological survey of Saddle Rock property; SR2.
Wm. Schroeder and L. Walton, 11/27-28, 12/14/2012.

Figure 21: Systematic XRF survey of Saddle Rock property; SR2 waste rock pile.
Jason Shira, Department of Ecology, 5/4-5/2012.

Figure 22: Systematic pedestrian archaeological survey of Saddle Rock property; SR2.
Wm. Schroeder and L. Walton, 11/27-28, 12/14/2012. Narrow gauge rail segment.

Figure 23: Systematic XRF survey of Saddle Rock property; SR3 waste rock pile.
Jason Shira, Department of Ecology, 5/4-5/2012.

Figure 24: Systematic pedestrian archaeological survey of Saddle Rock property; SR3.
Wm. Schroeder and L. Walton, 11/27-28, 12/14/2012. Historic-era mining prospect.

Figure 25: Systematic pedestrian archaeological survey of Saddle Rock property; SR3. Wm. Schroeder and L. Walton, 11/27-28, 12/14/2012. Historic-era prospect claim stake.

Figure 26: Systematic pedestrian archaeological survey of Saddle Rock property; SR3. Wm. Schroeder and L. Walton, 11/27-28, 12/14/2012. Possible blasting stage from 1957.

Figure 27: Systematic XRF survey of Saddle Rock property; SR4 collapsed prospect/collar. Jason Shira, Department of Ecology, 5/4-5/2012.

Figure 28: Historic-era prospect claim; possibly The "Little Wonder" Lode. Systematic pedestrian archaeological survey of Saddle Rock property; SR4. Wm. Schroeder and L. Walton, 12/14/2012.

Figure 29: Possible historic-era prospect claim boundary south of The "Little Wonder" Lode; SR4.
Wm. Schroeder and L. Walton, 12/14/2012.

Figure 30: Systematic XRF survey of Saddle Rock property; SR5 waste rock pile.
Jason Shira, Department of Ecology, 5/4-5/2012.

Figure 31: Systematic XRF survey of Saddle Rock property; SR5 waste rock pile.
Jason Shira, Department of Ecology, 5/4-5/2012.

Figure 32: Systematic pedestrian archaeological survey of Saddle Rock property; SR5.
Wm. Schroeder and L. Walton, 11/27-28, 12/14/2012; The “Washington” Lode.

Figure 33: Systematic XRF survey of Saddle Rock property; SR6 waste rock pile.
Jason Shira, Department of Ecology, 5/4-5/2012.

Figure 34: Systematic XRF survey of Saddle Rock property; SR6 waste rock pile.
Jason Shira, Department of Ecology, 5/4-5/2012.

Figure 35: Systematic XRF survey of Saddle Rock property; SR6 waste rock pile.
Jason Shira, Department of Ecology, 5/4-5/2012.

Figure 36: Systematic pedestrian archaeological survey of Saddle Rock property; near SR1.
Wm. Schroeder and L. Walton, 11/27-28, 12/12-13/2012. Historic-era irrigation pipe, isolated find.

Project Recommendations

During the course of inspection, RLR identified six historic mining sites, and one historic archaeological or historic property, and have uncovered evidence of a Native American traditional cultural property associated with the site. The archaeological properties have been recorded to the Washington State Department of Archaeology and Historic Preservation's Washington Information System for Architectural and Archaeological Records Data (WISAARD) database as archaeological sites. Prior to development of the project area, **Reiss-Landreau Research recommends that the stakeholders consider putting forth a district nomination for the sites associated with Saddle Rock, as their historic relationship is clear and notable. In addition, the eligibility of the sites under criterion A and B are clearly established.**

Inadvertent Discovery Procedure.

If any archaeological resources are discovered or suspected during the course of the project, activity in the immediate area shall stop until a professional archaeologist can assess the discovery.

If the inadvertent discovery is archaeological material:

1. The project proponent, Chelan County Department of Community Development and the Washington State Department of Archaeology and Historic Preservation (DAHP) will be contacted and work in that area will stop.

2. The archaeologist will contact the Project Proponent, The City of Wenatchee.

    a. Upon notification of discovery of potential archaeological deposits, a professional archaeologist will evaluate the remains.

    b. The DAHP will be given the opportunity to view the artifacts within 48 hours after the discovery or at the earliest possible time thereafter. The discovery will be kept confidential. After halting construction, securing the site, and notifying the contractor, the archaeologist will conduct a brief in-field evaluation. The purpose of the evaluation is to determine whether the discovered resources have potential to answer research questions.

    c. Evaluation protocols are described in the following section.

    d. If parties agree that the artifacts are not significant, RLR will ask the construction representatives to resume construction.

e. If parties agree that the artifacts are significant, the Washington State DAHP will issue a stop work order until further notice for all construction work in the area defined as a significant site.

Guidelines for the Discovery of Human Remains:

1. All persons who know of the existence and location of human remains must, by law, **notify the county coroner and local law enforcement**. This must be done in the most expeditious manner possible. (RCW 27.44; 68.50; 68.60);

2. Any person engaging in ground disturbing activity that encounters skeletal human remains must **cease all activity which may cause further disturbance to the remains, make a reasonable effort to protect the area from further disturbance, report the presence and location of those remains to the coroner and local law enforcement** (RCW 27.44; 68.50; 68.60). The remains should not be touched, moved, or further disturbed;

3. The county coroner will assume jurisdiction over the human skeletal remains and make a determination of whether those remains are forensic or non-forensic. (RCW 27.44; 68.50; 68.60);

4. If the county coroner determines the remains are non-forensic, then the Department of Archaeology and Historic Preservation will take jurisdiction over the remains. (RCW 27.44; 68.50; 68.60);

5. The State Physical Anthropologist will make a determination of whether the remains are Indian or Non-Indian and report that finding to the affected parties. (RCW 27.44, 68.50; 68.60);

6. The DAHP will handle all consultation with the affected parties as to the future preservation, excavation, and disposition of the remains if there is no federal agency involved.

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Appendix A: Property history

Grantee	Mine Name	Document type	Date	Location
State of Washington		School Grant Patent	11/11/1889	All of Section 16, T 22 N, R 20 E
D. A. Curry, John Flaherty, and F. M. Scheble, Locators and Claimants	The "Sunrise"	Location Notice Book K, pg. 428, **Kittitas County Mining Records**	Located 4/23/1894; Filed for record 5/1/1894	1,500 Lft by 600 Lft width on this lead ledge or Deposit containing Gold, Silver, and other minerals. At NW corner stake of T 22 E, R 20 running westerly approximately 1,500 or 2,000 ft. we come to SE corner of SE. End of Paymaster Claim, then running SW 600 ft to SE corner of stake of Sunrise Claim, then 750 ft in a NW course on parallel with Paymaster Claim back to NE boundary then 750 ft in same direction to NE corner of NW. The SW corner stake is to be known as the Sunrise situated about 3 ½ or 4 miles from town of Wenatchee.
John Flaherty and Mrs. M Currey, Locators and Claimants	The "Paymaster"	Location Notice Book K, pg. 429 **Kittitas County Mining Records**	Located 4/23/1894; Filed for record 5/1/1894	Commencing at the NW corner stake of T 22 N, R 20 and running in a westerly course about 1,500 to 2,000 ft we come to SE corner of SE, the Paymaster Claim, then running SW 600 ft to SE corner of stake of Paymaster Claim, then 750 ft in a NW course back to NE boundary then 750 ft in same direction to NE corner of NW. The SW corner stake is to be known as the Paymaster situated about 3 ½ or 4 miles from town of Wenatchee
July 18, 1894°. (12 Stat. § 114) A. Assessment work suspended—Notice of Intention to hold claim. This amendment suspends the requirement of section 2324 so that a mining claim should not be subject to forfeiture for the nonperformance of the assessment work for that year, if a notice of intention to hold and work the claim is properly filed. It is sufficient to file the good faith notices required by this act in lieu of the annual expenditure, the performance of which was excused by these statutes. °From this date forward, most of the records in the Kittitas County Mining Records concern re-filed claims with notice of intention to perform work in improvement on the claim as well as numerous "Amend Location Certificate" files. Many of these re-filed records have more precise locational information than the original claim.				
P. P. Schelby	The "Tibbie"	Notice that Mr. Schelby would like to take advantage of the revised statute; Mr. Schebly plans to work said claim, The "Tibbie". Book G, pg. 22	Filed for record 9/10/1894	

Grantee	Mine Name	Document type	Date	Location
H. B. Bagley	The "Bagley"	Amend Location Certificate Book G, pg. 80	Located 12/12/1893 Filed 12/22/1893 Re-filed 12/17/1894	Beginning at the northern corner of the Tibbie Lode (Which is N 37° 0' W 1,500 ft. from a point which is N 59° 30' W 1,500 ft. from a point which is 1,079 ft S and 766 ft. W of the ¼ section corner between Section 15 and Section 16, T 22 N, R 20 E, thence in a course N 27° 0' W 1,500 ft., thence S 30° 30' W 650 ft., thence S 27° 0' E 1,500 ft, thence S 30° 30' W 650 ft, thence S 27° 0' E 1,500 ft., thence N 30° 30' E 650 ft. to the place of beginning.
P. P. Schelby	The "Tibbie"	Notice of Intention Re-filed claim; Book G, pg. 82	Claimed 12/12/1893 Filed 12/22/1893 Re-filed 12/19/1894	Beginning 1,079 ft. S and 766 ft. W of the ¼ section corner between Section 15 and Section 16, T 22 N, R 20 E, thence in a course N 59° 30' W 1, 500 ft. to E corner of said claim, which is the point of the beginning and which is also the N corner of Sunrise Lode claim, thence in a course N 37° W 1,500 ft, thence S 30° 30' W 650 ft, thence S 37° 0' E 1,500 ft to a point which is also the E corner of the Sunrise Lode claim, thence N 30° 30' E 650 ft to place of beginning. This claim is bounded on the southerly end by Sunrise Claim, and on the northerly by the Bagley Claim.
Morgan J. Carkeek	The "Sunrise"	Amend Location Notice Book G, Pg. 84	Original claim 12/12/1893 Filed for record 12/22/1893 Certificate 12/17/1894 Notice of Location 12/17/1894 Book G, pg. 86	Beginning at a point (or stake) 1,079 ft. S and 766 ft. W of the ¼ section corner between Section 15 and Section 16, T 22 N, R 20 E, thence in a course N 59° 30' W 1,500 ft, thence S 30° 30' W 600 ft, thence S 59° 30' E 1,500 ft., thence N 30° 30' E 600 ft.
Angus Mackintosh	The "Mackintosh"	Amend Location Notice Book G, pg. 86-87	Original claim 12/12/1893 Filed for record 12/21/1893 (F/222) Certificate 12/17/1894 Notice of Location 12/19/1894	Beginning at a point 1,235 ft S and 229.5 ft. W of ¼ section corner between Section 15 and Section 16, T 22 N, R 20 E, thence S 75° 45' W 600 ft., thence S 14° 15' E 1,500 ft, thence N 75° 45' E 600 ft, thence N 14° 15' W 1,500 ft. to beginning.

Grantee	Mine Name	Document type	Date	Location
D. H. Gilman	The "Gilman"	Notice of Amended Location Book G, pg. 99	Original claim 12/12/1893 Filed for record 12/12/1893 Certificate 12/21/1894 Notice of Location 12/22/1894	Beginning at a point 1,235 ft. S and 229.5 ft W of the ¼ section corner between Section 15 and Section 16, T 22 N, R 20 E, thence S 14° 15' E 1,500 ft, thence S 75° 45' W 600 ft (S corner of Mackintosh Claim), thence S 14° 15' E 1,500 ft (E corner of Stanley Claim), thence N 75° 45' E 600 ft. (N corner of Stanley Claim), thence N 14° 15' W 1,500 ft.
Charles Robert Browne, Locator; Ada Pearce Browne attested	20 acres of placer mining ground	Location Notice Book 77, pg. 10 Chelan County General Index; Document # 22930	Discovered and Located 6/1/1908; filed for record 6/2 1908	Situated in the Wenatchee Mining District, Chelan Co., 1,320 ft running N from discovery post 100 ft and 1,220 ft running S of discovery post by 660 ft. east and west in Section 16; NW ¼ of SE ¼
Charles Robert Browne, Locator	20 acres of placer mining ground	Location Notice Book 77, pg. 17 Chelan County General Index; Document # 23311	Discovered and Located 7/1/1908; filed for record 7/3 1908	Situated in the Wenatchee Mining District, Chelan Co., 1,320 ft running N from discovery post 100 ft and 1,220 ft running S of discovery post by 660 ft. east and west in Section 16; NW ¼ of SE 1/4
John Kugan	Shamrock	Notice of Location Book 77, pg. 19; Document # 23442	Filed for record 7/16/1908 Notice for Quartz Location 7/16/1908; Located 5/24/1908. °°See record below which has different location info.	Commencing at a post marked No. 1 at the NW corner, from thence 300 ft. in a S 23° E direction to a center end post marked No 2, thence 300 ft. in a S 28° E direction to a corner post marked #3, thence 1,500 ft. in a SE 62° W direction to a corner post marked #4, thence 300 ft. in a N 28° W direction to a center end post marking #5, thence 300 ft. in a N 28° W direction to a corner post marked #6, thence 1,500 ft. to place of beginning, intending to claim 1.500 ft. in length and 600 ft. in width, for the purpose of mining the same, claiming all surface rights…on the summit of Squaw Saddle Mtn and immediately adjoining the west side of the Washington Lode, the NE corner, Section 16, T 22 N, R 20 E, bears N 63° 45' E a distance of 4,203 ft. from corner #1 of this Lode, We claim 300 ft. on the Easterly side, and 1,200 ft. on the westerly side of discovery. Posts are placed at each corner and at both ends of center line

Grantee	Mine Name	Document type	Date	Location
Patrick Heley	Washington	Notice of Quartz Location Book 77, pg. 19, Document # 23443	Filed for record 7/16/1908	Located 1,500 Lft. on the Washington Lode, situated in Chelan Co., in WA, in mining district, and further described as follows: commencing at a post marked No 1 at the NW corner, thence 300 ft. in a S 28° E direction to a center end post marked #2, thence 300 ft. in a S 28° E direction to a corner post marked #3, thence 1,500 ft. in a S 62° W direction to a corner post marked #4, thence 300 ft. in a N 28° W direction to a center end post marked #5, thence 300 ft. in a N 28° W direction to a corner post marked #6, thence 1,500 ft. to place of beginning … to claim 1,500 ft. in length and 600 ft. in width for the purpose of mining … on summit of Squaw Saddle Mtn. NE corner of Section 16, T 22 N, R 20 E bears N 60° 30' E a distance of 4,124 ft. from corner #1
Charles Robert Browne, Locator	Squaw Saddle Lode	Description of Work Done; Book 77, pg. 23 Chelan County General Index; Document # 23611	C. R. Browne attested that he spent in excess of $100 in improvements between 6/8/1908 and 8/1/1908 including $115 in help; other expenses $75 and $190.	No. 1 shaft sunk 21.5 ft by 6 by 8 on discovery. No. 2 shaft sunk 33 ft by 6 by 6 also dug trench 46 ft long east/west by 3 ft deep; Shafts located in the SE ¼ NE ¼ and NE ¼ SE ¼, Section 16.

Grantee	Mine Name	Document type	Date	Location
Patrick Heley, Mary F. Heley, from John Keegan	Squaw Saddle Mining & Milling Co.; Shamrock Lode Mining Claim	Deed, Book 77, pg. 181, Document # 29865	11/2/1909 filed for record; 10/26/1909; 10/27/1909 certificate	Extending 300 ft. on the easterly side and 1,200 ft. on the westerly side of the center of the discovery shaft or pit, comprising in all 1,500 ft. in length, and 600 ft. in width, situated on the summit of Squaw Saddle Mtn. about 2 miles in a southerly direction from Wenatchee and immediately adjoining the west side of the Washington Lode and being more particularly described as beginning at the NE corner of Section 16, T 22 N, R 20 E, bearing N 63°45' E a distance of 4,203 ft. to corner #1 of this lode, being the NW corner of said lode, thence running S 28° E 300 ft. to a center end post marked #2, thence S 28° E 300 ft. to corner #3, thence S 62° W 1,500 ft. to corner #4, thence N 28° W 300 ft. to center post #5, thence N 28° W 300 ft to corner post #6, thence 1,500 ft. to point of beginning….also the Washington Lode extending 112 ft. on the easterly side and 1,388 ft. on the westerly side of the center of the discovery shaft or pit, comprising in all 1,500 ft. in length and 600 ft. in width, … being situated on the summit of Squaw Saddle Mtn. being more particularly described as: beginning at the NE corner of Section 16, T 22 N R20 E, bearing N 60° 30'E a distance of 4,124 ft. to corner #1 of this lode, being the NW corner thereof, thence S 28° E 300 ft to center end post #2, thence S 28° E 300 ft to corner post #3, thence S 62° W 1,500 ft to corner #4, thence N 28° W 300 ft to center end post #5, thence N 28° W 300 ft. to corner #6, thence 1,500 ft. to point of beginning,

Grantee	Mine Name	Document type	Date	Location
Martin Keegan	Squaw Saddle Mining & Milling Co.; #2 Keegan Group mining claim	Deed, Book 77, pg. 182, Document # 29866	11/2/1909	Extending 250 ft in northerly direction and 1,250 ft. in a southerly direction from center of discovery shaft or pit, comprising in all 1,500 ft in length and 600 ft in width, being situated on Squaw Saddle Mtn. , beginning at the NE corner, whence the SE corner of Section 16, bears S 65° 10'E of a distance 3,918 ft. ; thence S 8° 35'E 1,500 ft; thence S 81° 25'E 600 ft; thence N 8° 35' W 1,500 ft; thence N 81° 25' W 600 ft, to point of beginning (see record Bk. 77, pg. 164); also #3 Keegan Group Mining Claim extending 1,032.7 ft. in a southerly direction from the center of the discovery shaft or pit comprising in all 1,032.7 ft. in length and 600 ft. in width, … being situated on Squaw Saddle Mtn. … beginning at the NE corner, whence the SE corner of Section 16, T 22 N, R 20 E, bears S 69° 30' E 3,050 ft, thence S 8° 35'X 1,032.7 ft; thence S 81° 25' E 600 ft.; thence N 8° 35'W 1,032.7 ft; thence N 81° 25'W 600 ft to point of beginning (see pg. 165); #4 Keegan Group Mining Claim extending 1,500 ft. in an easterly direction from center of discovery shaft or pit, comprising in all 1500 ft in length and 600 ft in width… being situated on Squaw Saddle Mtn. beginning at the NW corner, whence the SE corner of section 16, T 22 N, R 20 E, bears S 65° 10'E 3,918 ft, thence N 81°25'E 1500 ft, thence S 8° 35' E 600 ft; thence S 81° 25'W 1500 ft; thence N 8° 35' W 600 ft. to point of beginning.

Grantee	Mine Name	Document type	Date	Location
Frank A. Noble	Claim	Notice of Location Book 77, pg. 191; Document #30210	10/31/1909 discovered; located 11/1/1909; 11/22/1909 11/1/1909 notice of location;	Commencing at a point 280 ft. N of SE corner of the NW ¼ of SE ¼ of Section 16, T 22 NR 20 E, thence in a Northwesterly direction diagonally across said 40 Acre tract above described to the NW corner thereof and continuing into the SE ¼ of the NW ¼ of Section 16, extending 300 ft on either side of center of said vein…said NW ¼ of SE ¼ and SE ¼ of NW ¼ Section 16,
Carrol Hendron	Quartz Lode Claim	Notice of Location Book 77, pg. 193; Document # 30397	11/20/1909 discovered; located 11/23/1909; filed for record 12/4/1909	Commencing at a point in the SE corner of NW ¼ of SW ¼ of Section 16, T 22 N, R 20 E, diagonally across said 40 acre tract above described to the NW corner thereof, the same being the NW corner of said Section 16, marked the boundaries thereof extending 300 ft on either side of the center line of said ledge all above listed and described…claiming for prospect purposes the NW ¼ NW ¼ Section 16,
Squaw Saddle Mining & Milling Co.	The "Washington"	Notice of Location Book 77, pg. 210, Document # 31088	This amended certificate is to replace faulty records for this claim. This claim is to be known as the Washington Lode, Discovered in May, 1908, Located 5/24/1908, Filed for record 1/11/1910	The Squaw Saddle Mining & Milling Co., assignee Patrick Heley, Its President, and John Keegan(the original locators), on 1/11/1910 located and claimed 1,500 Lft and horizontal measurement on the Washington Lode, vein, ledge or deposit along the vein thereof, with all its dips, angles and variations, as allowed by law, together with 300 ft on the northerly side and 300 ft on the southerly side of said vein at the surface, running 112 ft easterly from center of discovery shafts and 1,388 ft running westerly from center of discovery shaft. Commencing at this discovery post, being the center of the vein or claim, thence 112 ft N 52° E to a post marked #2, being east center end; thence 300 ft. S 38° E to a post marked #3 (a corner); thence 1.500 ft s 52° W to a post marked #4; 5 being west center and thence 200 ft N 38°W to a post marked #6 (a corner), thence 1,500 ft N 52° E to a post marked #1, thence 300 ft. S 38°E to #2 post, center end. **Post #1 being 4,124 ft S 55° W of NE corner of Section 16, on southern slope of Squaw Saddle Mountain, on the SW side of City of Wenatchee, and extends along the SE side of Shamrock Lode.**

Grantee	Mine Name	Document type	Date	Location
Squaw Saddle Mining & Milling Co.; Martin and Thomas Keegan (the original Locators)	The "Keegan No 2"	Notice of Location Book 77, pg. 220, Document # 31089	This amended certificate is to replace faulty records for this claim. This claim is to be known as the Washington Lode, Discovered in May, 1908, Located 5/24/1908, Filed for record 1/11/1910	1,500 Lft on the No.2 Keegan Lode, thence 300 ft on E and 300 ft. on W of middle of vein at the surface, 250 ft northerly from center of discovery shaft, thence 250 ft. southerly from center of discovery shaft. Commencing at this discovery post: being the center of the vein (N center), thence 250 ft N 8° 52' W, thence 300 ft S 81° 25' W to a post marked NW corner, thence 1,500 ft. S 8°35' E, to a post marked SW corner, south center thence 300 ft. N 81° 25' E to a post marked SE corner, thence 1,500 ft N 8°25' W to a post marked NE corner, thence 300 ft. S 81° 25' W to north center end, **said NE corner being 3,918 ft N 65° 10' W of SE corner of Section 16, T 22 N, R 20 E.** Further described extending along the west end of No. 4 and west side of No. 3, Keegan Group mines; This claim is to be known as the No. 2 of the Keegan Group, discovered 8/1909, Located 9/9/1909.
Squaw Saddle Mining & Milling Co.; Martin and Thomas Keegan (the original Locators)	The "Keegan No 3"	Notice of Location Book 77, pg. 221, Document # 31090	Discovered in May, 1908, Located 5/24/1908, Filed for record 1/11/1910	1,032 Lft on the No.3 Keegan Lode, thence 300 ft on E and 300 ft. on W of middle of vein at the surface. At discovery post, commencing 300 ft. S 81° 25' W at NW corner, thence 1,032 ft S 8° 35' E to SW corner, thence 300 ft. N 81° 35' E to S center end, thence 300 ft N 81° 25' E to SE corner, thence 1,032 ft N 8 ° 35' W to Ne corner, thence 300 ft S S 81°35' W to discovery North center. **Said NE corner being 3,050 ft N 69° 30' W of SE corner of Section 16, T 22 N R 20 E;** along easterly side of No. 2 Keegan Group Lode.
Squaw Saddle Mining & Milling Co.; Martin and Thomas Keegan (the original Locators)	The "Keegan No 4"	Notice of Location Book 77, pg. 221, Document # 31091	Discovered in May, 1908, Located 5/24/1908, Filed for record 1/11/1910	**3,318 ft. N 65° 10' W of SE corner Section 19, T 22 N R 20 E.** Commencing at this discovery post; being the center of vein, thence 300 ft. S 8° 35' E (SW corner), thence 1,500 ft N 81° 25' E (SW corner), thence 300 ft N 8° 35' W (E center end); thence 300 ft N 8° 35' W to NE corner, thence 1,500 ft S 81° 25' W (NW corner), thence 300 ft S 8° 35' E to west center end.
Squaw Saddle Mining & Milling Co.; Patrick Heley and Thomas Keegan (the original Locators)	The "Shamrock" Lode	Notice of Location Book 77, pg. 222, Document # 31092	Discovered 5/15/1909, Located originally 5/24/1908; Filed for record 1/11/1910	**Post No.1, located 4,203 ft S 63° 45' W of NE corner of Section 16, T 22 N, R 20 E.** Commencing at this discovery post, being 300 ft N 52° E to post No. 2, thence 300 S 38° E to post No. 3, thence 1.500 ft S 52° W to post No. 4, thence 300 ft. N 38° W to post No. 5, thence 300 ft. N 38° W to Post No. 6, thence1,500 ft N 52° E to post No.1, thence S 38° E to post No. 2.
Martin Keegan	The "Little Wonder" Lode	Notice of Location Book 77, pg. 222, Document # 31093	Discovered 8/1909, Located 9/20/1909, Filed for record 1/11/1910	**The NE corner is 3,953 ft S 78° 54' W of NE corner of Section 16, T 22 N, R 20 E.** Commencing 350 ft N 4° 56' W, thence 300 ft. W to NW corner, thence 1, 500 ft S 4 ° 56' E to SW corner, thence 300 ft E to South Center, thence 300 ft E to SW corner, thence 1,500 ft N 4° 56' W to NE corner, thence 300 ft W to North Center.

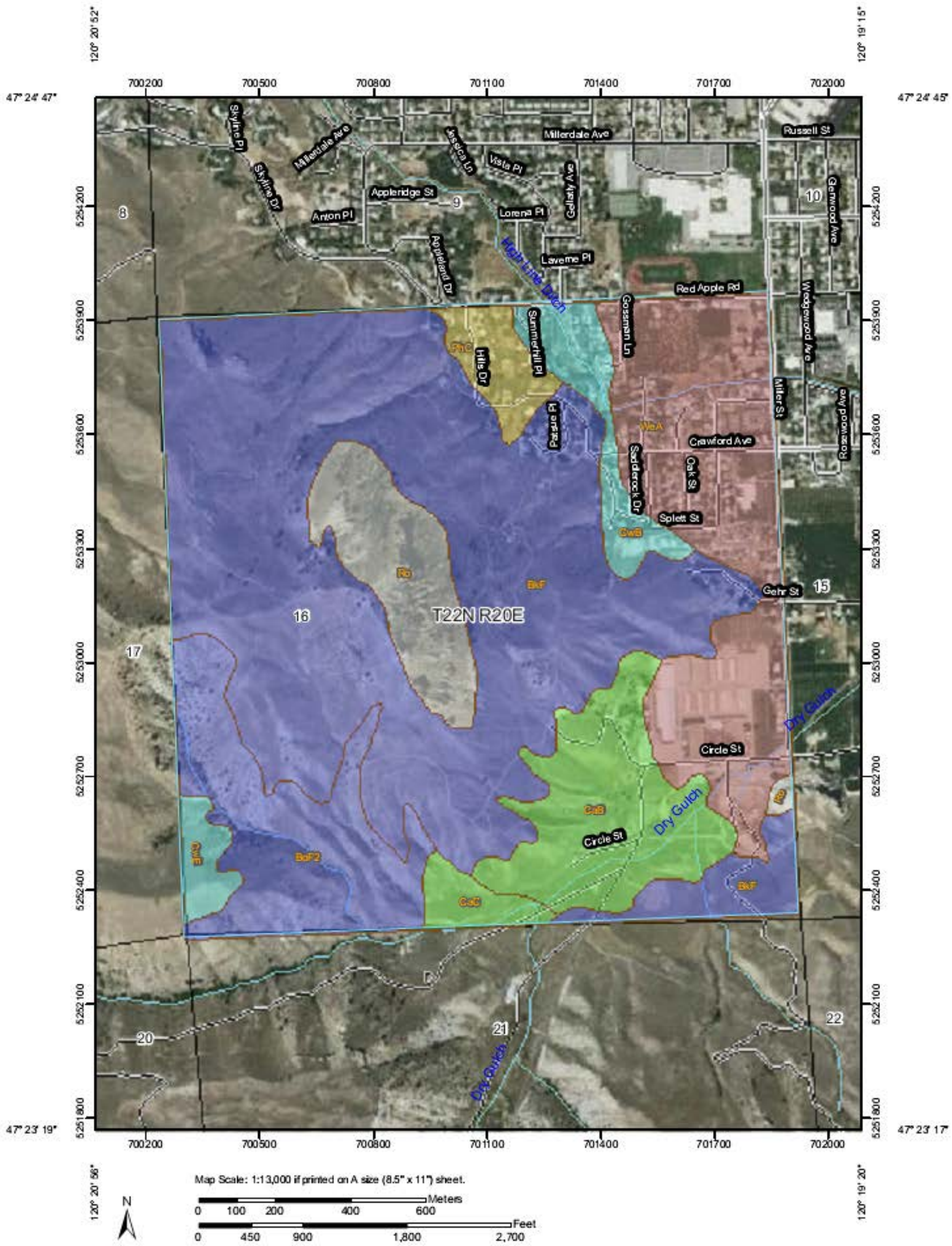
Grantee	Mine Name	Document type	Date	Location
Squaw Saddle Mining & Milling Co.; Patrick Heley and Thomas Keegan (the original Locators)°	The "Lucky Star" Lode	Notice of Location Book 77, pg. ZZZ Document # 31415	Filed for record 1/28/1910	**3,968 ft from SE corner of Section 16, T 22 N, R 20 E, South of Washington Lode**, thence 300 ft N 6° 5' W (NW corner), thence N 83° 45' E (NE corner), thence S 6°15' E (E center end), thence S 6° 15' E (SE corner), thence 1,500 ft S 83° 45' W (SW corner), thence 300 ft N 6° 15' W to West center end.
State of WA	Squaw Saddle Mining & Milling Co.; Patrick Heley, Pres.	Notice of Location Book 77, pg. 242, Document # 33010	Received 4/2/1910; Deed; indenture 3/18/1910; filed on 4/29/1910	This indenture (Chapter 102, Section 7 of the session laws of 1897) valid for 30 years…The E ½ SW ¼ Section 16, T 22 N, R 20 E, 80 acres +/- which premises are leased to the second party for no other purpose than the purpose of exploring for, mining, taking out and removing therefrom the merchantable shipping or containing copper, lead, silver, gold, gypsum, and other valuable metals or minerals, except coal…and use the timber found upon said premises for fuel and for the construction of buildings required in the operation of mines on the premises…drains, tramways, and supports for such mines, provided however State of WA reserves the right to terminate
D. O. Leavers		Application # 11581	Irrigation easement 12/16/1922	Over and across the NW ¼ of the SE ¼ of Section 16, 10 ft. in width. Beginning at a point on the south line of said NW ¼ SE ¼ which is S 89° 39' W 266.2 ft. distant from the SE corner of said subdivision and running thence N 66° 28' E 81.5 ft., N 24° 9' E 47.7 ft, N 0° 58' W 85.1 ft., N 46° 51' E 70.3 ft, N 32° 18' E 210.9 ft, N 22 ° 49' W 128 ft, N 35 ° 07' E 67.9 ft, and N 15° 5' E 118.2 ft. to a point on the east line of said subdivision which is N 0° 45' E 673.6 ft. distant from the SE corner thereof. (0.16 acres)
Puget Sound Power and Light Company	Power transmission line easement	Book 223, pg. 441 Document # 206415	Easement, filed on 2/10/1931; re-application in re: to PSPLC ROW 1/23/1931	Those portions of the of NW ¼ NW ¼, SE ¼ NW ¼, NW ¼ SE ¼ Section 16, T 22 N, R 20 E, a strip of land 100 ft in width, having 50 ft. on either side of center line beginning at a point on N line of said Section 16, which is S 87° 54' E 1,288.3 ft distant from the NW corner of Said Section, then running thence S 53° 19' 30" E 378.8 ft., S 37° 55' E 1.128.1 ft., S 27° 28' E 3,081.7 ft and S 57° 53' E 1,759.3 ft. to a point on the east line of said Section which is N 0° 38' 30"W 825.2 ft distant from SE corner thereof.

Grantee	Mine Name	Document type	Date	Location
Millerdale Irrigation District	Easement for irrigation ditch	Book 234, pg. 597 Document # 243061	Easement, filed on 10/22/1934	Unable to re-locate record.
Alex M. McDonald	Martin Keegan; Assignment	Book 480, pg. 652, Document #473144	Contract for mining 3/14/1949; Certified 10/1/1950; Assignment; filed on 6/9/1953	$10 in hand paid to M. Keegan…viz. NW ¼ SE ¼, SE ¼ SW ¼, Section 16, T 22 N, R 20 E, containing approximately 80 acres
State of WA	J. J. Keegan, Lease	Book 503, pg. 343, Document # 480883	12/16/1952 indenture, prospecting Lease; filed on 2/10/1954	N ½ of NW ¼ of Section 16, containing 80 acres +/-; the NE ¼ NW ¼ has been sold by the State and the permittee herein may not enter upon the land until a waiver has been secured from the owner thereof…for 2 years of prospecting…may cut and use timber on said premises for fuel and construction thereon of building required in the operation of any mine on said premises and drains, tramways, and supports of said mines but for no other purpose; cannot remove more than 5 tons of ore therefrom for assaying and testing purposes, shall remove no ore for any other purpose within 60 days of the expiration of this lease.
State of WA	Leasee: Joseph A. Janni °°UNSIGNED°°	Book 529, pg. 283, document # 496781	Mineral prospecting Lease, 2/25/1955;filed on 6/22/1955	SW ¼ SW ¼ Section 16, T 22 N, R 20 E containing 40 acres +/-, lessee is required to perform work or improve said land, … ,
E. H. Lovitt	The "Public" mine	Book 555, pg. 475, Document # 518441	3/14/1957; --Proof of Labor; Filed on 3/11/1957	Improvements to the NW ¼ SE ¼ and SE ¼ SW ¼ Section 16, T 22 N, R 20 E—for road construction and repairs, also for open cuts and test drilling and blasting; NO shipping. Extended over 7 days' time.
State of WA	Leasee: Joseph A. Janni	Book 570, pg. 384, Document # 538136	2/25/1957; Mineral Prospecting Lease, filed on 7/22/1958	SW ¼ SW ¼, Section 16, T 222 N, R 20 E, containing 40 acres---same as above (doc. 496781) except no use of timber.
State of WA	Real Estate contract	Book 614, pg. 259, Document # 54347	Contract for mining--Real estate contract; filed on 2/27/1961	This indenture 6/23/1960 for Jeanne F. Janni, SW ¼ SW ¼ Section 16, T 22 N, R 20 E, containing 40 acres or less

Grantee	Mine Name	Document type	Date	Location
Vernon F. and Jean Rosendahl	Lease	Book614, pg. 469, Document # 586603	Mineral Lease, filed on 11/9/1961; Signed 10/18/1961	Lot 3: a parcel of land in Tract 51, plat of Millerdale, in Section 16, T 22 N, R 20 E, commencing at the SE corner of said tract 51, thence N 89° 15' W along the southerly line of said tract 51 for 144 ft to the true point of beginning of this description, thence N 89° 15' W along said southerly line of Tract 51 for 78.7 ft; thence N 0° 12' E 76.3 ft.; thence N 31° 2' E 62.5 ft.; thence N 0° 12' E 199.8 ft; thence N 76° 44' E 48 ft; thence S 0° 12' W 342.6 ft to the true point of beginning containing 0.431 acres +/-. Lot 4, in tract 51, Millerdale…commencing at SE corner of Tract 51, thence N 89° 15' W along southerly line Tract 51 222.7 ft to the true point of beginning for this description; thence N 89° 15' W along said southerly line of Tract 51 97.9 ft to southwesterly corner of said Tract 51, thence N 0° 12' E along westerly line of said Tract 51 297.8 ft.; thence N 76° 44' E 133.3 ft; thence S 0° 12' W 199.8 ft; thence S 31°2' W 62.5 ft.; thence S 0° 12' W 76.3 ft to true point of beginning, containing 0.86 acres; lease for 5 yrs beginning 11/1/1961. For prospecting and assaying of minerals which may be found therein. Lessee may remove all buildings, machinery, equipment and personal property at any time.
State of WA DNR	Real estate contract with James A. O'Connor	Book614, pg. 497, pg. Document # 590850	Contract for Mining; indenture made 1/25/1962; signed 3/19/1962; Real estate contract, filed on 3/2/1962	For the term of 20 years, starting 3/7/1961; the N ½ of SW ¼ Section 16, T 22 N, R 20 E, 80 acres +/-; permitted to build roads, remove ore except coal, cut and use timber
State of WA DNR	Real estate contract with J. A. O'Connor	Book 614, pg. 500, Document # 590851	Contract for Mining indenture made ¼ 1962; signed 2/19/1962; Real estate contract, filed on 3/2/1962	For the term of 20 years, starting 3/7/1961; the NE ¼ SE ¼ NW ¼ Section 16, T 22 N, R 20 E, 20 acres +/-; permitted to build roads, remove ore except coal, cut and use timber—in the Greater Wenatchee Irrigation district.

Appendix B: Soil Parent Material Report and Summary

Parent Material Name—Chelan County Area, Washington (Parts of Chelan and Kittitas Counties)



USDA Natural Resources Conservation Service

Web Soil Survey
National Cooperative Soil Survey

10/18/2012
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MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils
- Soil Map Units

Soil Ratings
- alluvium with a minor amount of loess and volcanic ash in the surface
- glaciofluvial deposits
- residuum from schist, gneiss or sandstone with loess in the upper part
- residuum weathered from metamorphic and sedimentary rock with loess
- till and outwash with a component of loess and volcanic ash in the surface
- Not rated or not available

Political Features
- Cities
- PLSS Township and Range
- PLSS Section

Water Features
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Parent Material Name

Parent Material Name— Summary by Map Unit — Chelan County Area, Washington (Parts of Chelan and Kittitas Counties) (WA607)				
Map unit symbol	**Map unit name**	**Rating**	**Acres in AOI**	**Percent of AOI**
BkF	Bjork silt loam, 45 to 65 percent slopes	residuum from schist, gneiss or sandstone with loess in the upper part	318.2	48.8%
BoF2	Bjork-Rock outcrop complex, 25 to 65 percent slopes, eroded	residuum from schist, gneiss or sandstone with loess in the upper part	66.6	10.2%
CaB	Cashmere sandy loam, 3 to 8 percent slopes	glaciofluvial deposits	58.5	9.0%
CaC	Cashmere sandy loam, 8 to 15 percent slopes	glaciofluvial deposits	9.8	1.5%
CwB	Cowiche silt loam, 3 to 8 percent slopes	residuum weathered from metamorphic and sedimentary rock with loess	22.0	3.4%
CwE	Cowiche silt loam, 25 to 45 percent slopes	residuum weathered from metamorphic and sedimentary rock with loess	9.1	1.4%
PhC	Peshastin loam, 8 to 15 percent slopes	till and outwash with a component of loess and volcanic ash in the surface	14.8	2.3%
Ro	Rock outcrop		41.3	6.3%
WeA	Wenatchee silt loam, 0 to 3 percent slopes	alluvium with a minor amount of loess and volcanic ash in the surface	111.1	17.1%
Totals for Area of Interest			**651.3**	**100.0%**

Appendix C: Archaeological Site and Isolate forms.

STATE OF WASHINGTON
ARCHAEOLOGICAL ISOLATE INVENTORY FORM

Smithsonian Number:
County: Grant

Date: 12/12/2012 **Compiler:** Wm. Schroeder, M.S.

ISOLATE DESIGNATION

Isolate Name: D.O. Leavers' irrigation pipe segment
Field/ Temporary ID: D.O. Leavers' irrigation pipe segment
Site Type: Historic-era isolate

ISOLATE LOCATION

USGS Quad Map Name: Wenatchee 7.5' USGS Quadrangle
Legal Description: T 22 N **R** 20 E **Section:** 16
Quarter Section(s): SE NW SE
UTM: Zone 10 **Easting** 701449 **Northing** 5252817
Elevation (FT/M): 347m/1140 ft.
Other Maps: **Type:**
Scale: **Source:**
Drainage, Major: Columbia River **Drainage, Minor:** Wenatchee River **River Mile:** 465
Aspect: E/W **Slope:** 0-20%

Location Description *(General to Specific)***:** In the NW ¼ of the SE ¼ Section 16, T 22 N, R 20 E, in the Saddle Rock Park, City of Wenatchee, WA, at the first rock outcrop north of the park entrance is an upper area and a lower area where the trail divides. In between the upper and lower area where the trail divides is a small group of pine trees and a cleft in the bedrock. There, among the pine needles in the cleft on the west slope of the lower area by the first rock outcrop is a length of iron irrigation pipe, bent at almost a right angle, disconnected from additional pipe in the bedrock.

Approach *(For Relocation Purposes)***:** From Downtown Wenatchee at the Chelan County Court House, take Okanogan Ave. south 1.7 miles to Circle St. Take Circle St. left (west) 0.1 miles to the intersection of Circle St. and S. Miller St. Park in the parking lot/entrance. From the entrance, this isolated historic-era find is approximately 500 ft. north and slightly off the path near an outcrop of bedrock in a treed area.

ISOLATE DESCRIPTION

Narrative Description: a length of 3 in. diameter iron irrigation pipe approximately 30 ft. long, bent at a right angle and resting in a cleft in the footslope of Saddle Rock near an abandoned mining prospect. This length of irrigation pipe can be linked to D. O. Leavers, a local property owner who requested a Right of Way through the SE ¼ of Section 16, T 22 N, R 20 E on December 16, 1922 as evidenced by a record in the Chelan County Assessor's Office, application numbers 11581 and 13971.

Vegetation *(On Site)*: various grasses, Yarrow, Lupine, Arrowleaf balsamroot, Fir trees, Pine trees, , Oregon Grape, and several unidentified species

Local: Shrub Steppe/Montane **Regional:** Sage Steppe

Landforms *(On Site)*: mass wasting near vertical intrusive bedrock outcrop; foot slope

Local: glacial valley, river valleys, erosional scouring from Pleistocene flooding, mass wasting events; mining in historic period

Water Resources *(Type)*: **ephemeral** creek/stream **Distance:** 2,200 ft. S

Permanence: ephemeral

Method of Collection(s): N/A

Location of Artifacts *(Temporary/Permanent)*: N/A

ISOLATE AGE

Component: Historic-era **Dates:** 1922 **Dating Method:** application for ROW

Phase: N/A **Basis for Phase Designation:** N/A

ISOLATE RECORDERS

Observed by: Wm. Schroeder, M.S. **Address:** 805 E 5th Ave., Ellensburg, WA

Date Recorded: 11-27-2012

Recorded by *(Professional Archaeologist)***:** Wm. Schroeder, M.S.

Affiliation: Reiss-Landreau Research **Affiliation Phone Number:** 509-952-5130

Affiliation Address: PO Box 2215 Yakima, WA 98907

Affiliation E-mail: chrislandreau@charter.net

Date Revisited: **Revisited By:**

ISOLATE HISTORY

Previous Work *(Done on Area Where Isolate was Found)***:** none

LAND OWNERSHIP

Owner: City of Wenatchee

Address: PO Box 519. Wenatchee, WA 98807-0519

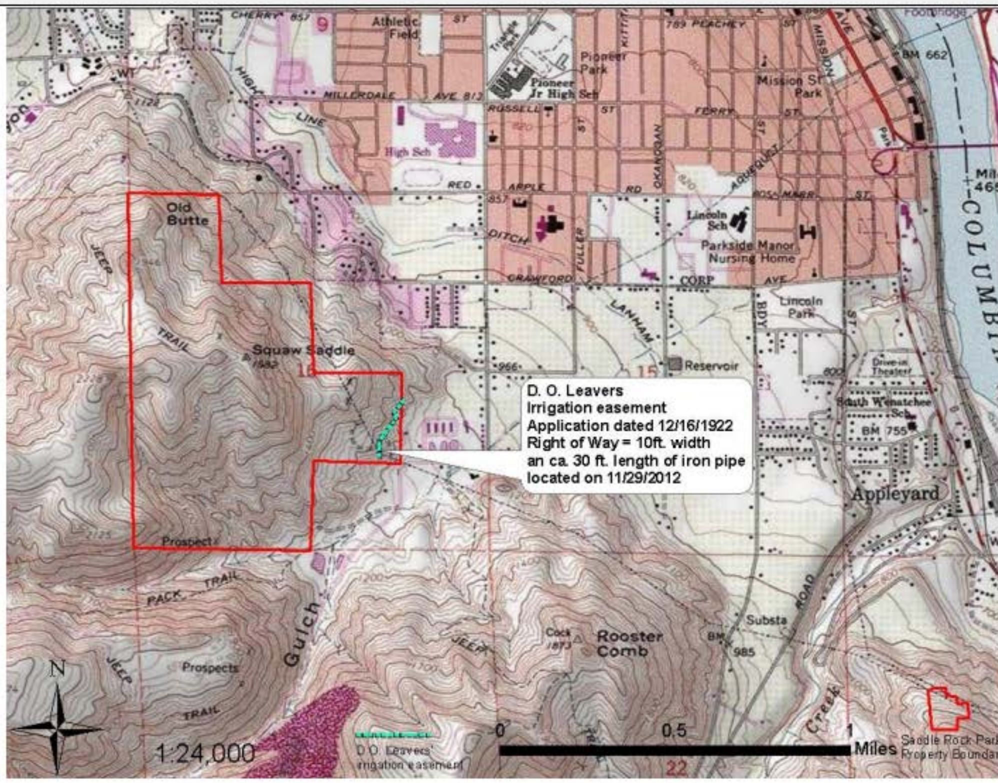
Tax Lot/ Parcel No: 222016300000 Property ID: 57419

RESEARCH REFERENCES

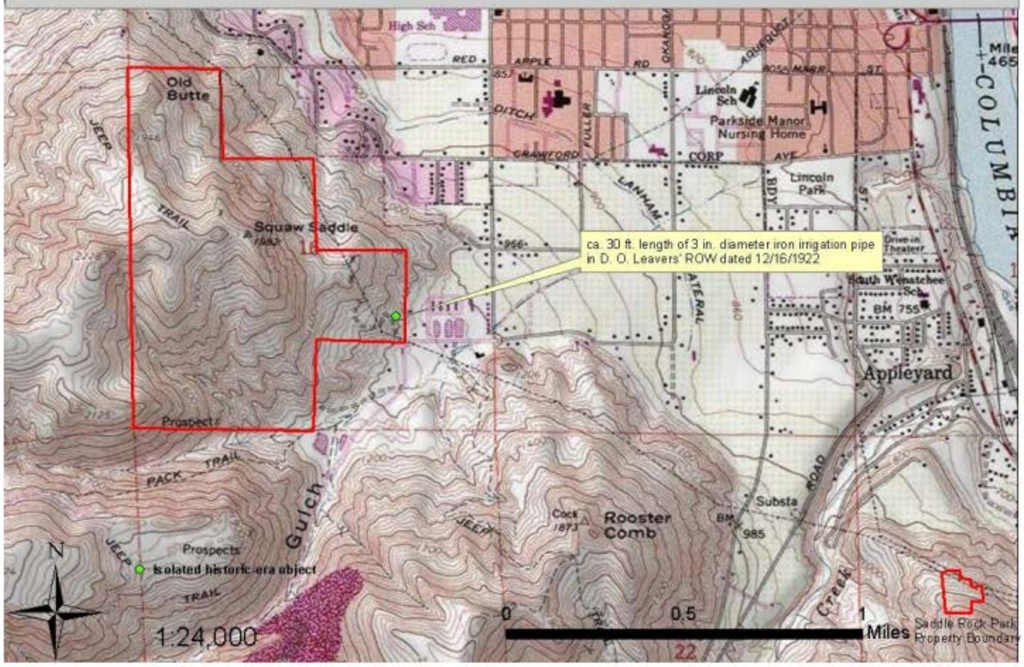
Chelan County Assessor's Office. General Index.

ARCHAEOLOGICAL ISOLATE INVENTORY FORM Smithsonian Number: ______________

USGS MAP



Saddle Rock Additional Land Use Actions 1940-1962
from Chelan County General Index



ARCHAEOLOGICAL ISOLATE INVENTORY FORM Smithsonian Number: ____________

PHOTOGRAPH(S)

Length of iron irrigation pipe, formerly used by D. O. Leavers ca. 1922.

STATE OF WASHINGTON
ARCHAEOLOGICAL SITE INVENTORY FORM

Smithsonian Number:
County: Chelan

Date: 12/27/2012 **Compiler:** Wm. Schroeder, M.S.
Location Information Restrictions: no **Human Remains?** ☐

SITE DESIGNATION

Site Name: Saddle Rock Mine Prospect #1
Field/ Temporary ID: SR1
Site Type(s): Historic Mining Property

SITE LOCATION

USGS Quad Map Name(s): Wenatchee USGS 7.5'
Legal Description: T 22 N R 20 E Section(s): 16
Quarter Section(s): NW ¼ SE ¼
UTM: Zone 10 Easting 0701508 **Northing** 5252746
Latitude: 47° 23' 49.218" N **Longitude:** 120° 19' 46.359" W **Elevation (ft/m): 1,100 ft./335m**
Other Maps: **Type:**
Scale: **Source:**
Drainage, Major: Columbia River **Drainage, Minor: Dry Gulch** **River Mile:** 465
Aspect: SE/NW **Slope:** 0-50% varies

Location Description *(General to Specific)*:): In the NW ¼ of the SE ¼ Section 16, T 22 N, R 20 E, in the Saddle Rock Park, City of Wenatchee, WA, at the first rock outcrop north of the park entrance is an upper area and a lower area where the trail divides. This site comprises all of the rock outcrop and a ca. 15m buffer around the site.

Directions *(For Relocation Purposes)*: From Downtown Wenatchee at the Chelan County Court House, take Okanogan Ave. south 1.7 miles to Circle St. Take Circle St. left (west) 0.1 miles to the intersection of Circle St. and S. Miller St. Park in the parking lot/entrance. From the entrance, this isolated historic-era find is approximately 500 ft. north and slightly off the path near an outcrop of bedrock in a treed area.

SITE DESCRIPTION

Narrative Description: This site may be characterized as a historic-era mining prospect with at least one attempted mine entrance. Saddle Rock 1 (SR1) is the first and nearest historic-era mining claim within Saddle Rock Park from the main entrance on Circle St. It is located ca. 500 ft. NNW of the entrance. Chelan County General Index records trace this mining claim or prospect to either the Squaw Saddle Mining & Milling Company's (SSMMC) Keegan #4 Lode, a placer mining claim under the name Charles Robert Browne, or both. A cavity in the exposed bedrock, backfilled with rocky debris, and rock debris piles within a ca. 240 ft. (ca. 49,000 ft^2) diameter circular area around a rock outcrop define the site.

Site Dimensions:

Length: 240 ft **Direction:** E/W x **Width:** 240 ft. **Direction:** N/S

Method of Horizontal Measurement: pace

Depth: N/A **Method of Vertical Measurement:** N/A

Vegetation *(On Site)***:** various grasses, Yarrow, Lupine, Arrowleaf balsamroot, Fir trees, Pine trees, , Oregon Grape, and several unidentified species

Local: Shrub Steppe/Montane **Regional:** Sage Steppe

Landforms *(On Site)***:** mass wasting near vertical intrusive bedrock outcrop; foot slope

Local: glacial valley, river valleys, erosional scouring from Pleistocene flooding, mass wasting events; mining in historic period

Water Resources *(Type)***: ephemeral** creek/stream **Distance: :** 1,100 ft. S

Permanence: ephemeral

CULTURAL MATERIALS AND FEATURES

Narrative Description: Saddle Rock 1 (SR1) is the first and nearest historic-era mining claim within Saddle Rock Park from the main entrance on Circle St. It is located ca. 500 ft. NNW of the entrance. Chelan County General Index records trace this mining claim or prospect to either the Squaw Saddle Mining & Milling Company's (SSMMC) Keegan #4 Lode, a placer mining claim under the name Charles Robert Browne, or both. A cavity in the exposed bedrock, backfilled with rocky debris, and rock debris piles within a ca. 240 ft. (ca. 49,000 ft^2) diameter circular area around a rock outcrop define the site.

Method of Collection: N/A

Location of Artifacts *(Temporary/Permanent)*: N/A

SITE AGE

Component: historic era **Dates:** 1908 **Dating Method:** Chelan Co. Assessor's Office records

Phase: N/A **Basis for Phase Designation:** N/A

SITE RECORDERS

Observed by: Wm. Schroeder, M. S. **Address:** 805 E 5th Ave. Ellensburg, WA

Date Recorded: 11/28 and 12/14/2012

Recorded by: Wm. Schroeder, M.S.

Organization: Reiss-Landreau Research **Organization Phone Number:** 509-952-5130

Organization Address: PO Box 2215 Yakima, WA 98907

Organization E-mail: chrislandreau@charter.net

Date Revisited: **Revisited By:**

SITE HISTORY

Previous Archaeological Work *(Done at Site)***:** none

LAND OWNERSHIP

Owner: City of Wenatchee

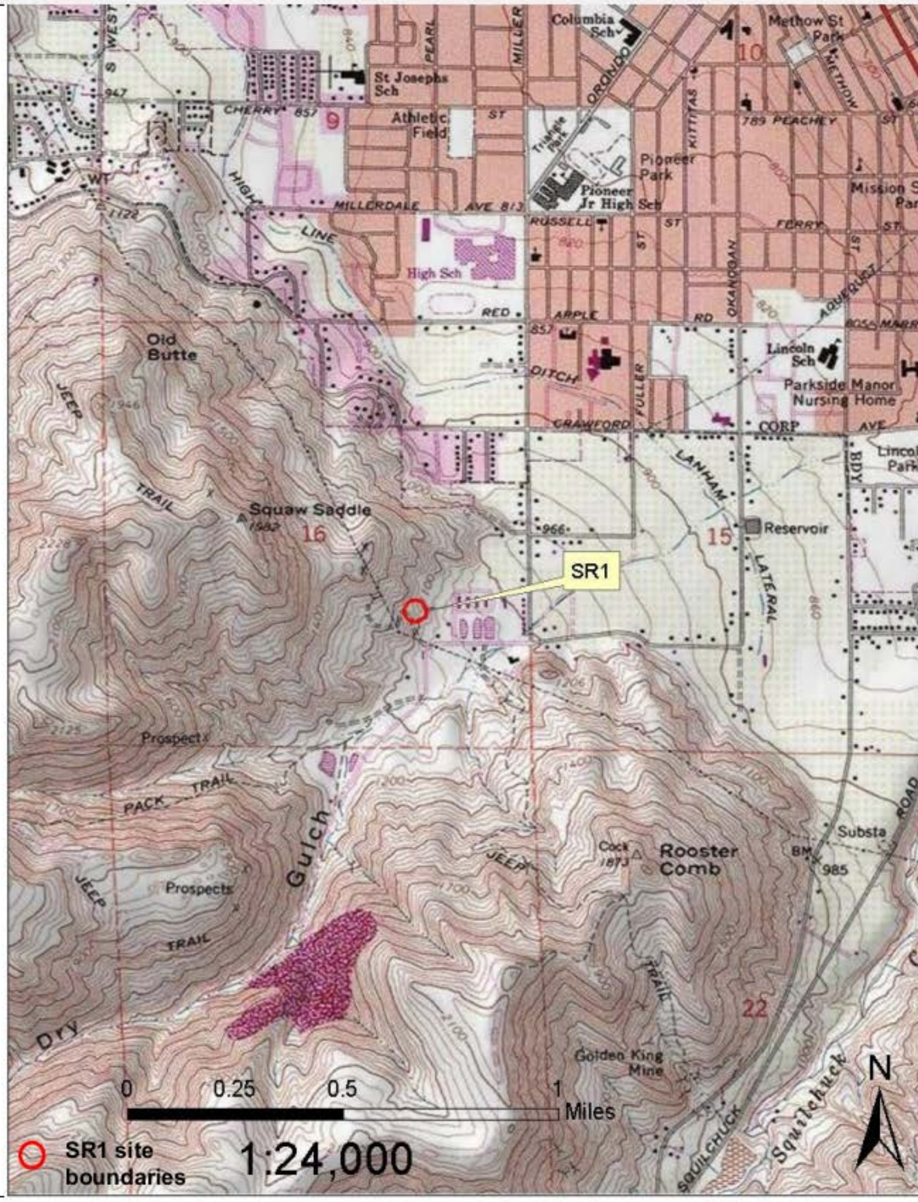
Address: PO Box 519. Wenatchee, WA 98807-0519

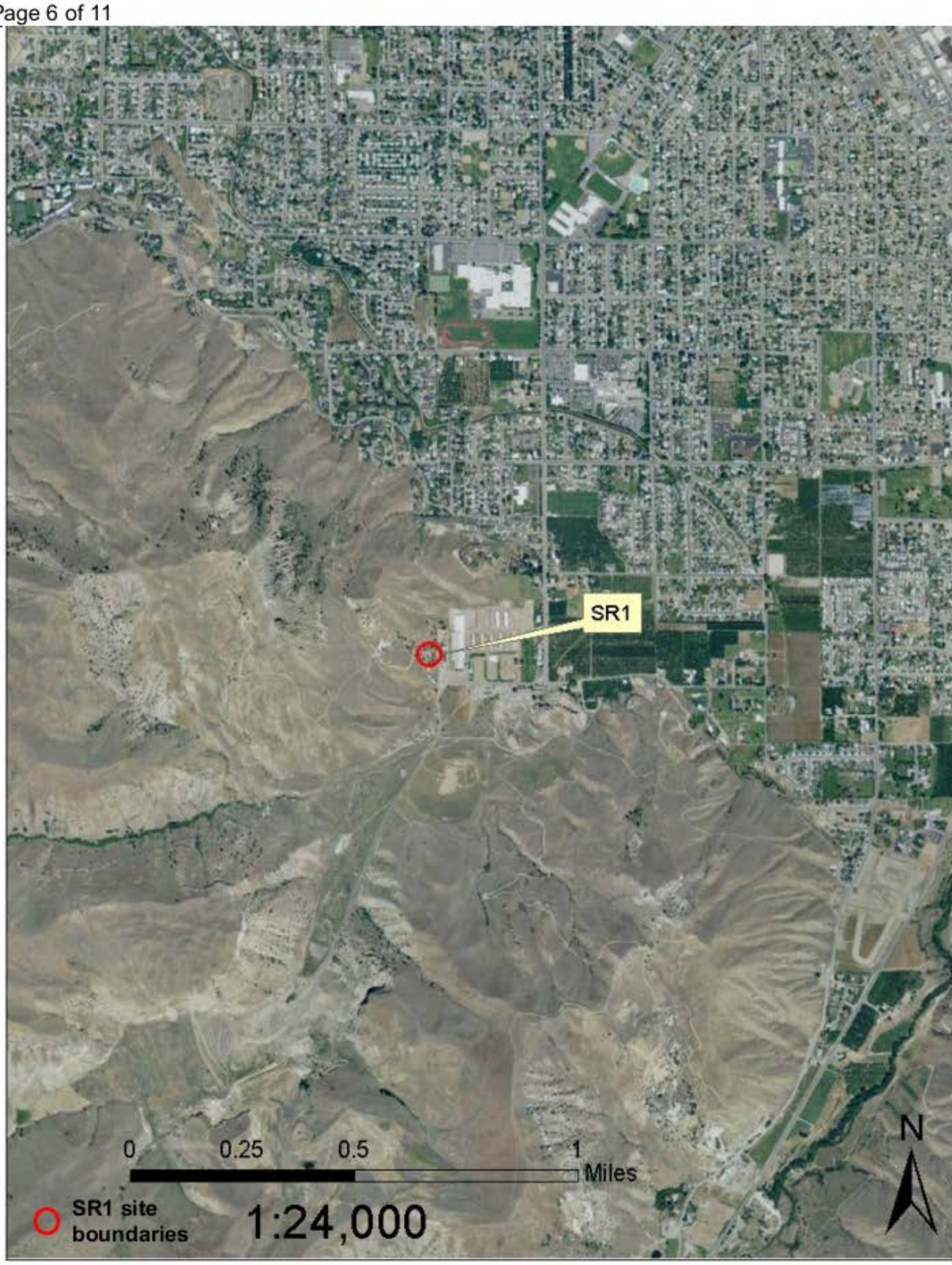
Tax Lot/ Parcel No: 222016300000 Property ID: 57419

RESEARCH REFERENCES

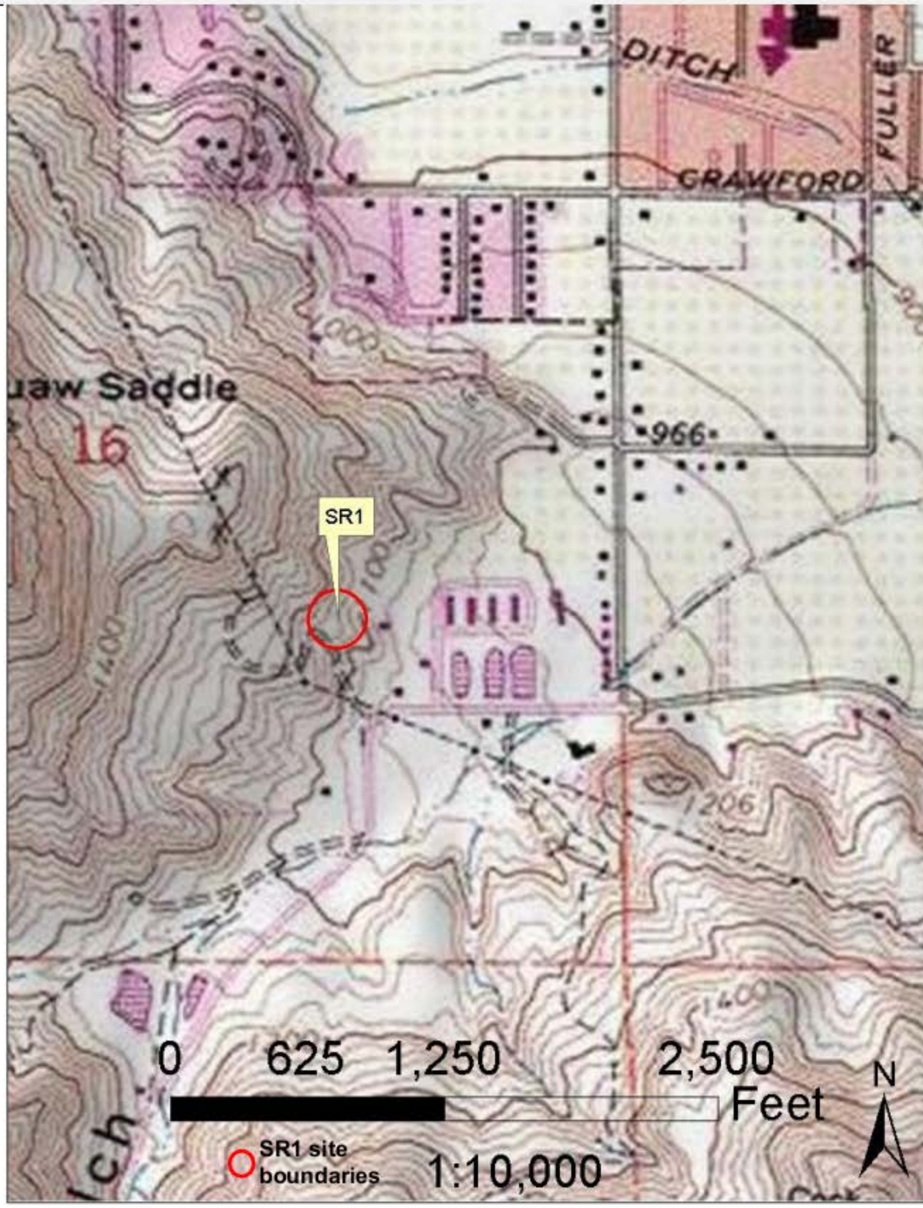
Items/Documents Used In Research *(Specify)***:** Chelan County Assessor's Office General Index

USGS MAP


SR1
Old Butte
Squaw Saddle
Rooster Comb
Golden King Mine
Reservoir
Lincoln Sch
Parkside Manor Nursing Home
Pioneer Jr High Sch
High Sch
St Josephs Sch
Columbia Sch
Prospects
Gulch
0
0.25
0.5
1
Miles
N
SR1 site boundaries
1:24,000


SR1
0
0.25
0.5
1
Miles
SR1 site boundaries
1:24,000
N

SKETCH MAP


DITCH
FULLER
CRAWFORD
900
1000
uaw Saddle
16
966
SR1
1400
1206
0
625
1,250
2,500
Feet
N
SR1 site boundaries
1:10,000

PHOTOGRAPH(S)

Photograph Description(s):

SR1 bedrock outcrop and possible trench (flume?).

Cavity in back dirt/spoils at base of rock outcrop with wooden debris.

Wooden debris in back dirt/spoils at base of rock outcrop.

Rocky debris/spoils? Between upper trail and lower trail area.

Lower trail area where people gather; lower entrance to site.

STATE OF WASHINGTON
ARCHAEOLOGICAL SITE INVENTORY FORM

Smithsonian Number:
County: Chelan

Date: 12/27/2012 **Compiler:** Wm. Schroeder, M.S.
Location Information Restrictions *(Yes/No/Unknown)*: no **Human Remains?** ☐

SITE DESIGNATION

Site Name: Saddle Rock Mine Prospect #2
Field/ Temporary ID: SR2
Site Type(s): Historic Mining Property

SITE LOCATION

USGS Quad Map Name(s): Wenatchee USGS 7.5'
Legal Description: T 22 N R 20 E Section(s): 16
Quarter Section(s): NW ¼ SE ¼
UTM: Zone 10 Easting 0701291 **Northing** 5252874
Latitude: 47° 23' 53.602" N **Longitude:** 120° 19' 56.491" W **Elevation (ft/m): 1,360 ft./415m**
Other Maps: **Type:**
Scale: **Source:**
Drainage, Major: Columbia River **Drainage, Minor: Dry Gulch** **River Mile:** 465
Aspect: NE/SW **Slope:** 0-50% varies

Location Description *(General to Specific)*:): In the NW ¼ of the SE ¼ Section 16, T 22 N, R 20 E, in the Saddle Rock Park, City of Wenatchee, WA, at the second rock outcrop north of the park entrance is an upper area and a lower area. This site comprises all of the rock outcrop and a ca. 15m buffer around the site including mining spoils piles which are arranged around the mining prospect.

Directions *(For Relocation Purposes)*: From Downtown Wenatchee at the Chelan County Court House, take Okanogan Ave. south 1.7 miles to Circle St. Take Circle St. left (west) 0.1 miles to the intersection of Circle St. and S. Miller St. Park in the parking lot/entrance. From the entrance, this isolated historic-era find is approximately 800 ft. north and slightly off the path near an outcrop of bedrock in a treed area.

SITE DESCRIPTION

Narrative Description: This site may be characterized as a historic-era mining prospect with at least one attempted mine entrance. Saddle Rock 2 (SR2) is the second historic-era mining claim within Saddle Rock Park from the main entrance on Circle St. It is located ca. 800 ft. NW of the main entrance along the main foot trail. Chelan County General Index records trace this mining claim or prospect to either the Squaw Saddle Mining & Milling Company's (SSMMC) Keegan #4 Lode, a placer mining claim under the name Charles Robert Browne, or both, though it is more likely a part of the SSMMC's Keegan #4 Lode given the amount of rocky debris surrounding the center of the site and the number of years the SSMMC was in operation. Indeed, a segment of narrow gage rail is exposed in one tailings pile and various-sized lumber is exposed in another tailings pile at the base of the bedrock outcrop near a small cavity within the site boundaries. This site measures ca. 200 ft. SW/NE by ca. 150 ft. SE/NW and is oval in shape with a bedrock outcrop in the middle.

Site Dimensions:

Length: 200 ft **Direction:** E/W x **Width:** 150 ft. **Direction:** N/S

Method of Horizontal Measurement: pace

Depth: N/A **Method of Vertical Measurement:** N/A

Vegetation *(On Site)*: various grasses, Yarrow, Lupine, Arrowleaf balsamroot, Fir trees, Pine trees, , Oregon Grape, and several unidentified species

Local: Shrub Steppe/Montane **Regional:** Sage Steppe

Landforms *(On Site)*: mass wasting near vertical intrusive bedrock outcrop; foot slope

Local: glacial valley, river valleys, erosional scouring from Pleistocene flooding, mass wasting events; mining in historic period

Water Resources *(Type)*: **ephemeral** creek/stream **Distance:** : 1,450 ft. S

Permanence: ephemeral

CULTURAL MATERIALS AND FEATURES

Narrative Description: This site may be characterized as a historic-era mining prospect with at least one attempted mine entrance. Saddle Rock 2 (SR2) is the second historic-era mining claim within Saddle Rock Park from the main entrance on Circle St. It is located ca. 800 ft. NW of the main entrance along the main foot trail. Chelan County General Index records trace this mining claim or prospect to either the Squaw Saddle Mining & Milling Company's (SSMMC) Keegan #4 Lode, a placer mining claim under the name Charles Robert Browne, or both, though it is more likely a part of the SSMMC's Keegan #4 Lode given the amount of rocky debris surrounding the center of the site and the number of years the SSMMC was in operation. Indeed, a segment of narrow gage rail is exposed in one tailings pile and various-sized lumber is exposed in another tailings pile at the base of the bedrock outcrop near a small cavity within the site boundaries. This site measures ca. 200 ft. SW/NE by ca. 150 ft. SE/NW and is oval in shape with a bedrock outcrop in the middle.

Method of Collection: N/A

Location of Artifacts *(Temporary/Permanent)*: N/A

SITE AGE

Component: historic era **Dates:** 1908 **Dating Method:** Chelan Co. Assessor's Office records

Phase: N/A **Basis for Phase Designation:** N/A

SITE RECORDERS

Observed by: Wm. Schroeder, M. S. **Address:** 805 E 5th Ave. Ellensburg, WA

Date Recorded: 11/28 and 12/14/2012

Recorded by: Wm. Schroeder, M.S.

Organization: Reiss-Landreau Research **Organization Phone Number:** 509-952-5130

Organization Address: PO Box 2215 Yakima, WA 98907

Organization E-mail: chrislandreau@charter.net

Date Revisited: **Revisited By:**

SITE HISTORY

Previous Archaeological Work *(Done at Site)***:** none

LAND OWNERSHIP

Owner: City of Wenatchee

Address: PO Box 519. Wenatchee, WA 98807-0519

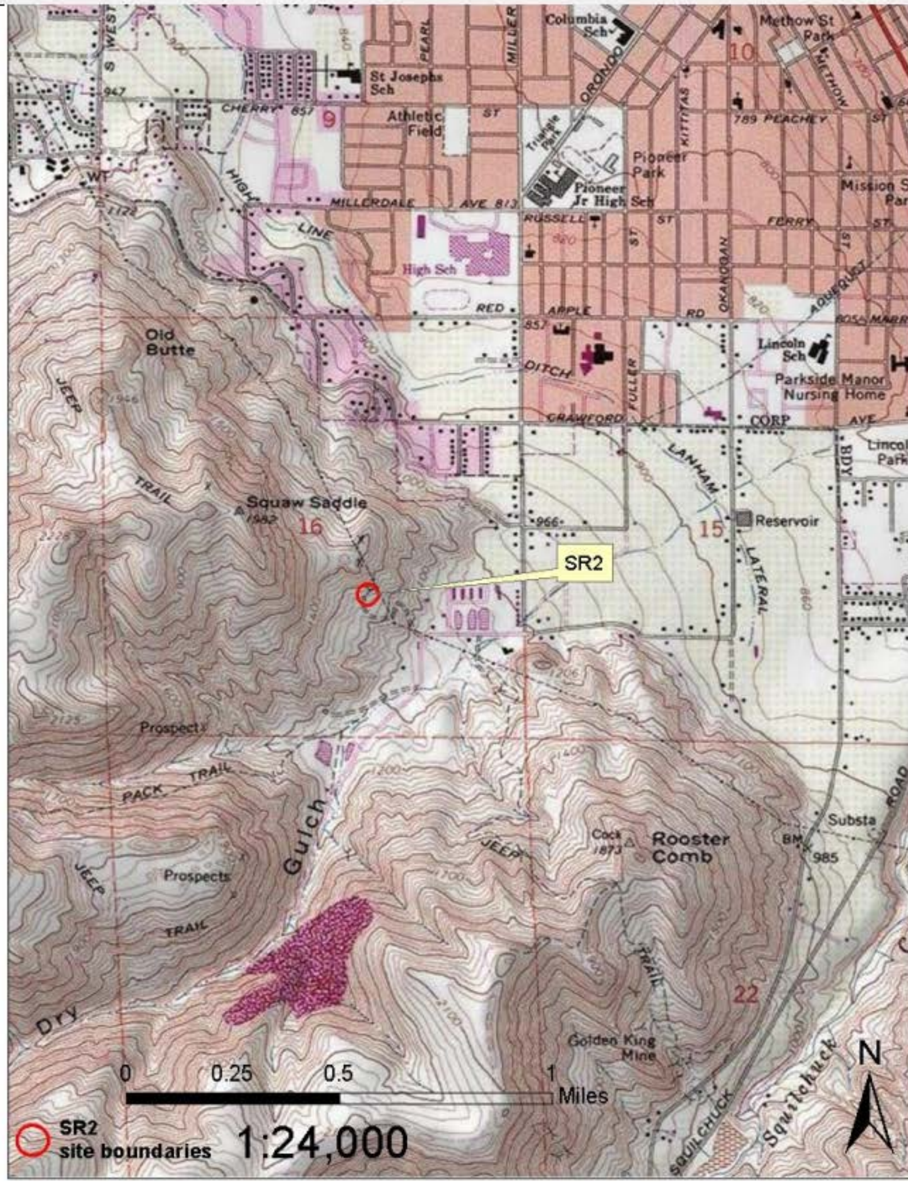
Tax Lot/ Parcel No: 222016300000 Property ID: 57419

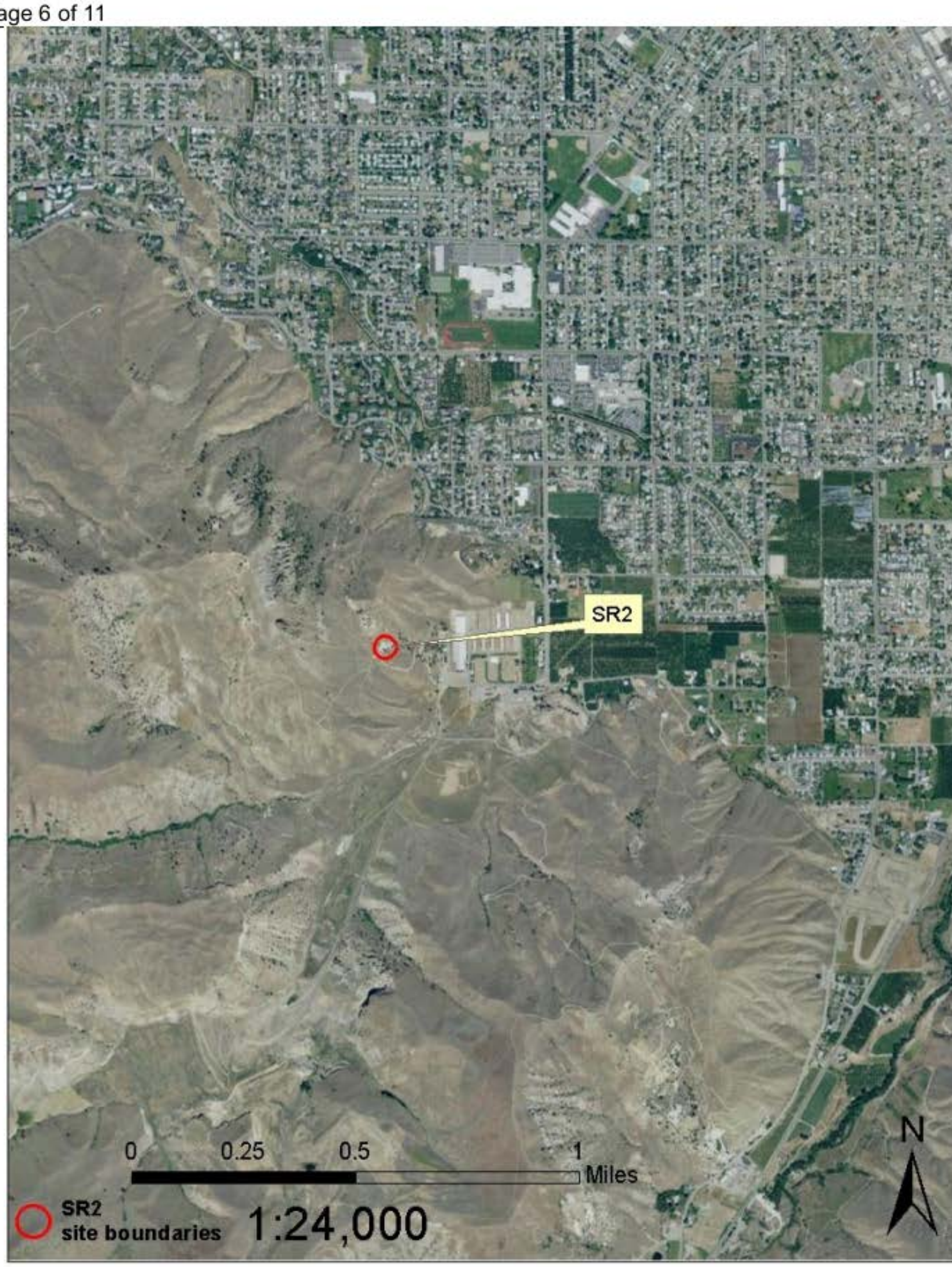
RESEARCH REFERENCES

Items/Documents Used In Research *(Specify)***:** Chelan County Assessor's Office General Index

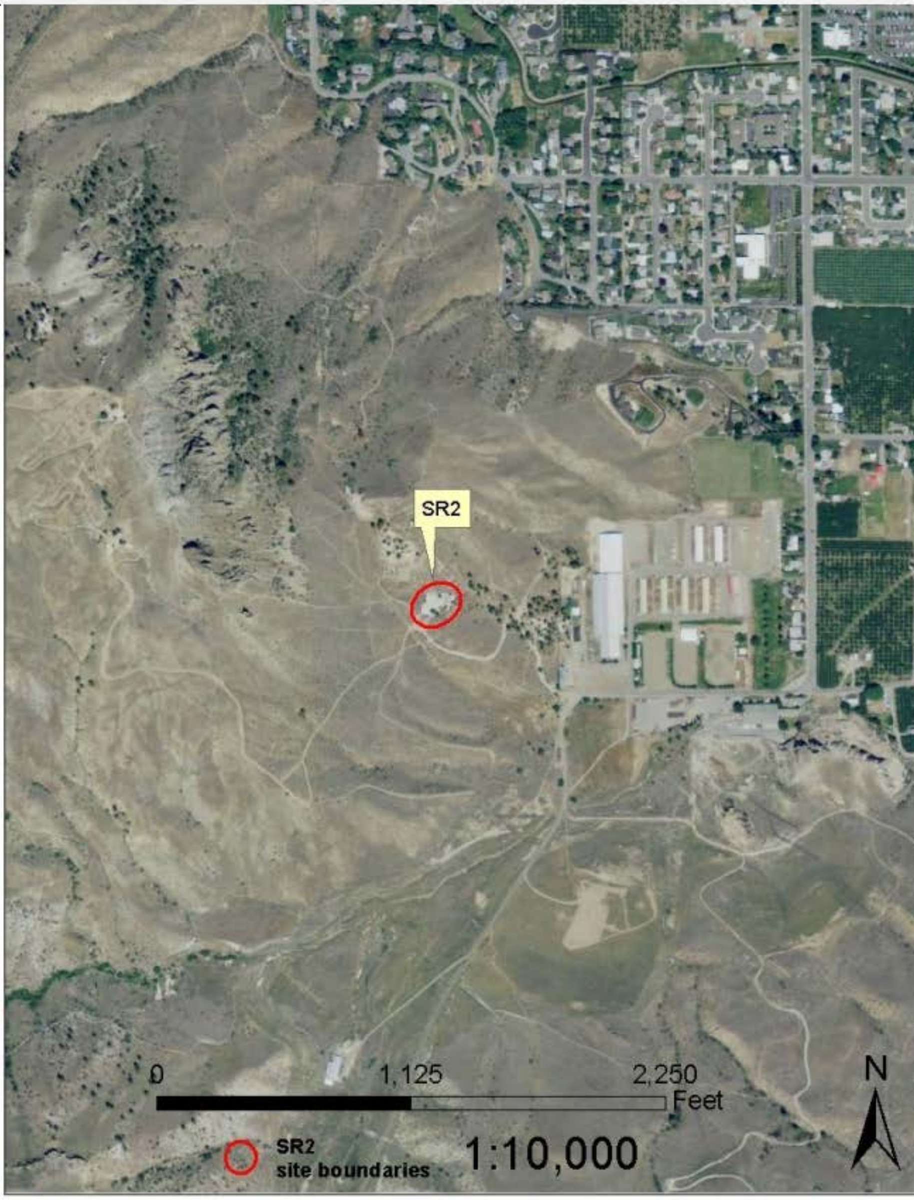
ARCHAEOLOGICAL SITE INVENTORY FORM Smithsonian Number: ____________

USGS MAP




SR2
0
0.25
0.5
1
Miles
N
SR2
site boundaries
1:24,000

SKETCH MAP



PHOTOGRAPH(S)

Photograph Description(s):

Concrete filled prospect in rock outcrop.

Possible back dirt/spoils pile.

Spoils pile outside prospect, Aspect SW.

Spoils pile outside prospect, Aspect NE.

Narrow gauge rail in spoils/backdirt pile outside of prospect; Aspect NW.

Mining prospect.

Possible blasting tubes from 1957 on top of rock outcrop.

CONTINUATION/ ADDENDUM SHEET
Label all additional pages by corresponding headings. *(e.g. Site Description, Site History, Research References)*

STATE OF WASHINGTON
ARCHAEOLOGICAL SITE INVENTORY FORM

Smithsonian Number:
County: Chelan

Date: 12/27/2012 **Compiler:** Wm. Schroeder, M.S.

Location Information Restrictions *(Yes/No/Unknown)*: no **Human Remains?** ☐

SITE DESIGNATION

Site Name: Saddle Rock Mine Prospect #3

Field/ Temporary ID: SR3

Site Type(s): Historic Mining Property

SITE LOCATION

USGS Quad Map Name(s): Wenatchee USGS 7.5'

Legal Description: T 22 N R 20 E Section(s): 16

Quarter Section(s): NW ¼ SE ¼

UTM: Zone 10 Easting 0701194 **Northing** 5253002

Latitude: 47° 23' 57.851" N **Longitude:** 120° 20' 0.905" W **Elevation (ft/m): 1,420 ft./433m**

Other Maps: **Type:**

Scale: **Source:**

Drainage, Major: Columbia River **Drainage, Minor: Dry Gulch** **River Mile:** 465

Aspect: SE/NW **Slope:** 0-50% varies

Location Description *(General to Specific)*:): In the NW ¼ of the SE ¼ Section 16, T 22 N, R 20 E, in the Saddle Rock Park, City of Wenatchee, WA, at the third rock outcrop north of the park entrance is an upper area and a second area, like a lazy figure 8, lies to the NW of the main site locus. This site comprises all of the rock outcrop, mine tailings piles, and a ca. 15m buffer around the site.

Directions *(For Relocation Purposes)*: From Downtown Wenatchee at the Chelan County Court House, take Okanogan Ave. south 1.7 miles to Circle St. Take Circle St. left (west) 0.1 miles to the intersection of Circle St. and S. Miller St. Park in the parking lot/entrance. From the entrance, this isolated historic-era find is approximately 1,150 ft. north and slightly off the path near an outcrop of bedrock in a treed area.

SITE DESCRIPTION

Narrative Description: Saddle Rock 3 (SR3) is the next nearest historic-era mining claim within Saddle Rock Park from the main entrance on Circle St. It is located ca. 1,150 ft. NW of the main entrance along the main foot trail. Chelan County General Index records trace this mining claim or prospect to either the Squaw Saddle Mining & Milling Company's (SSMMC) Keegan #4 Lode, a placer mining claim under the name Charles Robert Browne, or both, though it is more likely a part of the SSMMC's Keegan #4 Lode given the amount of rocky debris surrounding the center of the site and the number of years the SSMMC was in operation. This site measures ca. 180 ft. SW/NE by ca. 500 ft. SE/NW and is a "lazy 8" in shape with the long axis being SE/NW-oriented with bedrock outcrops in the middle. For Department of Ecology concerns, only the northwesternmost portion of the SR3 archaeological site was tested for arsenic; for DAHP concerns, the entire 90,000 ft^2 (2 acre 2,880 ft^2) area should be considered an archaeological site.

Site Dimensions:

Length: 500 ft **Direction:** SE/NW x **Width:** 180 ft. **Direction:** SW/NE

Method of Horizontal Measurement: pace

Depth: N/A **Method of Vertical Measurement:** N/A

Vegetation *(On Site)***:** various grasses, Yarrow, Lupine, Arrowleaf balsamroot, Fir trees, Pine trees, , Oregon Grape, and several unidentified species

Local: Shrub Steppe/Montane **Regional:** Sage Steppe

Landforms *(On Site)***:** mass wasting near vertical intrusive bedrock outcrop; foot slope

Local: glacial valley, river valleys, erosional scouring from Pleistocene flooding, mass wasting events; mining in historic period

Water Resources *(Type)***: ephemeral** creek/stream **Distance: :** 2,200 ft. S

Permanence: ephemeral

CULTURAL MATERIALS AND FEATURES

Narrative Description: Saddle Rock 3 (SR3) is the third nearest historic-era mining claim within Saddle Rock Park from the main entrance on Circle St. It is located ca. 1,150 ft. NW of the main entrance along the main foot trail. Chelan County General Index records trace this mining claim or prospect to either the Squaw Saddle Mining & Milling Company's (SSMMC) Keegan #4 Lode, a placer mining claim under the name Charles Robert Browne, or both, though it is more likely a part of the SSMMC's Keegan #4 Lode given the amount of rocky debris surrounding the center of the site and the number of years the SSMMC was in operation. This site measures ca. 180 ft. SW/NE by ca. 500 ft. SE/NW and is a "lazy 8" in shape with the long axis being SE/NW-oriented with bedrock outcrops in the middle. For Department of Ecology concerns, only the northwesternmost portion of the SR3 archaeological site was tested for arsenic; for DAHP concerns, the entire 90,000 ft^2 (2 acre 2,880 ft^2) area should be considered an archaeological site.

Method of Collection: N/A

Location of Artifacts *(Temporary/Permanent)*: N/A

SITE AGE

Component: historic era **Dates:** 1908 **Dating Method:** Chelan Co. Assessor's Office records

Phase: N/A **Basis for Phase Designation:** N/A

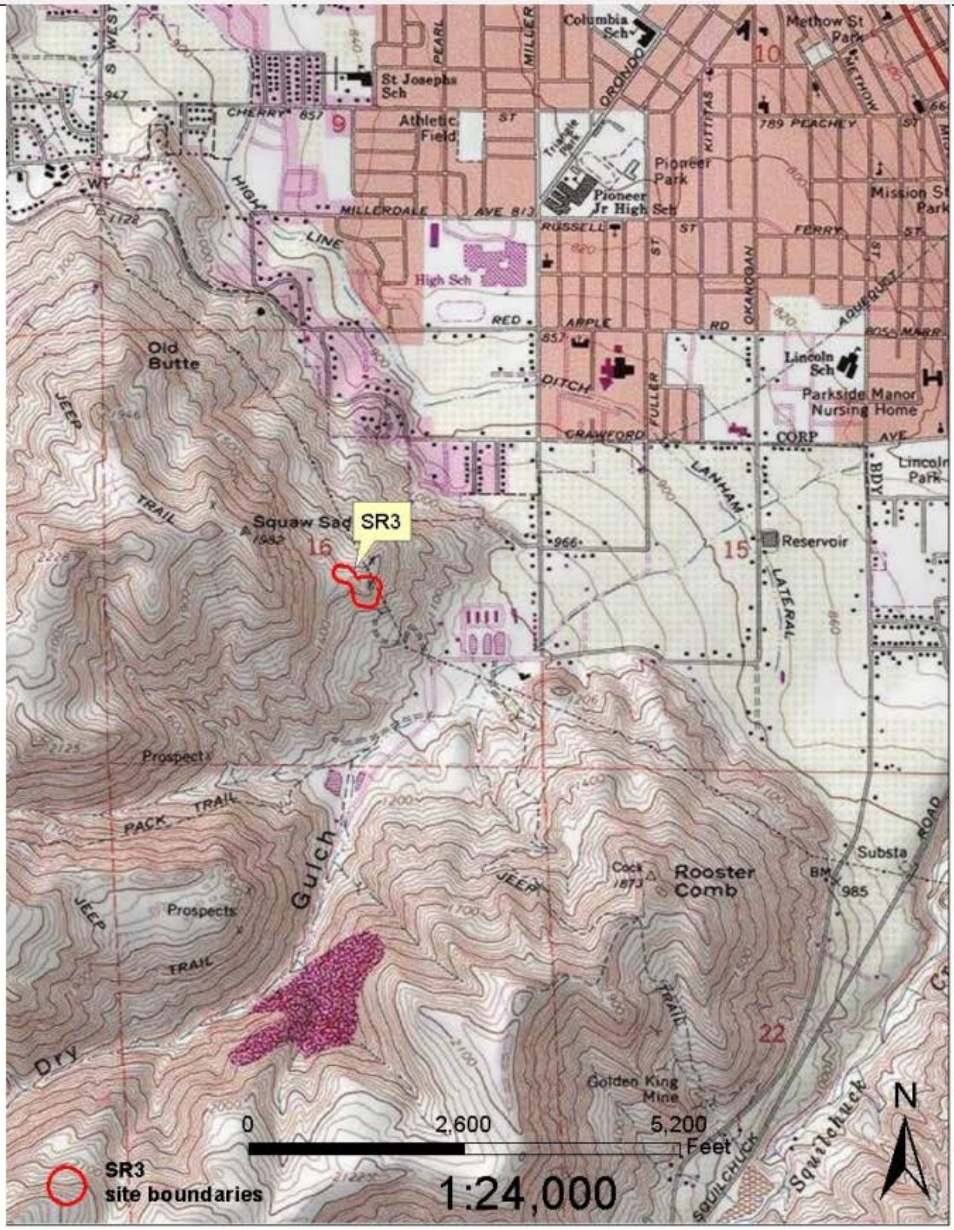
SITE RECORDERS	
Observed by: Wm. Schroeder, M. S.	**Address:** 805 E 5th Ave. Ellensburg, WA
Date Recorded: 11/28 and 12/14/2012	
Recorded by: Wm. Schroeder, M.S.	
Organization: Reiss-Landreau Research	**Organization Phone Number:** 509-952-5130
Organization Address: PO Box 2215 Yakima, WA 98907	
Organization E-mail: chrislandreau@charter.net	
Date Revisited:	**Revisited By:**

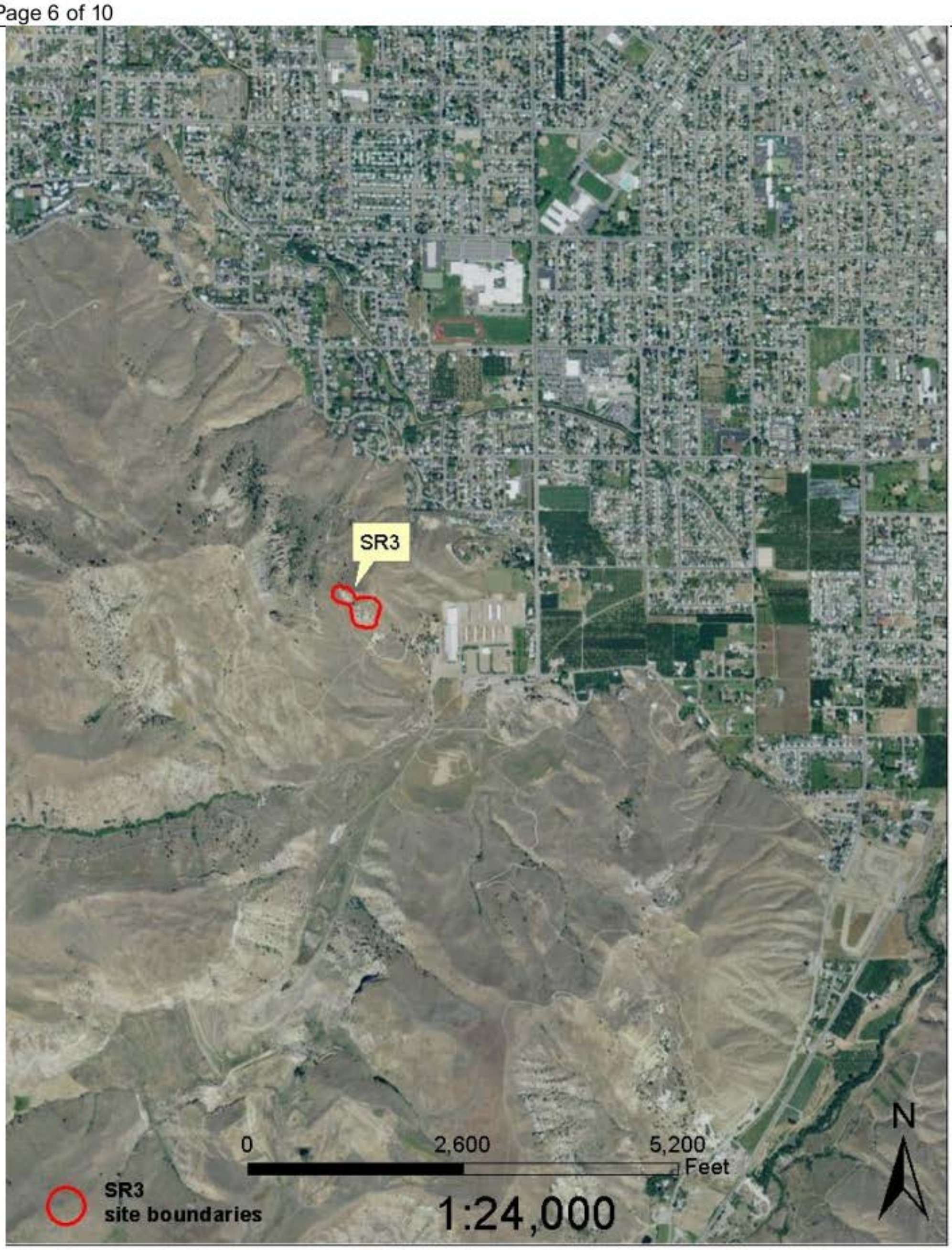
SITE HISTORY
Previous Archaeological Work *(Done at Site)***:** none

LAND OWNERSHIP
Owner: City of Wenatchee
Address: PO Box 519. Wenatchee, WA 98807-0519
Tax Lot/ Parcel No: 222016300000 Property ID: 57419

RESEARCH REFERENCES
Items/Documents Used In Research *(Specify)***:** Chelan County Assessor's Office General Index

USGS MAP


SR3
Squaw Saddle
Old Butte
Rooster Comb
Gulch
Dry
Prospects
Prospect
PACK TRAIL
JEEP TRAIL
Golden King Mine
Squilchuck
Reservoir
Lincoln Sch
Parkside Manor Nursing Home
Pioneer Park
Pioneer Jr High Sch
High Sch
St Josephs Sch
Athletic Field
Columbia Sch
Methow St Park
Mission St Park
Lincoln Park
Substa
0
2,600
5,200
Feet
N
SR3
site boundaries
1:24,000


SR3
0
2,600
5,200
Feet
SR3
site boundaries
1:24,000
N

SKETCH MAP

PHOTOGRAPH(S)

Photograph Description(s):

Possible tailings/spoils pile outside prospect.

Spoils/tailings pile, Aspect ESE.

Spoils/tailings, Aspect SW.

Spoils/tailings on saddle; Aspect NNW.

STATE OF WASHINGTON
ARCHAEOLOGICAL SITE INVENTORY FORM

Smithsonian Number:
County: Chelan

Date: 12/27/2012 **Compiler:** Wm. Schroeder, M.S.
Location Information Restrictions *(Yes/No/Unknown)*: no **Human Remains?** ☐

SITE DESIGNATION

Site Name: Saddle Rock Mine Prospect #4—The "Little Wonder" Lode
Field/ Temporary ID: SR4
Site Type(s): Historic Mining Property

SITE LOCATION

USGS Quad Map Name(s): Wenatchee USGS 7.5'
Legal Description: T 22 N R 20 E Section(s): 16
Quarter Section(s): NW ¼ SE ¼
UTM: Zone 10 Easting 0700483 **Northing** 5253561
Latitude: 47° 24' 16.729" N **Longitude:** 120° 20' 33.880" W **Elevation (ft/m): 1,760 ft./542m**

Other Maps: **Type:**
Scale: **Source:**
Drainage, Major: Columbia River **Drainage, Minor: Dry Gulch** **River Mile:** 465
Aspect: NE/SW **Slope:** 0-50% varies

Location Description *(General to Specific)*:): In the NW ¼ of the NW ¼ Section 16, T 22 N, R 20 E, in the Saddle Rock Park, City of Wenatchee, WA, at the bottom of a steep trail in a meadow-like clearing is a rock outcrop. This site is centered around the rock outcrop. This site comprises all of the rock outcrop and a ca. 15m buffer around the site.

Directions *(For Relocation Purposes)*: From Downtown Wenatchee at the Chelan County Court House, take Okanogan Ave. south 1.7 miles to Circle St. Take Circle St. left (west) 0.1 miles to the intersection of Circle St. and S. Miller St. Park in the parking lot/entrance. From the entrance, this isolated historic-era find is approximately 4,250 ft. north and slightly off the path near an outcrop of bedrock in a meadow-like area.

SITE DESCRIPTION

Narrative Description: Saddle Rock 4 (SR4) is the furthest historic-era mining claim within Saddle Rock Park from the entrance visited for the purposes of this investigation. It is located ca. 4,250 ft. NW of the main entrance and beyond the main foot trail. Chelan County General Index records trace this mining claim or prospect to either Martin Keegan's "Little Wonder" Lode, an Indenture and Prospecting Lease given to J. J. Keegan from the State of Washington, or both, though it is more likely a part of the "Little Wonder" Lode given the amount of rocky debris surrounding the center of the site and the number of years the SSMMC was in operation. The Notice of Location reads as follows:

> The NE corner is 3,953 ft S 78° 54' W of NE corner of Section 16, T 22 N, R 20 E. Commencing 350 ft N 4° 56' W, thence 300 ft. W to NW corner, thence 1, 500 ft S 4 ° 56' E to SW corner, thence 300 ft E to South Center, thence 300 ft E to SW corner, thence 1,500 ft N 4° 56' W to NE corner, thence 300 ft W to North Center.

J. J. Keegan's Indenture and Prospecting Lease goes as follows:

> N ½ of NW ¼ of Section 16, containing 80 acres +/-; the NE ¼ NW ¼ has been sold by the State and the permittee herein may not enter upon the land until a waiver has been secured from the owner thereof…for 2 years of prospecting…may cut and use timber on said premises for fuel and construction thereon of building required in the operation of any mine on said premises and drains, tramways, and supports of said mines but for no other purpose; cannot remove more than 5 tons of ore therefrom for assaying and testing purposes, shall remove no ore for any other purpose within 60 days of the expiration of this lease.

This site measures ca. 200 ft. SW/NE by ca. 150 ft. SE/NW and is ovoid in shape with the long axis being SW/NE-oriented with a weathered bedrock outcrop in the middle. For Department of Ecology concerns, the northeasternmost portion of the SR4 archaeological site tested strongly for arsenic along a SW/NE axis; for DAHP concerns, the entire 30,000 ft^2 area should be considered an archaeological site as should a linear excavated feature ca. 300 ft. SSE of the SR4 site locus. This trench-like feature is on the hill slope to the SE of SR4 ca. 360 ft. It is approximately 30 ft. wide by ca. 100 ft. long and is up to 10 ft. in height at the NE end where rock and soil is piled highest. It may represent the southern boundary of the "Little Wonder" claim and will be considered part of the SR4 site boundaries.

Site Dimensions:

Length: 200 ft **Direction:** NE/SW x **Width:** 150 ft. **Direction:** NW/SE

Method of Horizontal Measurement: pace

Depth: N/A **Method of Vertical Measurement:** N/A

Vegetation *(On Site)***:** various grasses, Yarrow, Lupine, Arrowleaf balsamroot, Fir trees, Pine trees, , Oregon Grape, and several unidentified species

Local: Shrub Steppe/Montane **Regional:** Sage Steppe

Landforms *(On Site)***:** mass wasting near vertical intrusive bedrock outcrop; foot slope

Local: glacial valley, river valleys, erosional scouring from Pleistocene flooding, mass wasting events; mining in historic period

Water Resources *(Type)***: ephemeral** creek/stream **Distance: :** 6,600 ft. S **Permanence:** ephemeral

CULTURAL MATERIALS AND FEATURES

Narrative Description: Saddle Rock 4 (SR4) is the furthest historic-era mining claim within Saddle Rock Park from the entrance visited for the purposes of this investigation. It is located ca. 4,250 ft. NW of the main entrance and beyond the main foot trail. Chelan County General Index records trace this mining claim or prospect to either Martin Keegan's "Little Wonder" Lode, an Indenture and Prospecting Lease given to J. J. Keegan from the State of Washington, or both, though it is more likely a part of the "Little Wonder" Lode given the amount of rocky debris surrounding the center of the site and the number of years the SSMMC was in operation. The Notice of Location reads as follows:

> The NE corner is 3,953 ft S 78° 54' W of NE corner of Section 16, T 22 N, R 20 E. Commencing 350 ft N 4° 56' W, thence 300 ft. W to NW corner, thence 1, 500 ft S 4 ° 56' E to SW corner, thence 300 ft E to South Center, thence 300 ft E to SW corner, thence 1,500 ft N 4° 56' W to NE corner, thence 300 ft W to North Center.

The "Little Wonder" Lode was discovered on 8/1908 and filed for record 1/11/1910.

J. J. Keegan's 12/16/1952 Indenture and 2/10/1954 Prospecting Lease go as follows:

> N ½ of NW ¼ of Section 16, containing 80 acres +/-; the NE ¼ NW ¼ has been sold by the State and the permittee herein may not enter upon the land until a waiver has been secured from the owner thereof…for 2 years of prospecting…may cut and use timber on said premises for fuel and construction thereon of building required in the operation of any mine on said premises and drains, tramways, and supports of said mines but for no other purpose; cannot remove more than 5 tons of ore therefrom for assaying and testing purposes, shall remove no ore for any other purpose within 60 days of the expiration of this lease.

This site measures ca. 200 ft. SW/NE by ca. 150 ft. SE/NW and is ovoid in shape with the long axis being SW/NE-oriented with a weathered bedrock outcrop in the middle. For Department of Ecology concerns, the northeasternmost portion of the SR4 archaeological site tested strongly for arsenic along a SW/NE axis; for DAHP concerns, the entire 30,000 ft^2 area should be considered an archaeological site as should a linear excavated feature ca. 300 ft. SSE of the SR4 site locus. This trench-like feature is on the hill slope to the SE of SR4 ca. 360 ft. It is approximately 30 ft. wide by ca. 100 ft. long and is up to 10 ft. in height at the NE end where rock and soil is piled highest. It may represent the southern boundary of the "Little Wonder" claim and will be considered part of the SR4 site boundaries.

Method of Collection: N/A

Location of Artifacts *(Temporary/Permanent)*: N/A

SITE AGE

Component: historic era **Dates: 1909-1910,** 1952 and 1954 **Dating Method:** Chelan Co. Assessor's Office records

Phase: N/A **Basis for Phase Designation:** N/A

SITE RECORDERS

Observed by: Wm. Schroeder, M. S. **Address:** 805 E 5th Ave. Ellensburg, WA

Date Recorded: 11/28 and 12/14/2012

Recorded by: Wm. Schroeder, M.S.

Organization: Reiss-Landreau Research **Organization Phone Number:** 509-952-5130

Organization Address: PO Box 2215 Yakima, WA 98907

Organization E-mail: chrislandreau@charter.net

Date Revisited: **Revisited By:**

SITE HISTORY

Previous Archaeological Work *(Done at Site)*: none

LAND OWNERSHIP

Owner: City of Wenatchee

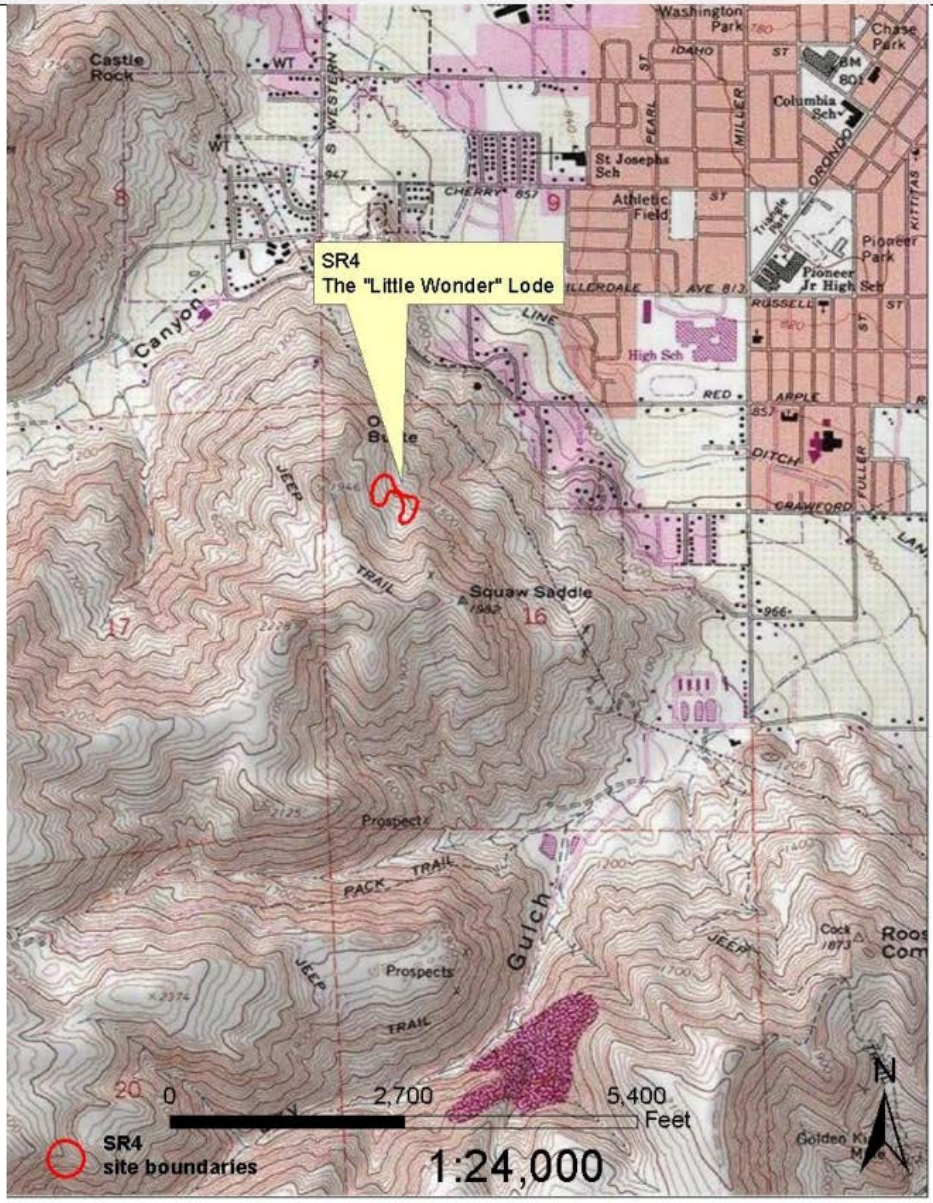
Address: PO Box 519. Wenatchee, WA 98807-0519

Tax Lot/ Parcel No: 222016300000 Property ID: 57419

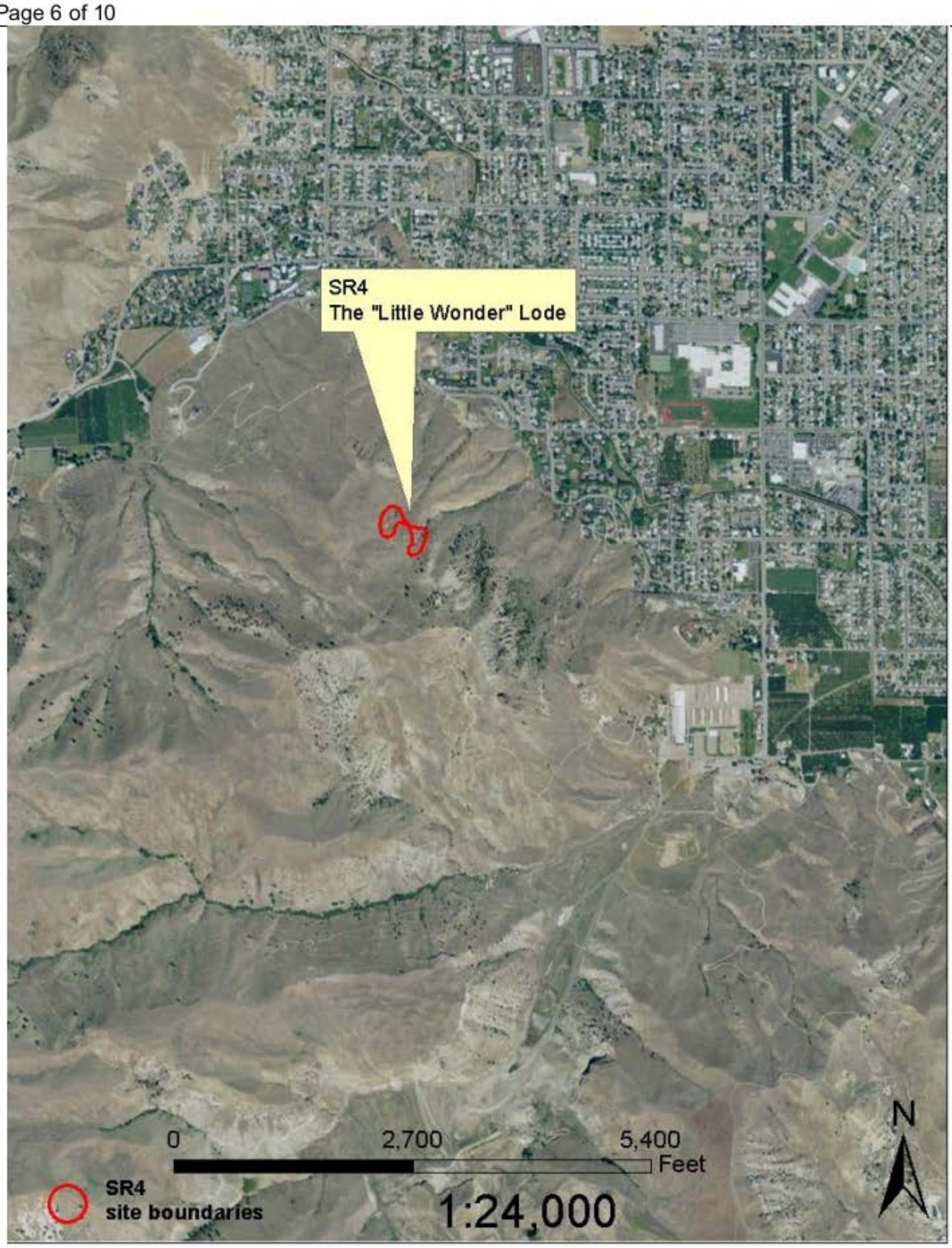
RESEARCH REFERENCES

Items/Documents Used In Research *(Specify)*: Chelan County Assessor's Office General Index

USGS MAP


SR4
The "Little Wonder" Lode
Castle Rock
Canyon
Squaw Saddle
Prospect
PACK TRAIL
Prospects
TRAIL
JEEP
Gulch
Washington Park
Chase Park
Columbia Sch
St Josephs Sch
Athletic Field
Pioneer Park
Pioneer Jr High Sch
High Sch
0
2,700
5,400
Feet
SR4
site boundaries
1:24,000
N

ARCHAEOLOGICAL SITE INVENTORY FORM Smithsonian Number: ______________



SKETCH MAP


SR4
The "Little Wonder" Lode
0
1,125
2,250
Feet
N
SR4
site boundaries
1:10,000

PHOTOGRAPH(S)

Photograph Description(s):

Collapsed collar/adit; The "Little Wonder" Lode, Aspect NW.

Mining spoils/back dirt pile near prospect opening.

Collar/adit opening under rock outcrop in middle of site boundaries.

Aspect S from The "Little Wonder" Lode location.

Aspect E looking at ca. 100 ft.-long linear feature; ostensibly the mining claim south boundary.

CONTINUATION/ ADDENDUM SHEET
Label all additional pages by corresponding headings. *(e.g. Site Description, Site History, Research References)*

STATE OF WASHINGTON
ARCHAEOLOGICAL SITE INVENTORY FORM

Smithsonian Number:
County: Chelan

Date: 12/27/2012 **Compiler:** Wm. Schroeder, M.S.
Location Information Restrictions *(Yes/No/Unknown)*: no **Human Remains?** ☐

SITE DESIGNATION

Site Name: Saddle Rock Mine Prospect #5—The "Shamrock" Lode
Field/ Temporary ID: SR5
Site Type(s): Historic Mining Property

SITE LOCATION

USGS Quad Map Name(s): Wenatchee USGS 7.5'
Legal Description: T 22 N R 20 E Section(s): 16
Quarter Section(s): NW ¼ SE ¼
UTM: Zone 10 Easting 0700641 **Northing** 5253292
Latitude: 47° 24' 7.850" N **Longitude:** 47° 24' 7.850" N **Elevation (ft/m): 1,880 ft./573m**
Other Maps: **Type:**
Scale: **Source:**
Drainage, Major: Columbia River **Drainage, Minor: Dry Gulch** **River Mile:** 465
Aspect: SE/NW **Slope:** 0-50% varies

Location Description *(General to Specific)*:): In the SW ¼ of the NW ¼ Section 16, T 22 N, R 20 E, in the Saddle Rock Park, City of Wenatchee, WA, at the top of the trail system near the crest of Saddle Rock, in an upper area and a lower area where the trail ends. This site comprises all of the rock outcrop and a ca. 15m buffer around the site.

Directions *(For Relocation Purposes)*: From Downtown Wenatchee at the Chelan County Court House, take Okanogan Ave. south 1.7 miles to Circle St. Take Circle St. left (west) 0.1 miles to the intersection of Circle St. and S. Miller St. Park in the parking lot/entrance. From the entrance, this isolated historic-era find is approximately 4,760 ft. northwest and adjacent to the path near an outcrop of bedrock in a treed area.

Narrative Description: Saddle Rock 5 (SR5) is located ca. 3,290 ft. northwest of the main entrance to Saddle Rock Park on Circle St. SR5 appears as a road cut on the SW slope of Saddle Rock until one notices that the material on either side of the road or trail is composed of mine tailings and debris. Based on Chelan County mining records, this property can be linked to the Squaw Saddle Mining & Milling Company (SSMMC) "Shamrock" Lode. Patrick Heley and Thomas Keegan are listed as the original locators on 5/24/1908 and filed for record on 1/11/1909. The SSMMC Notice of Location for this mining lode goes as follows:

> Post No.1, located 4,203 ft S 63° 45' W of NE corner of Section 16, T 22 N, R 20 E. Commencing at this discovery post, being 300 ft N 52° E to post No. 2, thence 300 S 38° E to post No. 3, thence 1.500 ft S 52° W to post No. 4, thence 300 ft. N 38° W to post No. 5, thence 300 ft. N 38° W to Post No. 6, thence1,500 ft N 52° E to post No.1, thence S 38° E to post No. 2.

Additionally, The SSMMC filed a Deed and an Indenture with the State of Washington on 3/18 and 4/29, 1910 respectively. Therein, a Notice of Location gave the SSMMC permission for 30 years:

> The E ½ SW ¼ Section 16, T 22 N, R 20 E, 80 acres +/- which premises are leased to the second party for no other purpose than the purpose of exploring for, mining, taking out and removing therefrom the merchantable shipping or containing copper, lead, silver, gold, gypsum, and other valuable metals or minerals, except coal…and use the timber found upon said premises for fuel and for the construction of buildings required in the operation of mines on the premises…drains, tramways, and supports for such mines, provided however State of WA reserves the right to terminate.

Later, long after the 30 years had expired for the previous Deed, James A O'Connor filed a Real Estate Contract with the State of Washington, a Contract for Mining, and an Indenture in 1962 for a term of 20 years starting 3/7/1961 for the:

> N ½ of SW ¼ Section 16, T 22 N, R 20 E, 80 acres +/-; permitted to build roads, remove ore except coal, cut and use timber.

It appears likely that the SSMMC is responsible for the mining spoils piles near SR5, but it is also possible that J. A. O'Connor contributed to the mining spoils piles within the historic period. Nonetheless, the site measures ca. 200 ft. E/W by ca. 180 ft. N/S in an oval-shaped area containing ca. 36,000 ft^2. For DOE concerns, the site was tested for arsenic and the highest concentrations were discovered within SR5 site boundaries in the SW portion. For DAHP concerns, given the number of years the SSMMC was in operation and the similarity to the weathering of bedrock exposed and general orientation of mining spoils near the site locus, the entire 36,000 ft^2 area is considered one historic-era archaeological site by RLR.

Site Dimensions:

Length: 200 ft **Direction:** E/W x **Width:** 180 ft. **Direction:** N/S
Method of Horizontal Measurement: pace
Depth: N/A **Method of Vertical Measurement:** N/A

Vegetation *(On Site)***:** various grasses, Yarrow, Lupine, Arrowleaf balsamroot, Fir trees, Pine trees, , Oregon Grape, and several unidentified species
Local: Shrub Steppe/Montane **Regional:** Sage Steppe
Landforms *(On Site)***:** mass wasting near vertical intrusive bedrock outcrop; foot slope
Local: glacial valley, river valleys, erosional scouring from Pleistocene flooding, mass wasting events; mining in historic period
Water Resources *(Type)***: ephemeral** creek/stream **Distance: :** 5,000 ft. S

Permanence: ephemeral

CULTURAL MATERIALS AND FEATURES

Narrative Description: Saddle Rock 5 (SR5) is located ca. 3,290 ft. northwest of the main entrance to Saddle Rock Park on Circle St. SR5 appears as a road cut on the SW slope of Saddle Rock until one notices that the material on either side of the road or trail is composed of mine tailings and debris. Based on Chelan County mining records, this property can be linked to the SSMMC "Shamrock" Lode. Patrick Heley and Thomas Keegan are listed as the original locators on 5/24/1908 and filed for record on 1/11/1909. The SSMMC Notice of Location for this mining lode goes as follows:

> Post No.1, located 4,203 ft S 63° 45' W of NE corner of Section 16, T 22 N, R 20 E. Commencing at this discovery post, being 300 ft N 52° E to post No. 2, thence 300 S 38° E to post No. 3, thence 1.500 ft S 52° W to post No. 4, thence 300 ft. N 38° W to post No. 5, thence 300 ft. N 38° W to Post No. 6, thence1,500 ft N 52° E to post No.1, thence S 38° E to post No. 2.

Additionally, The SSMMC filed a Deed and an Indenture with the State of Washington on 3/18 and 4/29, 1910 respectively. Therein, a Notice of Location gave the SSMMC permission for 30 years:

> The E ½ SW ¼ Section 16, T 22 N, R 20 E, 80 acres +/- which premises are leased to the second party for no other purpose than the purpose of exploring for, mining, taking out and removing therefrom the merchantable shipping or containing copper, lead, silver, gold, gypsum, and other valuable metals or minerals, except coal…and use the timber found upon said premises for fuel and for the construction of buildings required in the operation of mines on the premises…drains, tramways, and supports for such mines, provided however State of WA reserves the right to terminate.

Later, long after the 30 years had expired for the previous Deed, James A O'Connor filed a Real Estate Contract with the State of Washington, a Contract for Mining, and an Indenture in 1962 for a term of 20 years starting 3/7/1961 for the:

> N ½ of SW ¼ Section 16, T 22 N, R 20 E, 80 acres +/-; permitted to build roads, remove ore except coal, cut and use timber.

It appears likely that the SSMMC is responsible for the mining spoils piles near SR5, but it is also possible that J. A. O'Connor contributed to the mining spoils piles within the historic period. Nonetheless, the site measures ca. 200 ft. E/W by ca. 180 ft. N/S in an oval-shaped area containing ca. 36,000 ft^2. For DOE concerns, the site was tested for arsenic and the highest concentrations were discovered within SR5 site boundaries in the SW portion. For DAHP concerns, given the number of years the SSMMC was in operation and the similarity to the weathering of bedrock exposed and general orientation of mining spoils near the site locus, the entire 36,000 ft^2 area is considered one historic-era archaeological site by RLR.

Method of Collection: N/A

Location of Artifacts *(Temporary/Permanent)*: N/A

SITE AGE

Component: historic era **Dates:** 1908 **Dating Method:** Chelan Co. Assessor's Office records

Phase: N/A **Basis for Phase Designation:** N/A

SITE RECORDERS

Observed by: Wm. Schroeder, M. S. **Address:** 805 E 5th Ave. Ellensburg, WA

Date Recorded: 11/28 and 12/14/2012

Recorded by: Wm. Schroeder, M.S.

Organization: Reiss-Landreau Research **Organization Phone Number:** 509-952-5130

Organization Address: PO Box 2215 Yakima, WA 98907

Organization E-mail: chrislandreau@charter.net

Date Revisited: **Revisited By:**

SITE HISTORY

Previous Archaeological Work *(Done at Site)***:** none

LAND OWNERSHIP

Owner: City of Wenatchee

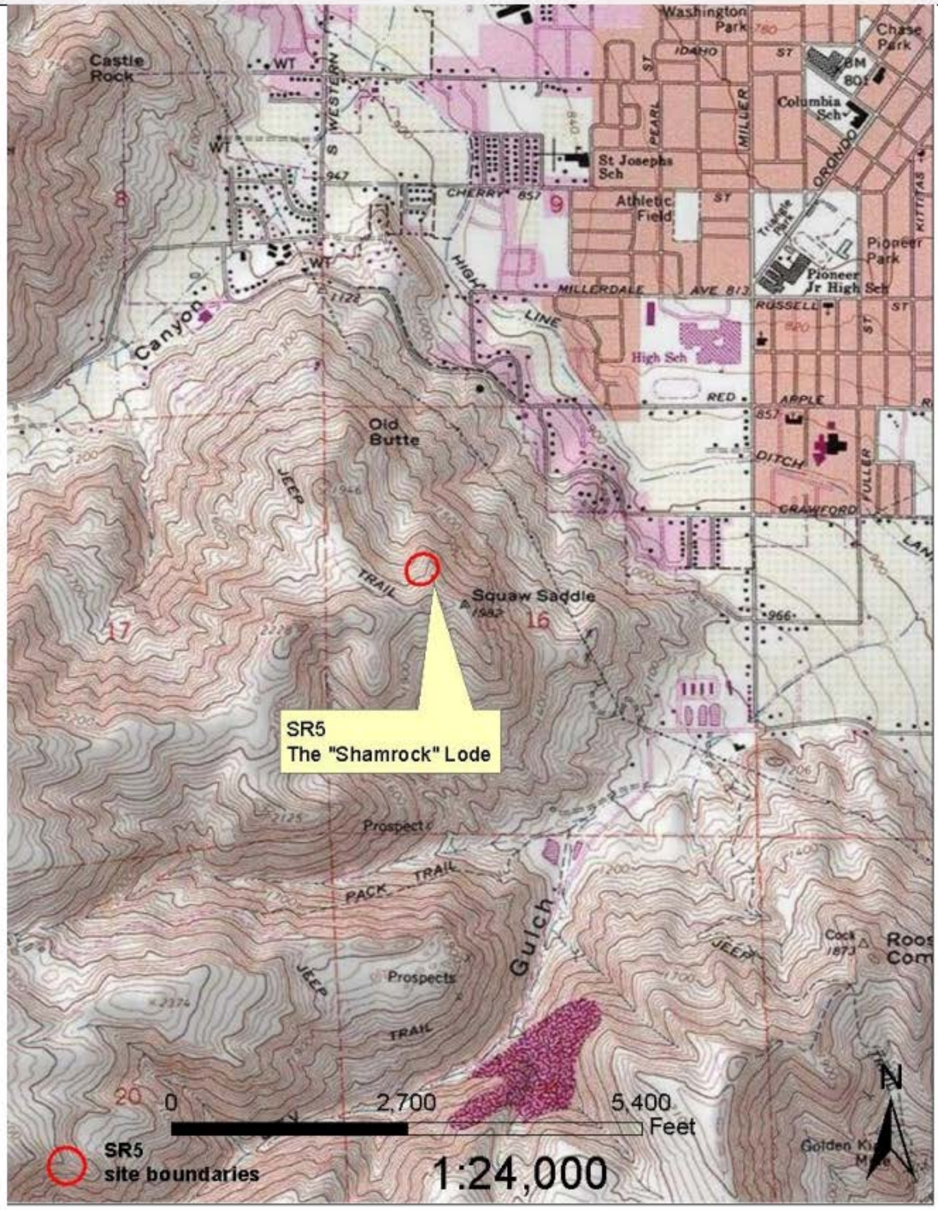
Address: PO Box 519. Wenatchee, WA 98807-0519

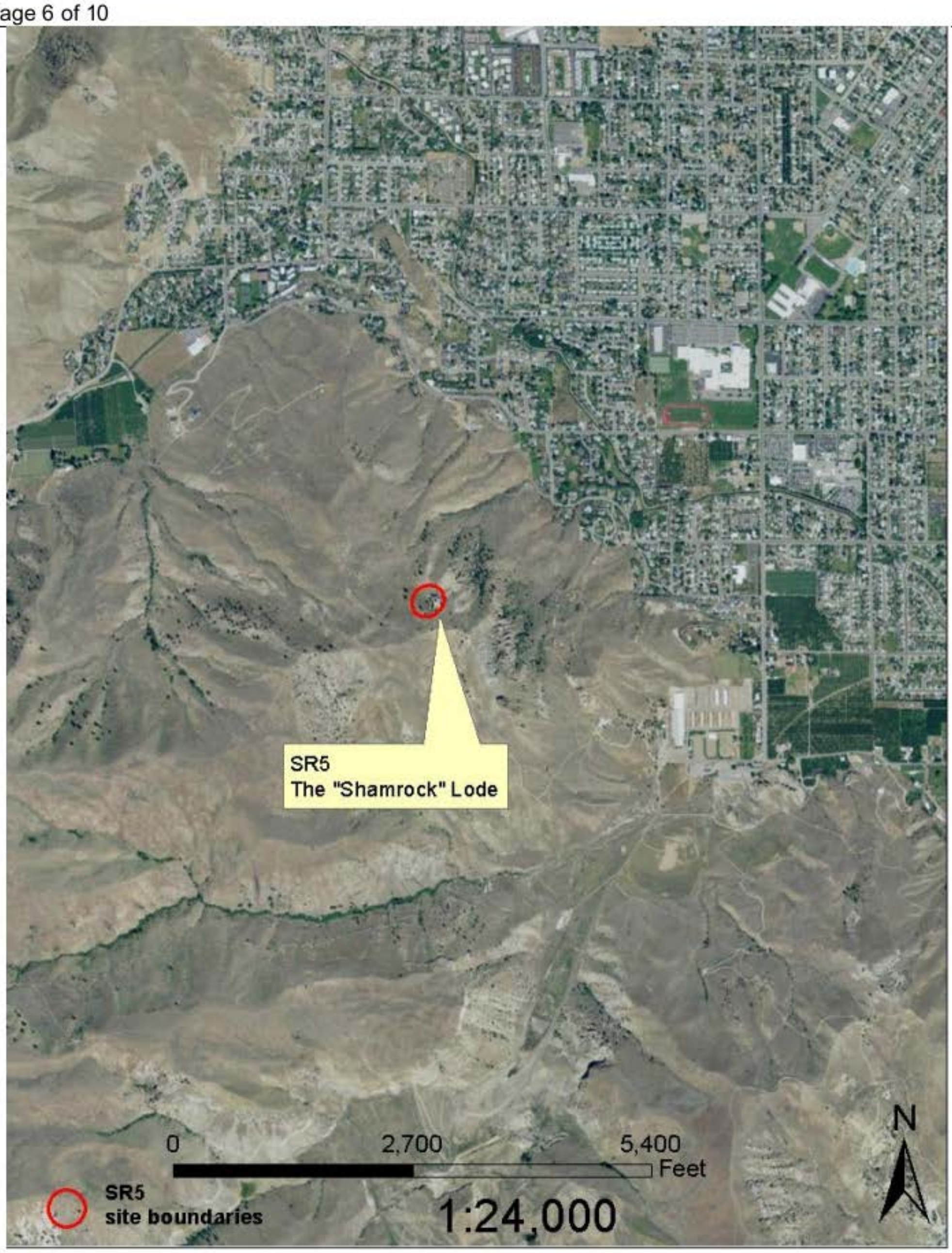
Tax Lot/ Parcel No: 222016300000 Property ID: 57419

RESEARCH REFERENCES

Items/Documents Used In Research *(Specify)***:** Chelan County Assessor's Office General Index

USGS MAP


SR5
The "Shamrock" Lode
Squaw Saddle
Old Butte
Castle Rock
Canyon
Gulch
Prospect
Prospects
PACK TRAIL
JEEP TRAIL
High Sch
Athletic Field
St Josephs Sch
Washington Park
Chase Park
Columbia Sch
Pioneer Park
Pioneer Jr High Sch
0
2,700
5,400
Feet
N
SR5
site boundaries
1:24,000


SR5
The "Shamrock" Lode
0
2,700
5,400
Feet
N
SR5
site boundaries
1:24,000

SKETCH MAP


SR5
The "Shamrock" Lode
0
1,125
2,250
Feet
N
SR5
site boundaries
1:10,000

PHOTOGRAPH(S)

Photograph Description(s):

Tailings/spoils piles, Aspect N from top of ridge.

Mine tailings/spoils distributed along ridge; Aspect E.

Bedrock and tailings exposure on ridge; Aspect SE.

Overview of exposed bedrock and mining spoils piles; Aspect SE.

STATE OF WASHINGTON
ARCHAEOLOGICAL SITE INVENTORY FORM

Smithsonian Number:

County: Chelan

Date: 12/27/2012 **Compiler:** Wm. Schroeder, M.S.

Location Information Restrictions *(Yes/No/Unknown)*: no **Human Remains?** ☐

SITE DESIGNATION

Site Name: Saddle Rock Mine Prospect #6—The "Washington" Lode

Field/ Temporary ID: SR6

Site Type(s): Historic Mining Property

SITE LOCATION

USGS Quad Map Name(s): Wenatchee USGS 7.5'

Legal Description: T 22 N R 20 E Section(s): 16

Quarter Section(s): NW ¼ SE ¼

UTM: Zone 10 Easting 0700771 **Northing** 5253160

Latitude: 47° 24' 3.434" N **Longitude:** 120° 20' 20.807" W **Elevation (ft/m): 1,960 ft./598m**

Other Maps: **Type:**

Scale: **Source:**

Drainage, Major: Columbia River **Drainage, Minor: Dry Gulch** **River Mile:** 465

Aspect: SE/NW **Slope:** 0-50% varies

Location Description *(General to Specific)*: In the SW ¼ of the NW ¼ Section 16, T 22 N, R 20 E, in the Saddle Rock Park, City of Wenatchee, WA. This site is near the crest of Saddle Rock along a foot trail system. This site comprises all of the rock outcrop and a ca. 15m buffer around the site.

Directions *(For Relocation Purposes)*: From Downtown Wenatchee at the Chelan County Court House, take Okanogan Ave. south 1.7 miles to Circle St. Take Circle St. left (west) 0.1 miles to the intersection of Circle St. and S. Miller St. Park in the parking lot/entrance. From the entrance, this isolated historic-era find is approximately 2,700 ft. northwest and slightly off the path near an outcrop of bedrock in a treed area.

SITE DESCRIPTION

Narrative Description: Saddle Rock 6 (SR6) is located ca. 2,730 ft. NW of the Saddle Rock Park entrance on Circle St. This location is characterized by what appears to be a road cut on the SW slope of Saddle Rock, adjacent to a relatively flat trail (road) which effectively dead ends nearby to the NE. Based on Chelan County General Index records, it is most likely that this site is the SSMMC "Washington" Lode. To wit:

> Commencing at this discovery post, being the center of the vein or claim, thence 112 ft N 52° E to a post marked #2, being east center end; thence 300 ft. S 38° E to a post marked #3 (a corner); thence 1.500 ft s 52° W to a post marked #4; 5 being west center and thence 200 ft N 38°W to a post marked #6 (a corner), thence 1,500 ft N 52° E to a post marked #1, thence 300 ft. S 38°E to #2 post, center end. Post #1 being 4,124 ft S 55° W of NE corner of Section 16, on southern slope of Squaw Saddle Mountain, on the SW side of City of Wenatchee, and extends along the SE side of Shamrock Lode.

This site may also be the result of road work performed in 1957 under a Proof of Labor document issued to E. H. Lovitt on 3/11/1957 as the "Public" mine. Mr. Lovitt had seven days to "improve" the land by building roads, cutting timber, and had the permission to blast, but it appears likely that that permission was not used. It seems likely that the main trail and other more substantial and relatively flat trails throughout the southeastern portion of Saddle Rock Park were made under this Proof of Labor in 1957. It is also possible that segments of iron pipe and drill holes in exposed bedrock near SR3 were in preparation to blast the bedrock under the 1957 Proof of Labor, but it is not self-evident that the physical evidence on the ground is proof of any preparations to blast the bedrock. This site does not contain an self-evident mine adit or collar, indeed it is difficult to discern if any formal mining occurred at this locale, though ore-bearing rock may have been removed in the road building process and could have been sent away for processing. Furthermore, the SSMMC had a Notice of Location and permission for 30 years for:

> [t]he E ½ SW ¼ Section 16, T 22 N, R 20 E, 80 acres +/- which premises are leased to the second party for no other purpose than the purpose of exploring for, mining, taking out and removing therefrom the merchantable shipping or containing copper, lead, silver, gold, gypsum, and other valuable metals or minerals, except coal…and use the timber found upon said premises for fuel and for the construction of buildings required in the operation of mines on the premises…drains, tramways, and supports for such mines, provided however State of WA reserves the right to terminate.

In either or both events, the land use actions which ostensibly created the trail or road on the SW face of Saddle Rock occurred in the historic period, therefore this location will be treated as a historic-era mining property archaeological site. For the purposes of DOE, this site was tested for arsenic and higher concentrations were found in the SW portion of the site. The site is defined as an oval-shaped area measuring ca. 200 ft. E/W by 110 ft. N/S and is bisected by a road or trail. For DAHP concerns, given the number of years the SSMMC was in operation and the similarity to the weathering of bedrock exposed near the site locus, the entire 36,000 ft^2 area is considered one historic-era archaeological site—The "Washington" Lode site--by RLR.

Site Dimensions:

Length: 200 ft **Direction:** E/W x **Width:** 110 ft. **Direction:** N/S

Method of Horizontal Measurement: pace

Depth: N/A **Method of Vertical Measurement:** N/A

Vegetation *(On Site)***:** various grasses, Yarrow, Lupine, Arrowleaf balsamroot, Fir trees, Pine trees, , Oregon Grape, and several unidentified species

Local: Shrub Steppe/Montane **Regional:** Sage Steppe

Landforms *(On Site)***:** mass wasting near vertical intrusive bedrock outcrop; foot slope

Local: glacial valley, river valleys, erosional scouring from Pleistocene flooding, mass wasting events; mining in historic period

Water Resources *(Type)***: ephemeral** creek/stream **Distance: :** 3,000 ft. S

Permanence: ephemera

CULTURAL MATERIALS AND FEATURES

Narrative Description: Saddle Rock 6 (SR6) is located ca. 2,730 ft. NW of the Saddle Rock Park entrance on Circle St. This location is characterized by what appears to be a road cut on the SW slope of Saddle Rock, adjacent to a relatively flat trail (road) which effectively dead ends nearby to the NE.

Based on Chelan County General Index records, it is most likely that this site is the SSMMC "Washington" Lode. To wit:

> Commencing at this discovery post, being the center of the vein or claim, thence 112 ft N 52° E to a post marked #2, being east center end; thence 300 ft. S 38° E to a post marked #3 (a corner); thence 1.500 ft s 52° W to a post marked #4; 5 being west center and thence 200 ft N 38°W to a post marked #6 (a corner), thence 1,500 ft N 52° E to a post marked #1, thence 300 ft. S 38°E to #2 post, center end. Post #1 being 4,124 ft S 55° W of NE corner of Section 16, on southern slope of Squaw Saddle Mountain, on the SW side of City of Wenatchee, and extends along the SE side of Shamrock Lode.

This site may also be the result of road work performed in 1957 under a Proof of Labor document issued to E. H. Lovitt on 3/11/1957 as the "Public" mine. Mr. Lovitt had seven days to "improve" the land by building roads, cutting timber, and had the permission to blast, but it appears likely that that permission was not used. It seems likely that the main trail and other more substantial and relatively flat trails throughout the southeastern portion of Saddle Rock Park were made under this Proof of Labor in 1957. It is also possible that segments of iron pipe and drill holes in exposed bedrock near SR3 were in preparation to blast the bedrock under the 1957 Proof of Labor, but it is not self-evident that the physical evidence on the ground is proof of any preparations to blast the bedrock. This site does not contain an self-evident mine adit or collar, indeed it is difficult to discern if any formal mining occurred at this locale, though ore-bearing rock may have been removed in the road building process and could have been sent away for processing. Furthermore, the SSMMC had a Notice of Location and permission for 30 years for:

> [t]he E ½ SW ¼ Section 16, T 22 N, R 20 E, 80 acres +/- which premises are leased to the second party for no other purpose than the purpose of exploring for, mining, taking out and removing therefrom the merchantable shipping or containing copper, lead, silver, gold, gypsum, and other valuable metals or minerals, except coal…and use the timber found upon said premises for fuel and for the construction of buildings required in the operation of mines on the premises…drains, tramways, and supports for such mines, provided however State of WA reserves the right to terminate.

In either or both events, the land use actions which ostensibly created the trail or road on the SW face of Saddle Rock occurred in the historic period, therefore this location will be treated as a historic-era mining property archaeological site. For the purposes of DOE, this site was tested for arsenic and higher concentrations were found in the SW portion of the site. The site is defined as an oval-shaped area measuring ca. 200 ft. E/W by 110 ft. N/S and is bisected by a road or trail. For DAHP concerns, given the number of years the SSMMC was in operation and the similarity to the weathering of bedrock exposed near the site locus, the entire 36,000 ft^2 area is considered one historic-era archaeological site—The “Washington” Lode site--by RLR.

Method of Collection: N/A

Location of Artifacts *(Temporary/Permanent)*: N/A

SITE AGE

Component: historic era **Dates: 1908-1910;** 1957 **Dating Method:** Chelan Co. Assessor's Office records

Phase: N/A **Basis for Phase Designation:** N/A

SITE RECORDERS

Observed by: Wm. Schroeder, M. S. **Address:** 805 E 5th Ave. Ellensburg, WA

Date Recorded: 11/28 and 12/14/2012

Recorded by: Wm. Schroeder, M.S.

Organization: Reiss-Landreau Research **Organization Phone Number:** 509-952-5130

Organization Address: PO Box 2215 Yakima, WA 98907

Organization E-mail: chrislandreau@charter.net

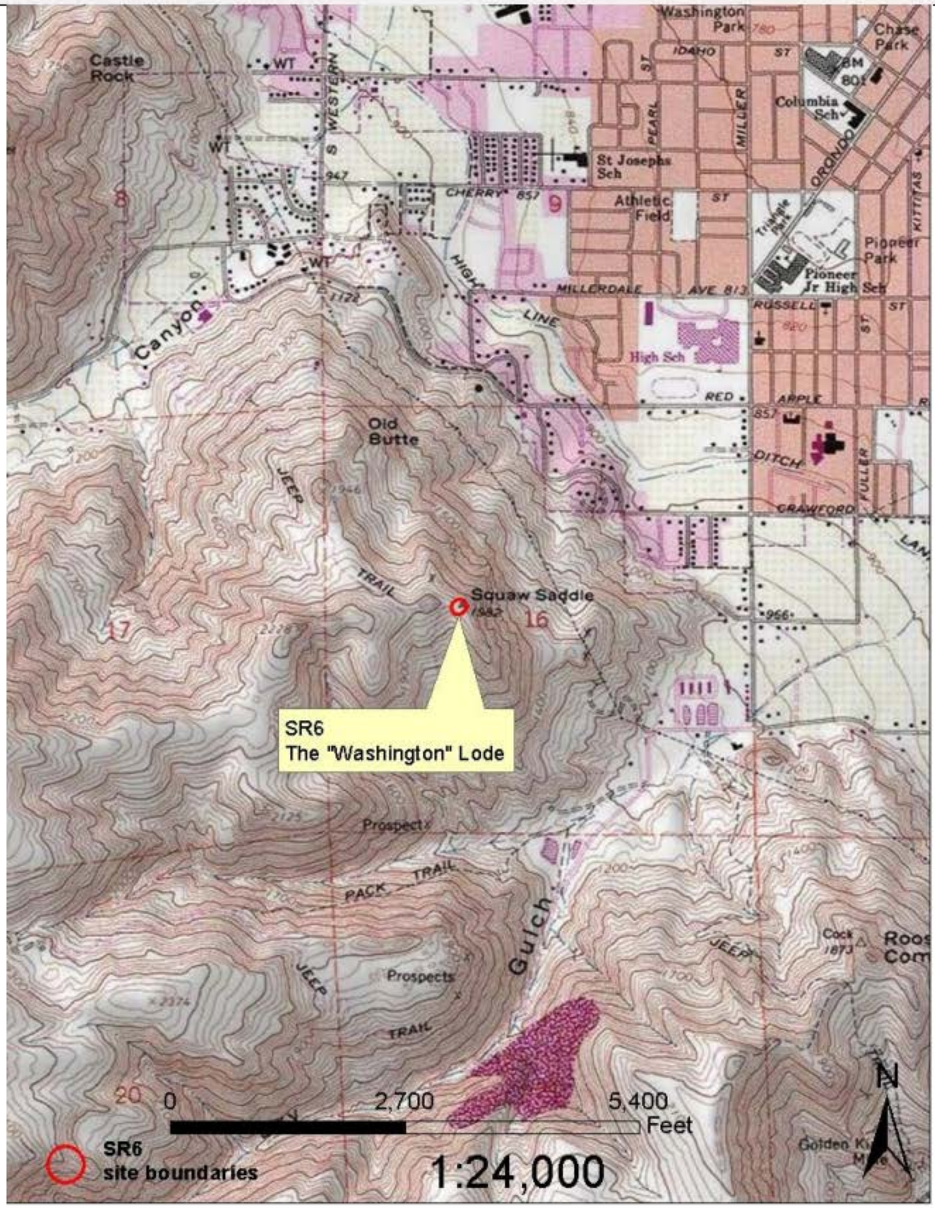
Date Revisited: **Revisited By:**

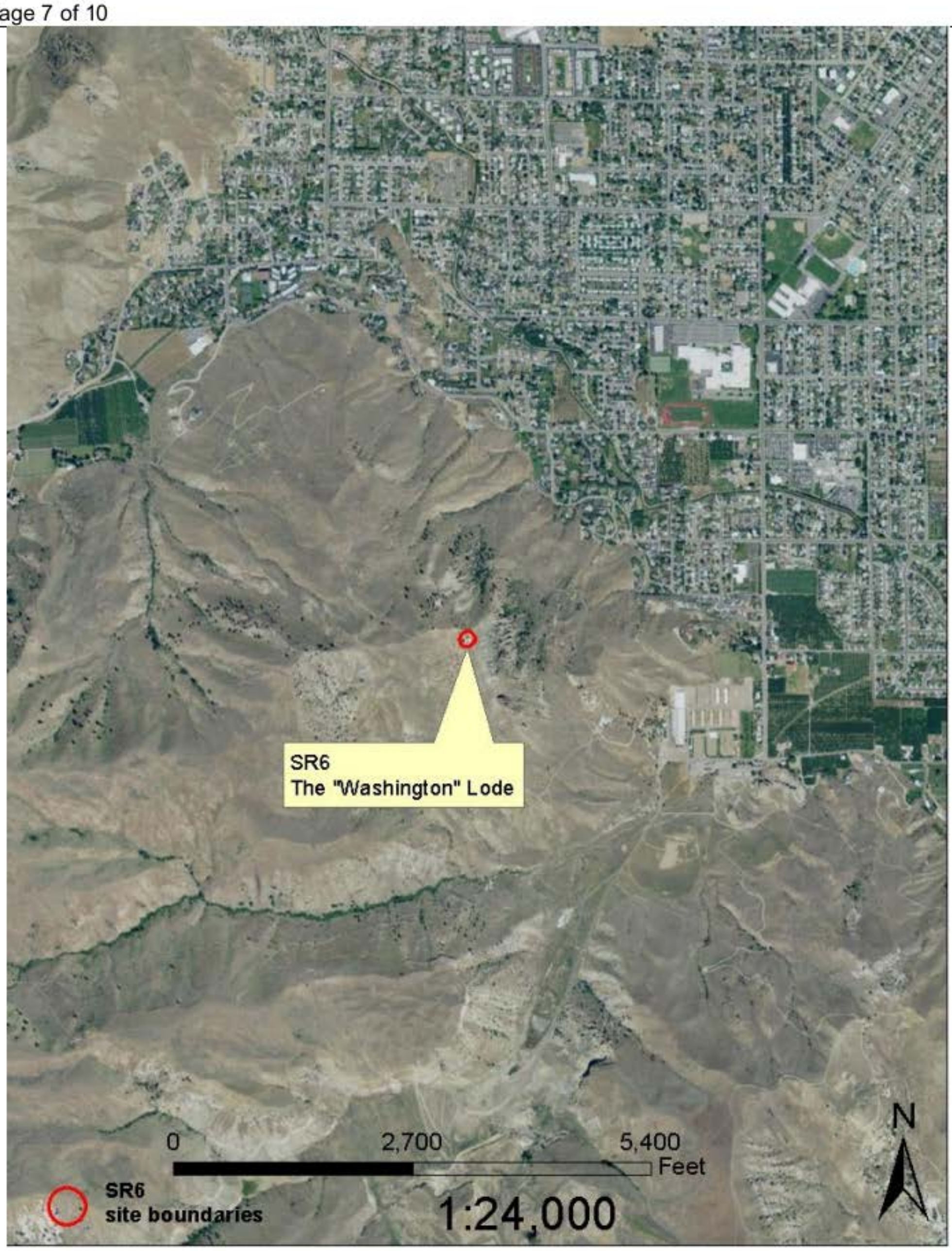
SITE HISTORY

Previous Archaeological Work *(Done at Site)*: none

LAND OWNERSHIP
Owner: City of Wenatchee **Address:** PO Box 519. Wenatchee, WA 98807-0519 **Tax Lot/ Parcel No:** 222016300000 Property ID: 57419
RESEARCH REFERENCES
Items/Documents Used In Research *(Specify)*: Chelan County Assessor's Office General Index

USGS MAP


SR6
The "Washington" Lode
Squaw Saddle
Castle Rock
Old Butte
Canyon
Gulch
Prospects
0
2,700
5,400
Feet
SR6
site boundaries
1:24,000
N


SR6
The "Washington" Lode
0
2,700
5,400
Feet
SR6
site boundaries
1:24,000
N

SKETCH MAP


SR6
The "Washington" Lode
0
1,125
2,250
Feet
N
SR6
site boundaries
1:10,000

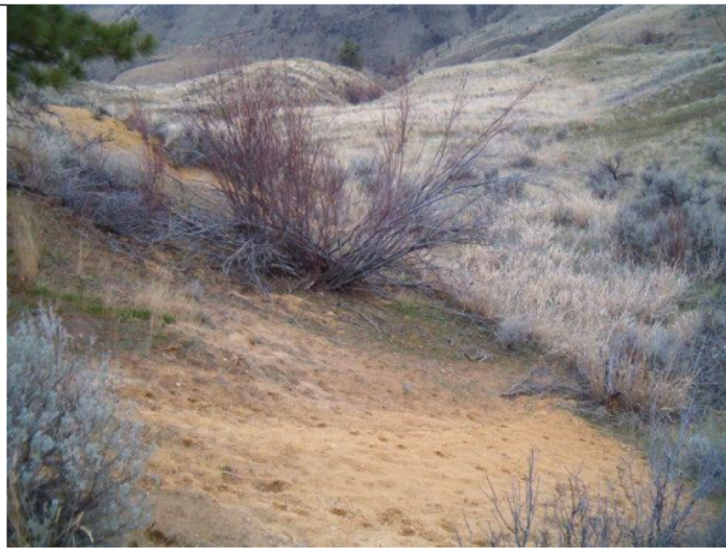
ARCHAEOLOGICAL SITE INVENTORY FORM Smithsonian Number: ______________

PHOTOGRAPH(S)

Photograph Description(s):

Hydrothermally altered bedrock outcrop and road cut; Aspect NNE.

Detail of mining spoils/back dirt.

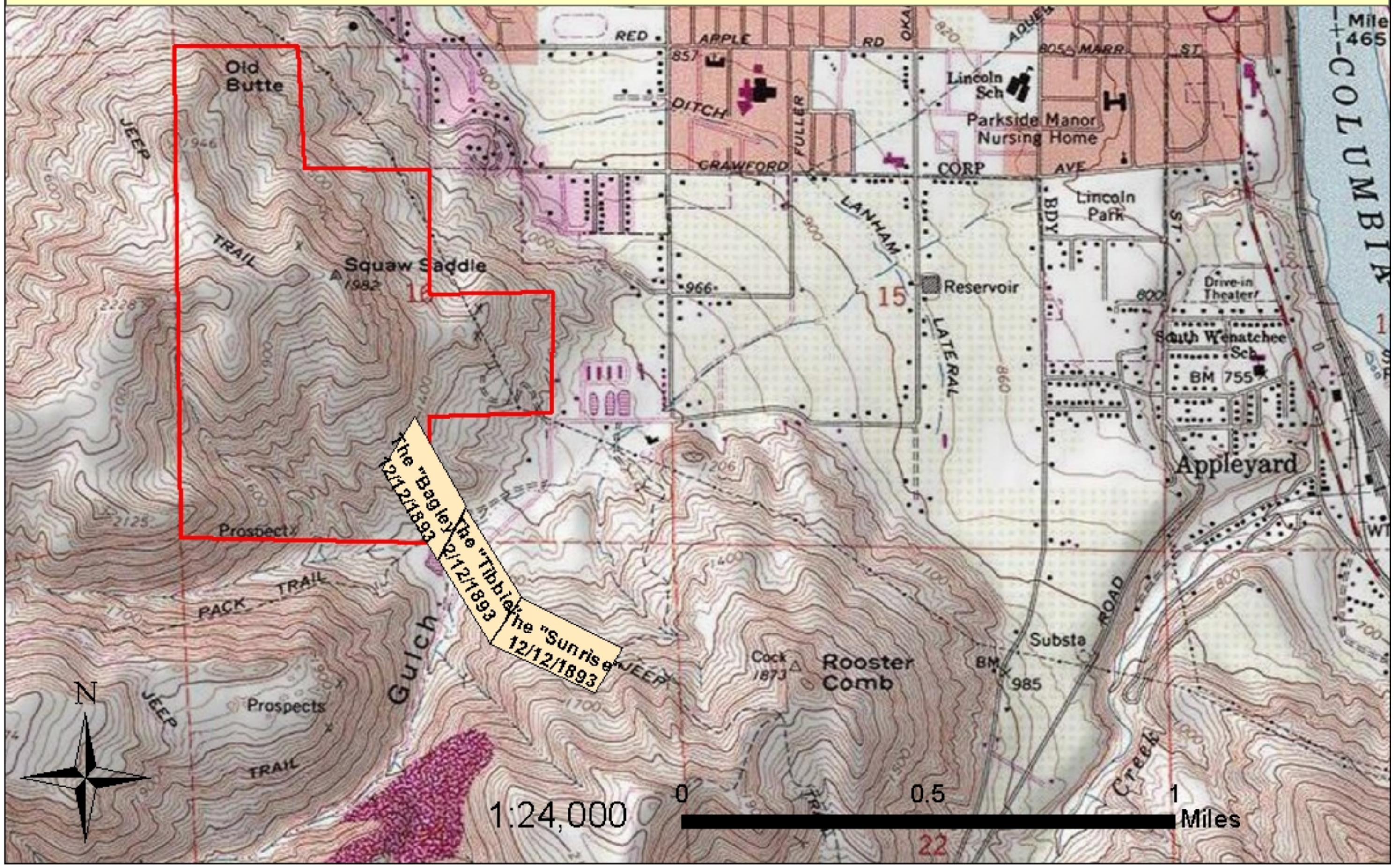


Exposed mining spoils/back dirt, Aspect SE from trail/road.

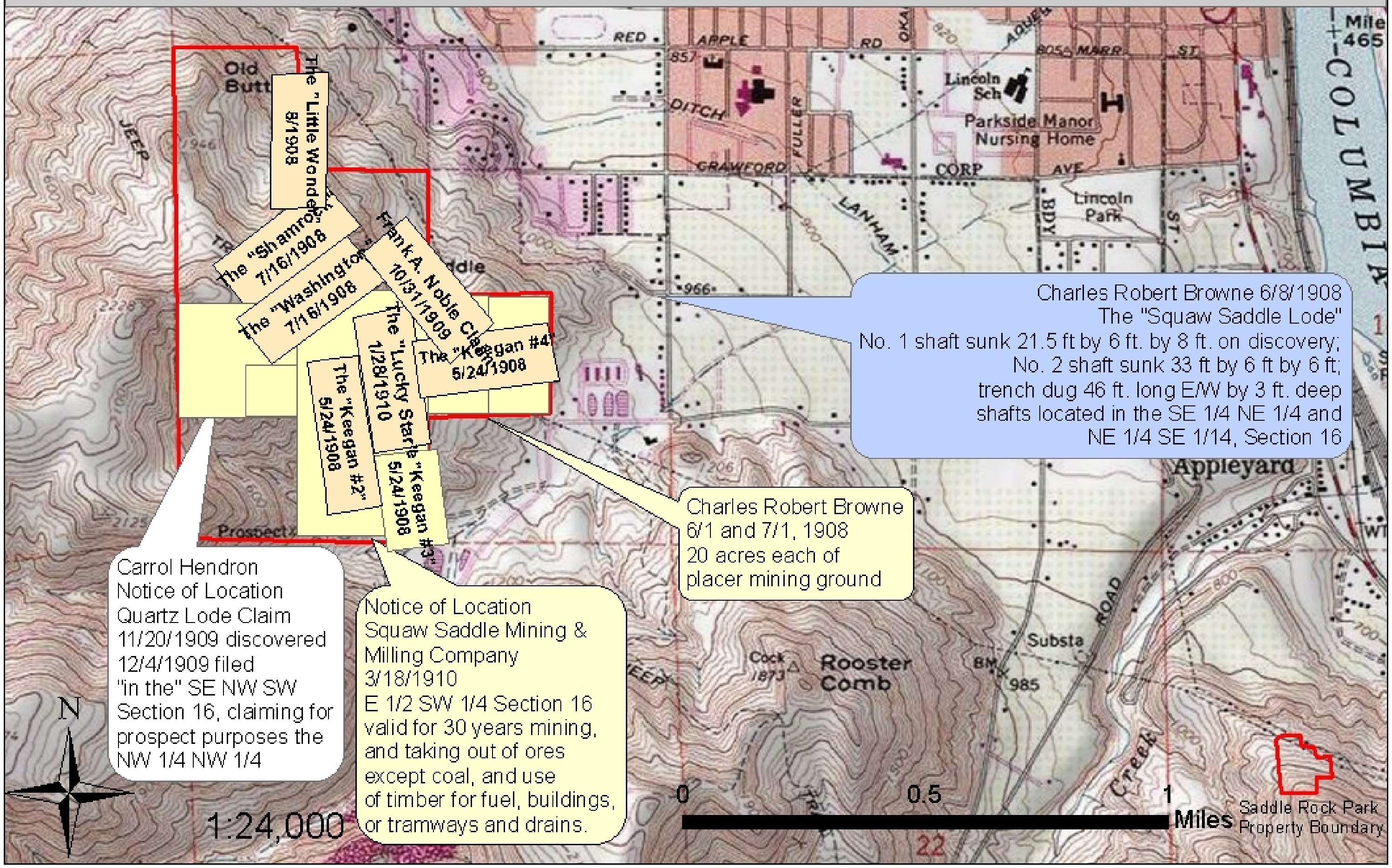
CONTINUATION/ ADDENDUM SHEET
Label all additional pages by corresponding headings. *(e.g. Site Description, Site History, Research References)*

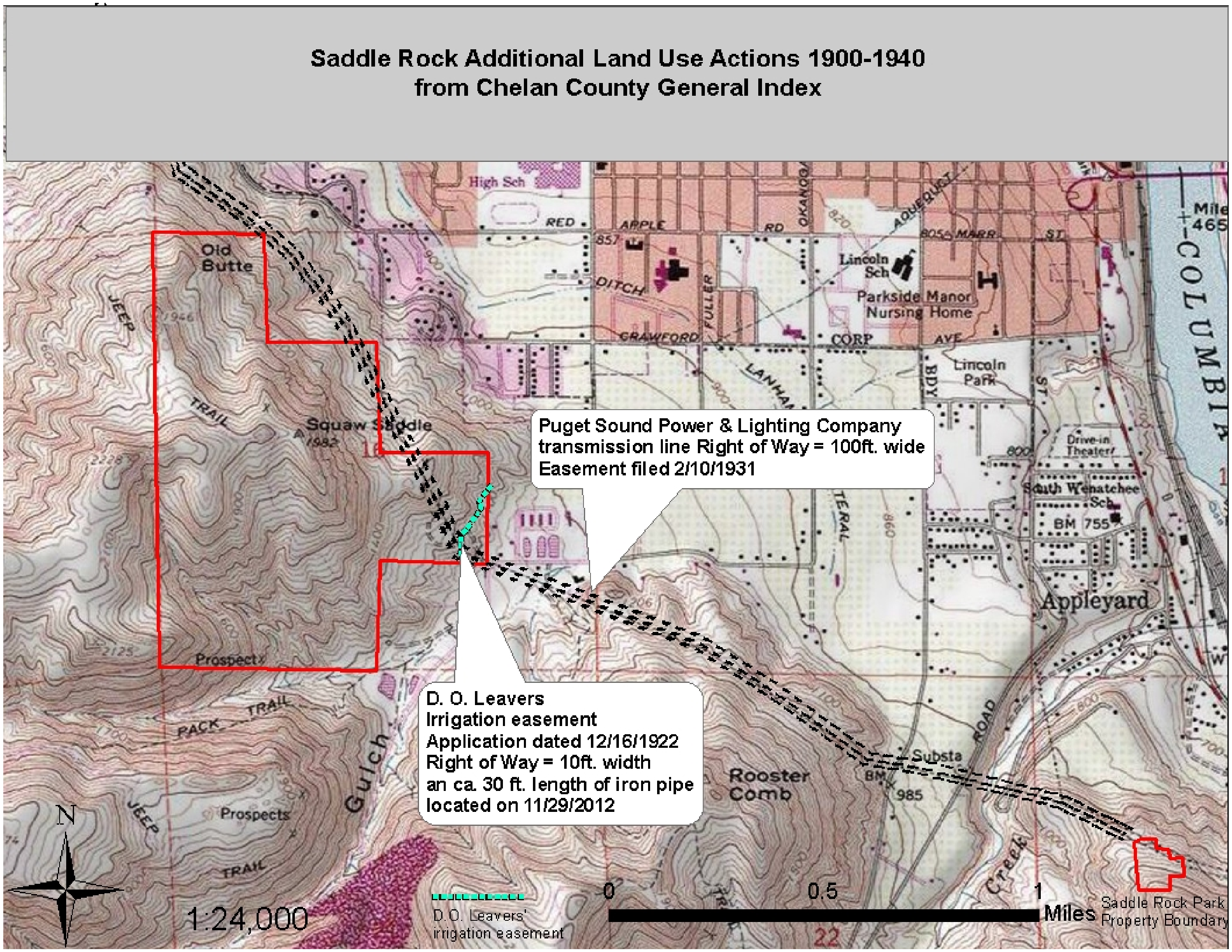
Appendix D: Additional 1:24,000 scale topographic maps.

Saddle Rock Mines 1890s
from Book of Mines F, Kittitas County Assessor's Office

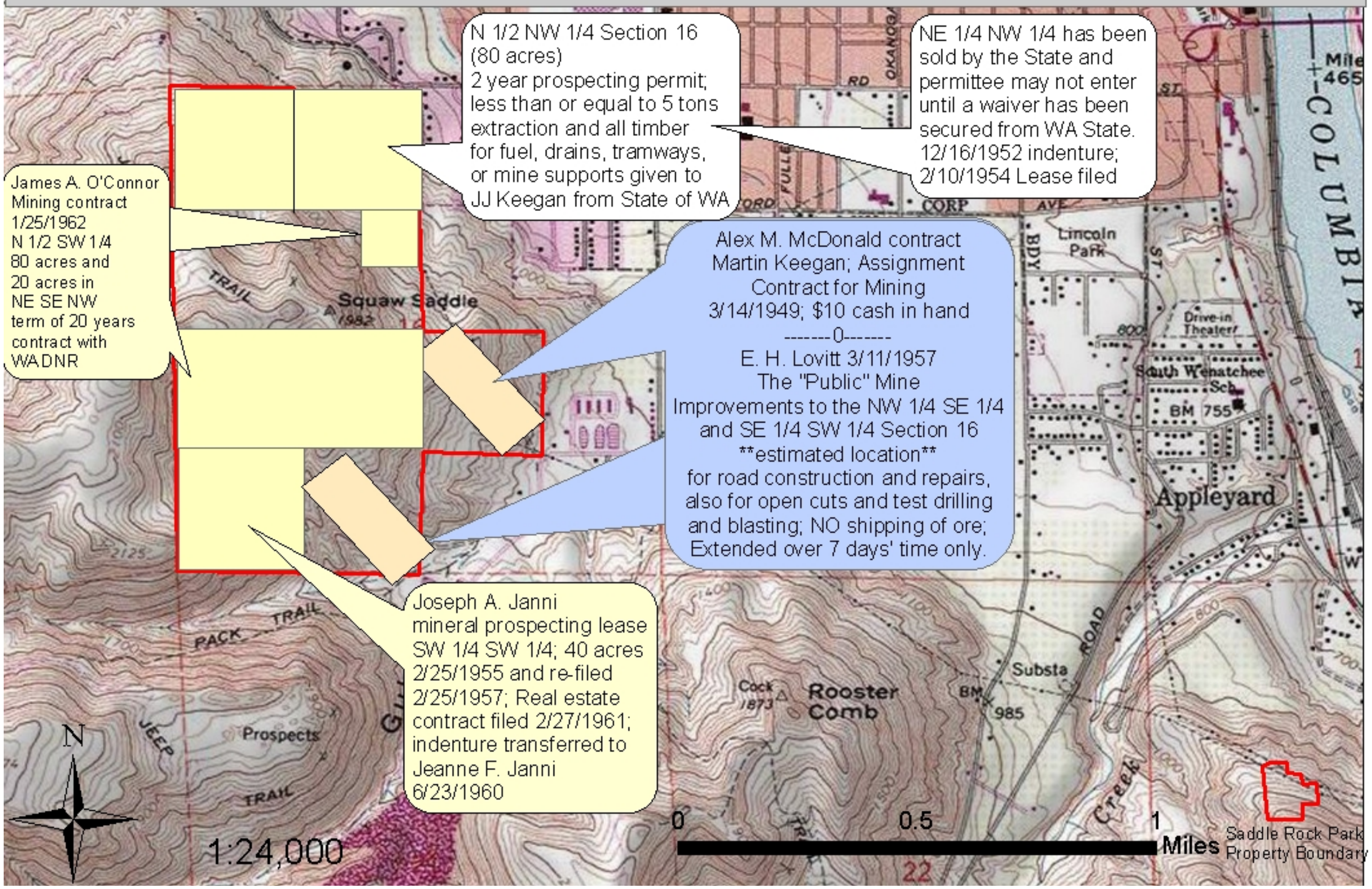


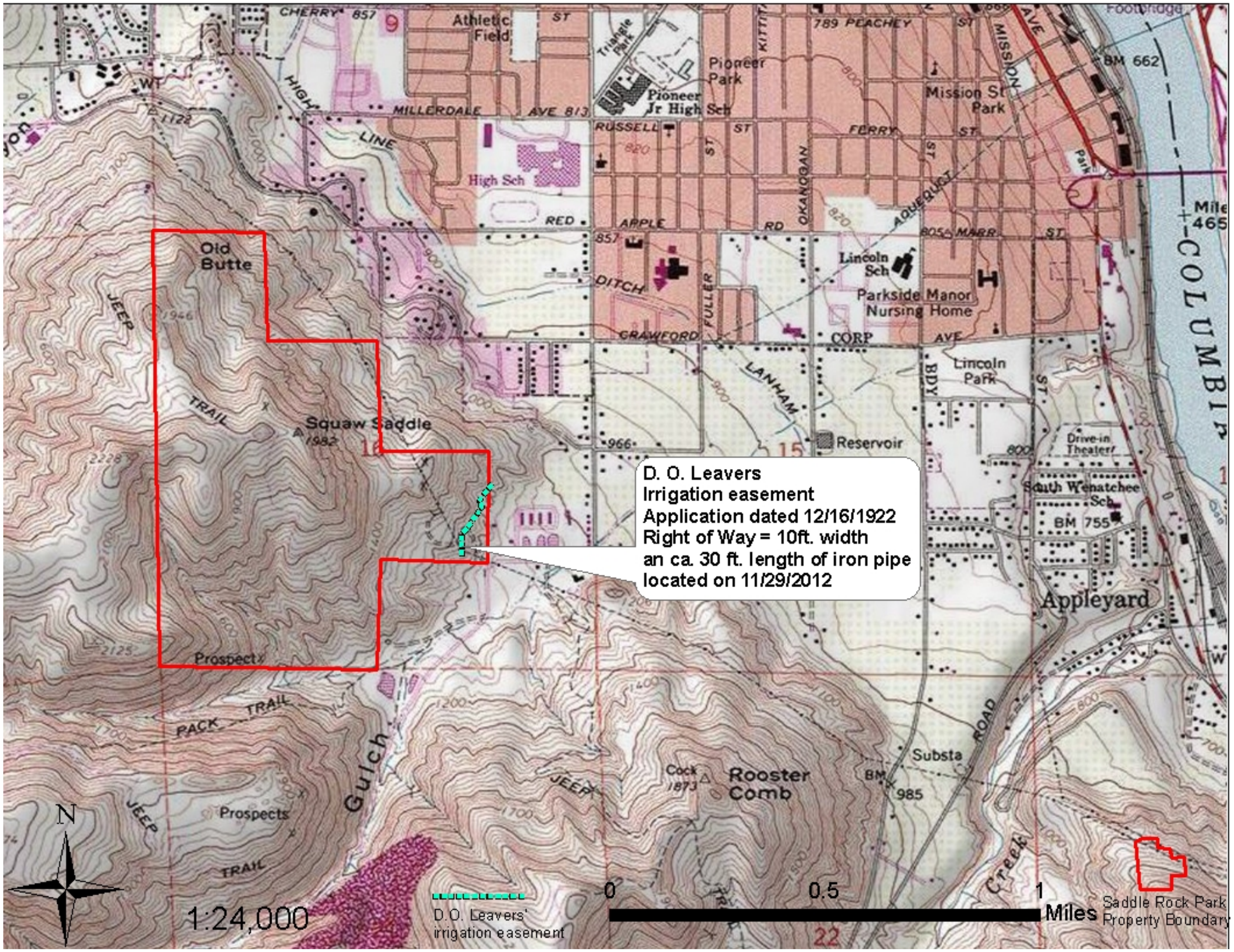
Saddle Rock Mines 1908-1910
from Chelan County General Index



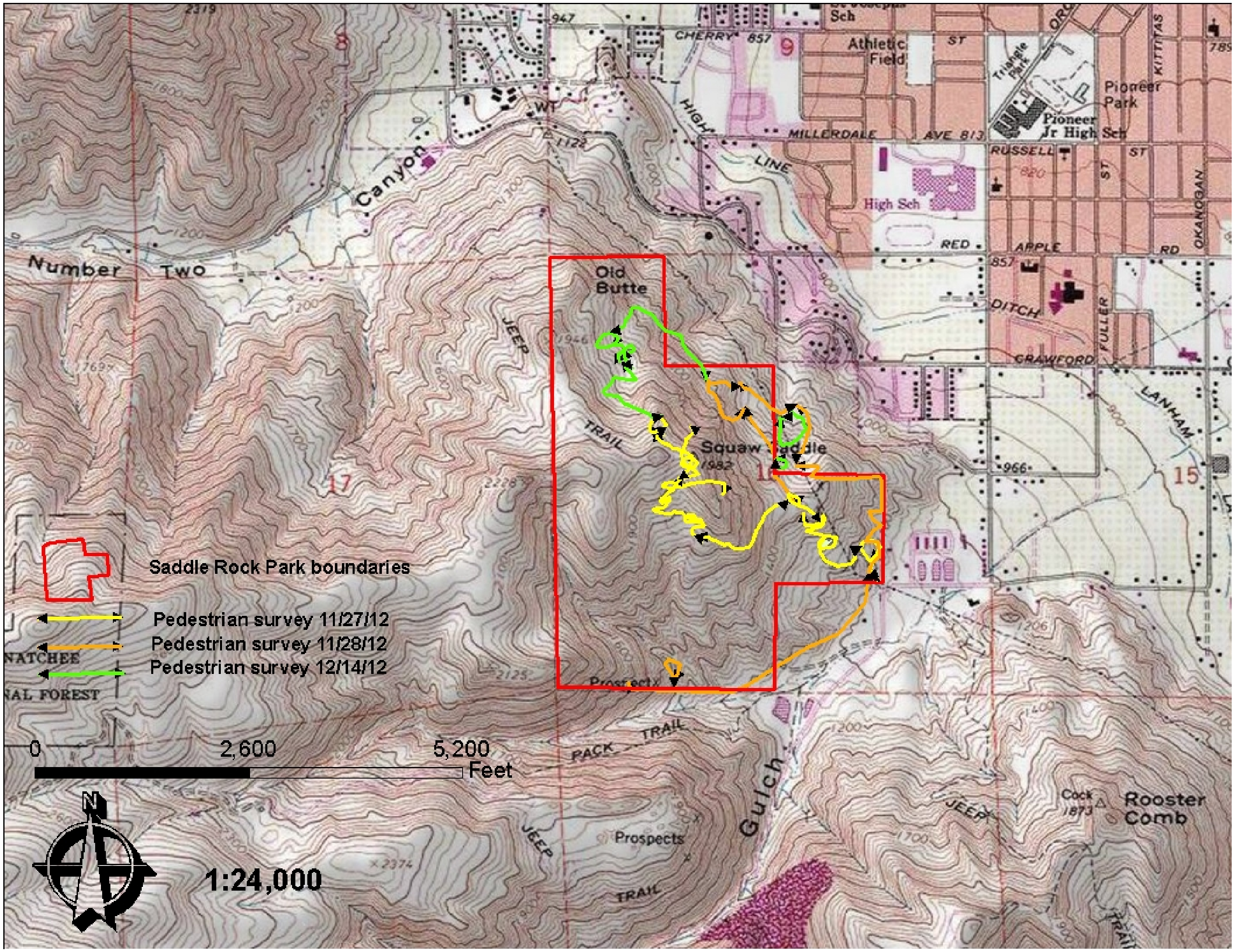

Saddle Rock Additional Land Use Actions 1900-1940
from Chelan County General Index
Puget Sound Power & Lighting Company
transmission line Right of Way = 100ft. wide
Easement filed 2/10/1931
D. O. Leavers
Irrigation easement
Application dated 12/16/1922
Right of Way = 10ft. width
an ca. 30 ft. length of iron pipe
located on 11/29/2012
Old Butte
Squaw Saddle
Rooster Comb
Appleyard
COLUMBIA
Lincoln Park
Parkside Manor Nursing Home
South Wenatchee Sch
Drive-in Theater
High Sch
Lincoln Sch
Gulch
Substa
1:24,000
N
D.O. Leavers' irrigation easement
0
0.5
1
Miles
Saddle Rock Park Property Boundary

Saddle Rock Additional Land Use Actions 1940-1962
from Chelan County General Index





D. O. Leavers
Irrigation easement
Application dated 12/16/1922
Right of Way = 10ft. width
an ca. 30 ft. length of iron pipe
located on 11/29/2012
Old Butte
Squaw Saddle
Rooster Comb
Appleyard
Prospect
Prospects
Reservoir
Lincoln Park
Pioneer Park
Mission St Park
High Sch
COLUMBIA
N
1:24,000
D.O. Leavers' irrigation easement
0
0.5
1
Miles
Saddle Rock Park Property Boundary


Saddle Rock Park boundaries
Pedestrian survey 11/27/12
Pedestrian survey 11/28/12
Pedestrian survey 12/14/12
0
2,600
5,200
Feet
1:24,000
Old Butte
Squaw Saddle
Number Two
Canyon
Gulch
Rooster Comb
Pioneer Park
Athletic Field
High Sch

APPENDIX B
FIELD INVESTIGATION PROCEDURES

APPENDIX B
FIELD INVESTIGATION PROCEDURES

Our soil sampling program consisted of collecting discrete samples from the waste rock piles, collecting composite samples downslope from the waste rock piles, and collecting background soil samples from undisturbed areas of the park. Samples were collected so that they were representative of the targeted depth profile. Care was taken to collect all soil fractions smaller than 2 mm to avoid losing fine material.

Field staff collected samples and documented activities in a consistent manner throughout the park as described in the Sampling and Analysis Plan (SAP) (Hart Crowser 2013). Sample locations were visually assessed and waste rock pile measurements were taken to estimate the area and volume of waste rock.

Observations were recorded on field data forms, in field notebooks, and as photographs. The information recorded included the following:

- Details of sample collection, including GPS coordinates;
- Date, time, and identification of each sample, including number of jars and tests requested;
- Description of photographs;
- Any deviation from the approved SAP; and
- General observations.

Selected photographs are included at the end of this appendix. Please refer to Table B-1 for a summary of sample numbers, GPS coordinates, and descriptions of deviations from SAP.

Discrete Samples from Waste Rock Piles

Discrete samples were collected from waste rock piles and submitted for chemical analysis to determine concentrations of metals of potential concern for each waste rock pile. Five discrete samples were collected from each waste rock pile of 1,000 cubic yards (cy) or less, and ten samples were collected from piles greater than 1,000 cy. The sample locations were distributed uniformly across the waste rock pile.

Samples were collected from 0 to 12 inches beneath the surface. Samples were sieved through a 2 mm sieve and the material passing the sieve was submitted for chemical analysis.

Composite Samples

Ten-point composite soil samples were collected downslope of the toe of each waste rock pile to determine the extent of potential waste rock migration. A randomized 10-point composite sample was collected from each of the following three zones beyond any visible extent of the waste rock pile:

- 0 to 20 feet,
- 20 to 40 feet, and
- 40 to 60 feet.

Samples were collected from 0 to 12 inches beneath the surface after any duff layer was removed. Equal volumes from each of the 10 locations was placed in a stainless steel bowl and homogenized prior to placing in sample containers. Since the downslope samples consisted of fine-grained materials, they were not sieved.

Background Soil Samples

Twenty soil samples were collected from locations identified to represent background (i.e., not visibly disturbed) conditions at the Site. Background samples were collected from locations outside of areas potentially impacted by historical mining activities or other disturbances. Sample locations were distributed to provide spatial coverage across the entire Site, sampling the range of soil types and underlying geological units. Background soil samples were collected from 0 to 6 inches beneath the surface.

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Table B-1 - Summary of Sample GPS Coordinates and Deviations from SAP

Sample Number	Latitude	Longitude	Type of Sample	Deviations from SAP during Sample Collection
SR01-C01-D	47.397747	-120.329968	Discrete	Sample was not placed on ice until the day after collection.
SR01-C02-D	47.397674	-120.329942	Discrete	
SR01-C03-D	47.397663	-120.329852	Discrete	
SR01-D01	47.397744	-120.330162	Discrete	
SR01-D02	47.397754	-120.330054	Discrete	
SR01-D03	47.397812	-120.330082	Discrete	
SR01-D04	47.397869	-120.330064	Discrete	
SR01-D05	47.397829	-120.329984	Discrete	
SR01-C01	n/a	n/a	Composite	
SR01-C02	n/a	n/a	Composite	
SR01-C03	n/a	n/a	Composite	
SR02-C01-D	47.398262	-120.331929	Discrete	
SR02-C02-D	47.398132	-120.332156	Discrete	
SR02-C03-D	47.398001	-120.332364	Discrete	
SR02-D01	47.398404	-120.332525	Discrete	
SR02-D02	47.398203	-120.332526	Discrete	Did not sieve because sample was too wet.
SR02-D03	47.398219	-120.332399	Discrete	
SR02-D04	47.398325	-120.33238	Discrete	
SR02-D05	47.39837	-120.332311	Discrete	
SR02-D06	47.398287	-120.332226	Discrete	Did not sieve because sample was too wet.
SR02-D07	47.398419	-120.33219	Discrete	Did not sieve because sample was too wet.
SR02-D08	47.398342	-120.332084	Discrete	Sample collected from 0-10" depth. Did not sieve because sample was too wet.
SR02-D09	47.398392	-120.332043	Discrete	Did not sieve because sample was too wet.
SR02-D10	47.398358	-120.331952	Discrete	Did not sieve because sample was too wet.
SR02-C01	n/a	n/a	Composite	
SR02-C02	n/a	n/a	Composite	
SR02-C03	n/a	n/a	Composite	
SR03-C01-D	47.399436	-120.333819	Discrete	
SR03-C02-D	47.399626	-120.334221	Discrete	
SR03-C03-D	47.400078	-120.334189	Discrete	
SR03-D01	47.399557	-120.33372	Discrete	Sample collected from 0-11" depth.
SR03-D02	47.399597	-120.33384	Discrete	Sample collected from 0-10" depth.
SR03-D03	47.399602	-120.333943	Discrete	Sample collected from 0-8" depth.
SR03-D04	47.399659	-120.333973	Discrete	Sample collected from 0-7" depth.
SR03-D05	47.399745	-120.33405	Discrete	Sample collected from 0-8" depth.
SR03-D06	47.399927	-120.334206	Discrete	Sample collected from 0-6" depth.
SR03-D07	47.399843	-120.334122	Discrete	
SR03-D08	47.399807	-120.334004	Discrete	Did not sieve because sample was too wet.
SR03-D09	47.399723	-120.333949	Discrete	Sample collected from 0-9" depth.
SR03-D10	47.399676	-120.333827	Discrete	
SR03-C01	n/a	n/a	Composite	
SR03-C02	n/a	n/a	Composite	
SR03-C03	n/a	n/a	Composite	
SR04-C01-D	47.40429	-120.342667	Discrete	
SR04-C02-D	47.404247	-120.342568	Discrete	
SR04-C03-D	47.404359	-120.342752	Discrete	
SR04-D01	47.404183	-120.342805	Discrete	
SR04-D02	47.404175	-120.342767	Discrete	
SR04-D03	47.404185	-120.342739	Discrete	
SR04-D04	47.404206	-120.342703	Discrete	
SR04-D05	47.404217	-120.342682	Discrete	
SR04-C01	n/a	n/a	Composite	
SR04-C02	n/a	n/a	Composite	
SR04-C03	n/a	n/a	Composite	
SR05-C01-D	47.402189	-120.340916	Discrete	
SR05-C02-D	47.40215	-120.341062	Discrete	
SR05-C03-D	47.40228	-120.341005	Discrete	
SR05-D01	47.402288	-120.340595	Discrete	
SR05-D02	47.402249	-120.340817	Discrete	
SR05-D03	47.402178	-120.340702	Discrete	Did not sieve because sample was too wet.
SR05-D04	47.402109	-120.340778	Discrete	
SR05-D05	47.402176	-120.340817	Discrete	Did not sieve because sample was too wet.
SR05-C01	n/a	n/a	Composite	
SR05-C02	n/a	n/a	Composite	Top 3" of ground was frozen.
SR05-C03	n/a	n/a	Composite	Top 3" of ground was frozen.
SR06-C01-D	47.399057	-120.339402	Discrete	
SR06-C02-D	47.399004	-120.339348	Discrete	
SR06-C03-D	47.399031	-120.339597	Discrete	
SR06-D01	47.399272	-120.339129	Discrete	Sample collected from 0 to 10" horizontal depth from face of sheer road cut.
SR06-D02	47.399267	-120.33903	Discrete	Sample collected from 0 to 10" horizontal depth from face of sheer road cut.
SR06-D03	47.39913	-120.33916	Discrete	
SR06-D04	47.399111	-120.339327	Discrete	
SR06-D05	47.399083	-120.339359	Discrete	Did not sieve because sample was too wet.
SR06-C01	n/a	n/a	Composite	
SR06-C02	n/a	n/a	Composite	
SR06-C03	n/a	n/a	Composite	
SR07-C01-D	n/a	n/a	Discrete	Did not collect a discrete sample from the 3rd composite zone.
SR07-C02-D	n/a	n/a	Discrete	Did not collect a discrete sample from the 3rd composite zone.
SR07-D01	47.398838	-120.332879	Discrete	GPS coordinates estimated.
SR07-D02	47.398826	-120.332886	Discrete	GPS coordinates estimated.
SR07-D03	47.398821	-120.33286	Discrete	Sample collected from 0-8" depth. GPS coordinates estimated.
SR07-D04	47.398825	-120.332844	Discrete	Sample collected from 0-10" depth. GPS coordinates estimated.
SR07-D05	47.398836	-120.332834	Discrete	Sample collected from 0-11" depth. GPS coordinates estimated.
SR07-C01	n/a	n/a	Composite	Did not collect a composite sample from zone 3.
SR07-C02	n/a	n/a	Composite	Did not collect a composite sample from zone 3.
SR08-C01-D	47.39945	-120.332607	Discrete	
SR08-C02-D	47.399468	-120.332542	Discrete	
SR08-C03-D	47.399448	-120.332451	Discrete	
SR08-D01	47.399382	-120.332828	Discrete	
SR08-D02	47.399415	-120.332848	Discrete	Did not sieve because sample was too wet.
SR08-D03	47.399454	-120.332773	Discrete	
SR08-D04	47.399465	-120.332724	Discrete	Did not sieve because sample was too wet.
SR08-D05	47.399484	-120.332779	Discrete	Did not sieve because sample was too wet.
SR08-C01	n/a	n/a	Composite	
SR08-C02	n/a	n/a	Composite	
SR08-C03	n/a	n/a	Composite	

BG-D01	47.405537	-120.345108	Discrete	
BG-D02	47.406199	-120.342863	Discrete	
BG-D03	47.403783	-120.344118	Discrete	
BG-D04	47.401115	-120.343360	Discrete	Soil frozen, sample collected from 0" to 3" depth.
BG-D05	47.399965	-120.342846	Discrete	
BG-D06	47.397996	-120.344517	Discrete	
BG-D07	47.398601	-120.341159	Discrete	
BG-D08	47.395375	-120.340218	Discrete	
BG-D09	47.397163	-120.332301	Discrete	
BG-D10	47.396397	-120.338368	Discrete	
BG-D11	47.397251	-120.335473	Discrete	
BG-D12	47.398618	-120.334794	Discrete	
BG-D13	47.399521	-120.336352	Discrete	Relocated about 50' east (downslope) from proposed location due to safety concerns.
BG-D14	47.39855	-120.338226	Discrete	
BG-D15	47.399995	-120.338868	Discrete	Soil frozen, sample collected from 0" to 2" depth.
BG-D16	47.400125	-120.330892	Discrete	
BG-D17	47.401732	-120.338970	Discrete	Soil frozen at 2" depth, sample collected from 0" to 3.5" depth.
BG-D18	47.402543	-120.335510	Discrete	Soil frozen, sample collected from 0" to 2" depth.
BG-D19	47.40394	-120.340493	Discrete	Soil frozen, sample collected from 0" to 2" depth.
BG-D20	47.40716	-120.345158	Discrete	Relocated about 300' southwest (above rock formation) from proposed location due to safety concerns. Soil frozen, sample collected from 0" to 3" depth.


Photograph B-1 – Outcrop and waste rock material at SR-01.


Photograph B-2 – Mine opening in ground at SR-01.

Photograph B-3 – Flags marking a ten point composite sample beyond the toe of the waste rock pile at SR-01.

Photograph B-4 – Waste rock at SR-02. The rail protruding from the soil may be a remnant of historical mine workings.

Photograph B-5 – Sealed adit at SR-02. The opening is filled with concrete.

Photograph B-6 – Collecting a discrete sample from the waste rock pile at SR-02.

Photograph B-7 – Area where discrete samples were collected at SR-03.

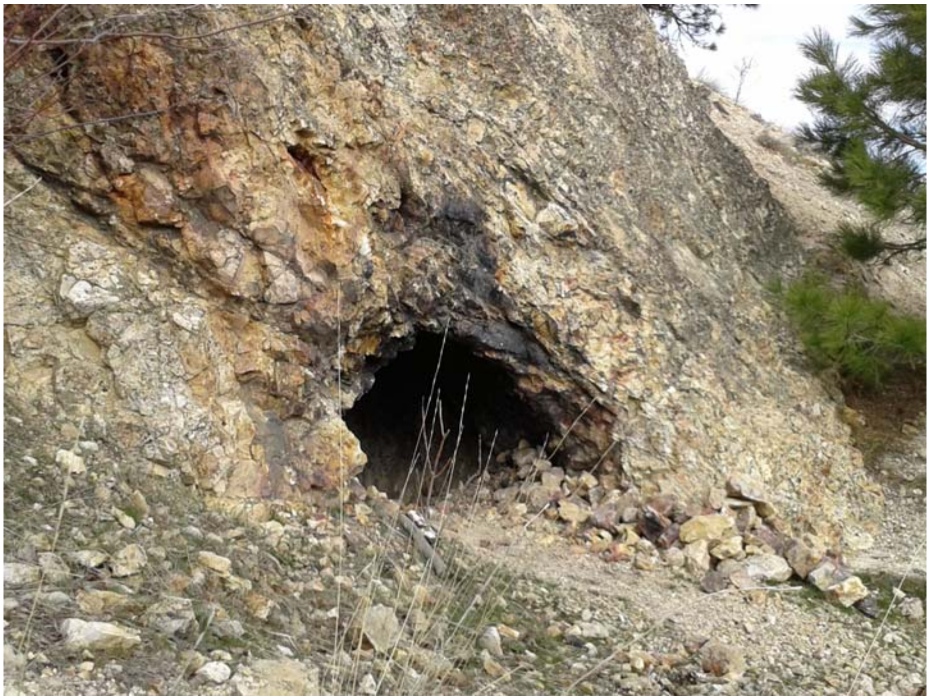
Photograph B-8 – Area where discrete samples were collected at SR-04.


Photograph B-9 – Open adit at SR-04.


Photograph B-10 – Area where discrete samples were collected at SR-05.

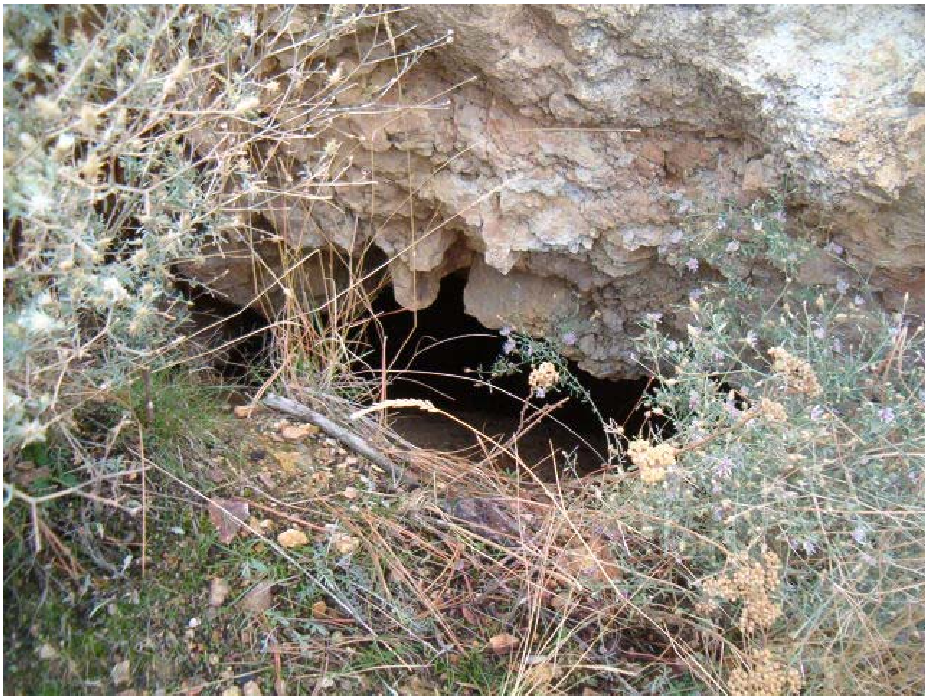
Photograph B-11 – Overview of SR-06. Discrete samples were collected from the sheer slope beneath the exposed tree roots, the hiking path in the foreground of this photograph, and material slumped onto the slope beneath the path (not visible in this photograph).

Photograph B-12 – Area where discrete samples were collected at SR-07.



Photograph B-13 – Shallow adit at SR-07.

Photograph B-14 – Waste rock at SR-08.



Photograph B-15 – Adit at SR-08.

Photograph B-16 – Road features at Saddle Rock Park.

APPENDIX C
ANALYTICAL RESULTS, DATA QUALITY, AND DATA VALIDATION

APPENDIX C
CHEMICAL DATA QUALITY REVIEW AND LABORATORY REPORTS

Chemical Data Quality Review

Data quality is represented by its precision, accuracy, representativeness, completeness, and comparability (PARCC). All analyses were performed in a manner consistent with the methods and guidelines stated in the SAP/QAPP. The chemistry data were reviewed and validated by Hart Crowser chemists. Overall, the data quality objectives (DQOs), as set forth in the SAP, were achieved, and the data for this project are acceptable for use, as qualified.

Precision

Laboratory Duplicates. A laboratory duplicate is a second laboratory sample taken from a submitted sample. The duplicate is then prepared along with the original. It is analyzed and compared to the first to assess the precision of the analytical method and the potential variability of the sample matrix. This comparison is reported as the relative percent difference (RPD). All sample duplicate results for submitted samples were within acceptability criteria or qualified.

Field Duplicates. A field duplicate is a second field sample collected from a selected sample location. The field duplicate sample serves as a check on laboratory quality as well as on potential variability in the sampling method and the sample matrix. The field duplicate is analyzed and compared to the first sample to assess the precision of the sampling and analytical methods. This comparison can be expressed as the RPD between the original and duplicate samples. Sample results were not qualified for field duplicate exceedances.

Accuracy

Matrix Spike Samples. Matrix spike analyses are performed on samples of the same matrix as the sample that are spiked with known levels of the constituents of interest. These analyses are used to assess the potential for matrix interference with recovery or detection of the constituents of interest and the accuracy of the determination. The spiked sample results are compared to the expected result (i.e., sample concentration plus spike amount) and are reported as percent recovery. Matrix spike analytical results were generally within acceptable ranges, or samples were evaluated and qualified when matrix spike results fell outside control criteria.

Matrix spike recoveries for antimony were below ten percent for all matrix spikes. Laboratory control samples and post-digestion spike analyses for antimony were all within control limits, indicating a matrix effect. All antimony results for the samples were qualified as estimated (J/UJ).

Laboratory Control Samples. Laboratory control samples (LCS) were used by the laboratory to assess the accuracy of the analytical equipment. The sample is prepared from the analyte-free matrix, which is then spiked with known levels of the constituents of interest (i.e., a standard). The concentrations are measured, and the results are compared to the known spiked levels. This comparison is expressed as percent recovery. All LCS results were within acceptable limits.

Representativeness

Representativeness is a measure of how closely the results reflect the actual concentration of the parameters in the medium sampled. It is not possible to measure this directly, so representativeness is controlled and ensured by using standard protocols for sample handling and custody, analyzing samples within prescribed holding times, and analyzing blank samples.

Sample Handling and Custody. We collected samples in general accordance with industry standards. These included requirements for collection, containers, labeling, packaging, shipping, and storage. Compliance with these procedures has been documented on chain of custody forms. Copies of the chain of custody forms are included with each laboratory report.

Holding Times. Collection dates for all samples submitted are documented on the chain of custody form. Collection and analysis dates are indicated in the laboratory report. Holding times were met for all samples.

Sample Quality. All samples were collected in general accordance with industry standards. No issues associated with sample quality were identified.

Method Blanks. Method blanks are prepared by the laboratory and analyzed to check for the possibility that the sample may become contaminated during the analysis process. Blanks were analyzed for all analytical tests requested. No analytes were detected in the method blanks.

Completeness

Completeness is defined as the percentage of measurements made that are judged to be valid. The completeness goal is essentially that a sufficient amount of valid data is generated to meet the objectives of the data. No results were rejected as a result of the QA/QC review; therefore, data for this project are 100 percent complete.

Comparability

All samples were analyzed in accordance with accepted methods of the EPA. Because similar or the same methods were used, the quality of the data collected is consistent for all data sets and is therefore, comparable.

Chemical Data Validation

Hart Crowser collected 116 soil samples and ten field duplicates at the Saddle Rock Park in Wenatchee, Washington, between February 18 and February 22, 2013. All samples were submitted to Analytical Resources, Inc. (ARI), in Tukwila, Washington, for chemical analysis or archiving. The laboratory reported the results as ARI Job Numbers (Sample Delivery Group, SDG) WE79, WE80, WE81, WE82, WE83, and WI50. The sample identifications, analytical tests, and SDGs are presented in Table C-1.

The samples were analyzed for one or more of the following:

- Total mercury by EPA method 7471A;
- Total metals (Al, Ba, Fe, and Mn) by EPA method 6010C;
- Total metals (Sb, As, Cr, Pb, Se, Ag, and V) by EPA method 200.8;
- pH by EPA method 9045; and
- Total solids by SM2540B.

Following review of the analytical results for the total metals, selected samples were composited at the laboratory for analysis of:

- Leachable metals (As) by Toxicity Characteristic Leaching Procedure (TCLP) by EPA methods 1311/6010C;
- Leachable metals (Hg) by TCLP by EPA methods 1311/ 7470A; and
- Leachable metals (As, Ag, and Al) by Synthetic Precipitation Leaching Procedure (SPLP) by EPA methods 1312/6010C.

The laboratory performed quality assurance/quality control (QA/QC) reviews on an ongoing basis. Hart Crowser reviewed the data to ensure they met data quality objectives for the project and recorded the results on laboratory quality control summary sheets. The following criteria were evaluated:

- Holding times;
- Reporting limits (RL);

- Method blanks (MB);
- Laboratory control sample (LCS) recoveries;
- Matrix spike/matrix spike duplicate (MS/MSD) recoveries;
- Laboratory duplicate relative percent differences (RPDs);
- Field duplicate RPDs;
- Continuing calibration verifications (CCV);
- ICP interference check samples; and
- Post-digest spike recoveries (where applicable).

The data were determined to be acceptable for use with some qualification. The data review is summarized in the following pages, and the complete laboratory reports are included at the end of this appendix.

Total Mercury by EPA Method 7471A

Holding times and reporting limits were acceptable. No MB contamination was detected. The LCS recoveries were within method and QAPP control limits. The laboratory duplicate RPD was within method and QAPP control limits or not applicable because the sample and duplicate were less than five times the RL. The field duplicate RPD was within QAPP control limits. Calibration criteria were within control limits.

The MS recoveries were within method and QAPP control limits except for:

- SR-01-D01 MS: The recovery for Hg was below the control limits. The results for Hg in the source sample (SR-01-D01) and field duplicate (SR-01-D06) were therefore qualified as estimated (J).

Total Metals by EPA Method 6010C (includes Al, Ba, Fe, and Mn)

Holding times and reporting limits were acceptable. No MB contamination was detected. The LCS recoveries were within method and QAPP control limits. The laboratory duplicate RPD was within method and QAPP control limits or was not applicable because the sample and duplicate were less than five times the RL. The ICP interference check samples and CCVs were within control limits.

The MS recoveries were within method and QAPP control limits except for:

- SR-01-D01 MS: The recoveries for Al, Fe, and Mn failed high. The amount of those metals in the source sample exceeded the amount spiked into the sample. Sample results were not qualified.

- SR-03-D02 MS: The recoveries for Al and Fe failed high. The amount of those metals in the source sample exceeded the amount spiked into the sample. Sample results were not qualified.

- SR-05-D01 MS: The recoveries for Al and Fe failed high. The amount of those metals in the source sample exceeded the amount spiked into the sample. Sample results were not qualified.

- SR-07-C01 MS: The recovery for Al failed high. The recovery for Fe failed low. The amount of those metals in the source sample exceeded the amount spiked into the sample. Sample results were not qualified.

- BG-D13 MS: The recoveries for Al, Fe, and Mn failed high. The amount of those metals in the source sample exceeded the amount spiked into the sample. Sample results were not qualified.

- BG-D14 MS: The recovery for Al failed high. The recoveries for Fe and Mn failed low. The amount of those metals in the source sample exceeded the amount spiked into the sample. Sample results were not qualified.

The field duplicate RPDs were within QAPP control limits except for:

- SR-02-D03/SR-02-D11: The RPD for Mn exceeded the QAPP control limits due to sample heterogeneity. Sample results were not qualified for field duplicate exceedances.

Total Metals by EPA Method 200.8 (includes Sb, As, Cr, Pb, Se, Ag, and V)

Holding times were acceptable. No MB contamination was detected. The LCS recoveries were within method and QAPP control limits. CCVs were within control limits. Post-digestion spikes (PS) were within method control limits.

The reporting limits for selenium exceeded the screening level criteria. The samples were evaluated to the Method Detection Limit, which met the criteria.

The MS recoveries were within method and QAPP control limits except for:

- SR-01-D01 MS: The recovery for arsenic fell within control limits. However, the control limits were not applicable as the amount of arsenic in the source sample was greater than the amount spiked into the sample. No sample results were qualified.

- SR-01-D01 MS: Antimony (Sb) did not recover (0 percent). The laboratory performed a post-digestion spike, and the recovery fell within control limits. The results for Sb are qualified as estimated (J) in all associated samples (SR-01-D01, SR-01-D02, SR-01-D03, SR-01-D04, SR-01-D05, SR-01-D06, SR-01-C01, SR-01-C02, SR-01-C03, SR-02-D01, SR-02-D02, SR-02-D03, SR-02-D04, SR-02-D05, SR-02-D06, SR-02-D07, SR-02-D08, SR-02-D09, SR-02-D10, SR-02-D11, SR-02-C01, SR-02-C02, SR-02-C03, and SR-03-D01).

- SR-03-D02 MS: The recovery for Arsenic failed low. The recovery for antimony failed below ten percent (0.8 percent). The laboratory performed a PS which was within control limits for As and Sb. The amount of As spiked into the sample was less than the amount of As in the source sample, and the result for As in the source sample SR-03-D02 was qualified as estimated (J). The results for Sb were qualified as estimated (J) in all associated samples (SR-03-D02, SR-03-D03, SR-03-D04, SR-03-D05, SR-03-D06, SR-03-D07, SR-03-D08, SR-03-D09, SR-03-D10, SR-03-D11 SR-03-C01, SR-03-C02, SR-03-C03, SR-04-D01, SR-04-D02, SR-04-D03, SR-04-D05, SR-04-D06, SR-04-D04, SR-04-C01, SR-04-C02, and SR-04-C03).

- SR-05-D01 MS: The recovery for As failed high. The recovery for Sb failed below ten percent (1.1 percent). The laboratory performed a PS which was within control limits for As and Sb. The amount of As spiked into the sample was less than the amount of As in the source sample, and the result for As in the source sample SR-05-D01 was qualified as estimated (J). The results for Sb were qualified as estimated (J) in all associated samples (SR-05-D01, SR-05-D02, SR-05-D03, SR-05-D04, SR-05-D05, SR-05-D06, SR-05-C01, SR-05-C02, SR-05-C03, SR-06-D01, SR-06-D02, SR-06-D03, SR-06-D04, SR-06-D05, SR-06-D06, SR-06-C01, SR-06-C02, SR-06-C03, SR-07-D01, SR-07-D02, SR-07-D03, SR-07-D04, SR-07-D05, and SR-07-D06).

- SR-07-C01 MS: The recovery for As failed low. The recovery for Sb failed below ten percent (1.2 percent). The laboratory performed a PS which was within control limits for Sb. The amount of As spiked into the sample was less than the amount of As in the source sample, and the result for As in the source sample SR-07-C01 was qualified as estimated (J). The results for Sb were qualified as estimated (J) in all associated samples (SR-07-C01, SR-07-C02, SR-08-D01, SR-08-D02, SR-08-D03, SR-08-D04, SR-08-D05, SR-08-D06, SR-08-C01, SR-08-C02, SR-08-C03, BG-D01, BG-D02, BG-D03, BG-D04, BG-D05, BG-D06, BG-D07, BG-D08, BG-D09, BG-D10, BG-D11, and BG-D12).

- BG-D13 MS and BG-D14 MS: The recoveries for Sb failed below ten percent (3.3 and 4.6 percent). The laboratory performed post-digestion spikes, and the recoveries fell within control limits. The results for Sb are qualified as estimated (J) in all associated samples (BG-D13, BG-D14, BG-D15, BG-D16, BG-D17, BG-D18, BG-D19, BG-D20, BG-D21, and BG-D22).

The laboratory duplicate RPD was within method and QAPP control limits or not applicable because the sample and duplicate were less than five times the RL, except for:

- SR-03-D02: The RPD for vanadium (V) exceeded the control limits. The result for V was qualified as estimated (J) in SR-03-D02.

The field duplicate RPDs were within QAPP control limits except for:

- SR-02-D03/SR-02-D11: The RPDs for Cr and V exceeded the QAPP control limits due to sample heterogeneity. Sample results were not qualified for field duplicate exceedances.

Soil pH by EPA Method 9045

Holding times and reporting limits were acceptable. The LCS recoveries were within laboratory control limits. The laboratory replicate RPD was within laboratory control limits.

Total Solids by SM 2540B

Holding times and reporting limits were acceptable. The field duplicate RPDs were within QAPP control limits.

TCLP Arsenic by EPA Methods 1311/6010C

Holding times and reporting limits were acceptable. No MB contamination was detected. The laboratory duplicate RPD was within method and QAPP control limits or not applicable because the sample and duplicate were less than five times the RL. Calibration criteria were within control limits. The MS recoveries were within method and QAPP control limits.

TCLP Mercury by EPA Methods 1311/7470A

Holding times and reporting limits were acceptable. No MB contamination was detected. The laboratory duplicate RPD was within method and QAPP control limits. Calibration criteria were within control limits. The MS recoveries were within method and QAPP control limits.

SPLP Aluminum, Arsenic, and Silver by EPA Methods 1312/6010C

Holding times and reporting limits were acceptable. No MB contamination was detected. The laboratory duplicate RPD was within method and QAPP control limits or not applicable because the sample and duplicate were less than five times the RL. Calibration criteria were within control limits. The MS recoveries were within method and QAPP control limits.

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Table C-1 - Soil Sample Location and Analysis Summary

Sample ID	Sample Type (Composite [1] or Discrete)	Sample Date	Sample Time	Matrix	# of Jars	Analyses: Total Metals (4oz jar #1)	pH	SPLP Metals (8 oz jar)	TCLP Metals (8 oz jar)	Archive	Lab SDG No.	Comments
Background Samples												
BG-D01	BG	2/21/2013	0946	Soil	1	x					WE82	
BG-D02	BG	2/21/2013	1121	Soil	1	x					WE82	
BG-D03	BG	2/21/2013	1341	Soil	1	x					WE82	
BG-D04	BG	2/22/2013	0930	Soil	1	x					WE82	
BG-D05	BG	2/22/2013	0952	Soil	1	x					WE82	
BG-D06	BG	2/22/2013	1025	Soil	1	x					WE82	
BG-D07	BG	2/20/2013	1635	Soil	1	x					WE82	
BG-D08	BG	2/22/2013	1055	Soil	1	x					WE82	
BG-D09	BG	2/22/2013	1503	Soil	1	x					WE82	
BG-D10	BG	2/20/2013	1607	Soil	1	x					WE82	
BG-D11	BG	2/20/2013	1538	Soil	1	x					WE82	
BG-D12	BG	2/22/2013	1440	Soil	1	x					WE82	
BG-D13	BG	2/22/2013	1339	Soil	1	x					WE83	
BG-D14	BG	2/22/2013	1225	Soil	1	x					WE83	
BG-D15	BG	2/22/2013	1158	Soil	1	x					WE83	
BG-D16	BG	2/20/2013	0813	Soil	1	x					WE83	
BG-D17	BG	2/21/2013	1620	Soil	1	x					WE83	
BG-D18	BG	2/22/2013	1420	Soil	1	x					WE83	
BG-D19	BG	2/21/2013	1158	Soil	1	x					WE83	
BG-D20	BG	2/21/2013	1026	Soil	1	x					WE83	
BG-D21	DUP	2/22/2013	1022	Soil	1	x					WE83	Field duplicate of BG-D05
BG-D22	DUP	2/22/2013	1533	Soil	1	x					WE83	Field duplicate of BG-D09

Sample ID	Sample Type (Composite [1] or Discrete)	Sample Date	Sample Time	Matrix	# of Jars	Analyses: Total Metals (4oz jar #1)	pH	SPLP Metals (8 oz jar)	TCLP Metals (8 oz jar)	Archive	Lab SDG No.	Comments
Waste Rock Piles												
SR01-C01	Composite	2/18/2013	1728	Soil	1	x					WE79	
SR01-C02	Composite	2/18/2013	1828	Soil	1	x					WE79	
SR01-C03	Composite	2/19/2013	0800	Soil	1	x					WE79	
SR01-C01-D	Discrete	2/18/2013	1613	Soil	1					x	WE84	
SR01-C02-D	Discrete	2/18/2013	1728	Soil	1					x	WE84	
SR01-C03-D	Discrete	2/19/2013	0813	Soil	1					x	WE84	
SR01-D01	Discrete	2/18/2013	1625	Soil	1	x					WE79	
SR01-D02	Discrete	2/18/2013	1552	Soil	1	x					WE79	
SR01-D03	Discrete	2/18/2013	1651	Soil	1	x					WE79	
SR01-D04	Discrete	2/18/2013	1711	Soil	1	x					WE79	
SR01-D05	Discrete	2/18/2013	1731	Soil	1	x					WE79	
SR01-D06	Duplicate	2/18/2013	1655	Soil	1	x					WE79	Field duplicate of SR01-D01
SR02-C01	Composite	2/19/2013	1020	Soil	1	x					WE79	
SR02-C02	Composite	2/19/2013	1103	Soil	1	x					WE79	
SR02-C03	Composite	2/19/2013	1137	Soil	1	x					WE79	
SR02-C01-D	Discrete	2/19/2013	0952	Soil	1					x	WE84	
SR02-C02-D	Discrete	2/19/2013	1050	Soil	1					x	WE84	
SR02-C03-D	Discrete	2/19/2013	1128	Soil	1					x	WE84	
SR02-D01	Discrete	2/19/2013	1053	Soil	1	x	x				WE79	
SR02-D02	Discrete	2/19/2013	1032	Soil	1	x					WE79	
SR02-D03	Discrete	2/19/2013	1014	Soil	1	x					WE79	
SR02-D04	Discrete	2/19/2013	0953	Soil	1	x					WE79	
SR02-D05	Discrete	2/19/2013	0919	Soil	1	x					WE79	
SR02-D06	Discrete	2/19/2013	1118	Soil	1	x					WE79	
SR02-D07	Discrete	2/19/2013	1130	Soil	1	x					WE79	
SR02-D08	Discrete	2/19/2013	1153	Soil	1	x					WE79	
SR02-D09	Discrete	2/19/2013	1214	Soil	1	x					WE79	
SR02-D10	Discrete	2/19/2013	1219	Soil	1	x					WE79	
SR02-D11	Duplicate	2/19/2013	1044	Soil	1	x					WE79	Field duplicate of SR02-D03
SR02 Composite	Composite	2/19/2013		Soil	5			x	x		WI50	Samples SR02-D03, SR02-D04, SR02-D05, SR02-D07, and SR02-D09 were composited at the laboratory. The composite sample was analyzed for As, Ag, and Al by SPLP, and for As by TCLP.

Table C-1 - Soil Sample Location and Analysis Summary

						Analyses						
Sample ID	Sample Type (Composite [1] or Discrete)	Sample Date	Sample Time	Matrix	# of Jars	Total Metals (4oz jar #1)	pH	SPLP Metals (8 oz jar)	TCLP Metals (8 oz jar)	Archive	Lab SDG No.	Comments
SR03-C01	Composite	2/20/2013	1137	Soil	1	x					WE80	
SR03-C02	Composite	2/20/2013	1240	Soil	1	x					WE80	
SR03-C03	Composite	2/20/2013	1343	Soil	1	x					WE80	
SR03-C01-D	Discrete	2/20/2013	1100	Soil	1					x	WE84	
SR03-C02-D	Discrete	2/20/2013	1210	Soil	1					x	WE84	
SR03-C03-D	Discrete	2/20/2013	1315	Soil	1					x	WE84	
SR03-D01	Discrete	2/20/2013	0943	Soil	1	x	x				WE79	
SR03-D02	Discrete	2/20/2013	1007	Soil	1	x					WE80	
SR03-D03	Discrete	2/20/2013	1031	Soil	1	x					WE80	
SR03-D04	Discrete	2/20/2013	1127	Soil	1	x					WE80	
SR03-D05	Discrete	2/20/2013	1157	Soil	1	x					WE80	
SR03-D06	Discrete	2/20/2013	1327	Soil	1	x					WE80	
SR03-D07	Discrete	2/20/2013	1300	Soil	1	x					WE80	
SR03-D08	Discrete	2/20/2013	1227	Soil	1	x					WE80	
SR03-D09	Discrete	2/20/2013	1059	Soil	1	x					WE80	
SR03-D10	Discrete	2/20/2013	1047	Soil	1	x					WE80	
SR03-D11	Duplicate	2/20/2013	1117	Soil	1	x					WE80	Field duplicate of SR03-D10
SR03 Composite	Composite	2/20/2013		Soil	5			x	x		WI50	Samples SR03-D01, SR03-D02, SR03-D03, SR03-D07, and SR03-D08 were composited at the laboratory. The composite sample was analyzed for As, Ag, and Al by SPLP, and for As by TCLP.
SR04-C01	Composite	2/21/2013	1158	Soil	1	x					WE80	
SR04-C02	Composite	2/21/2013	1221	Soil	1	x					WE80	
SR04-C03	Composite	2/21/2013	1238	Soil	1	x					WE80	
SR04-C01-D	Discrete	2/21/2013	1146	Soil	1					x	WE84	
SR04-C02-D	Discrete	2/21/2013	1213	Soil	1					x	WE84	
SR04-C03-D	Discrete	2/21/2013	1226	Soil	1					x	WE84	
SR04-D01	Discrete	2/21/2013	1005	Soil	1	x					WE80	
SR04-D02	Discrete	2/21/2013	1015	Soil	1	x					WE80	
SR04-D03	Discrete	2/21/2013	1025	Soil	1	x					WE80	
SR04-D04	Discrete	2/21/2013	1048	Soil	1	x					WE80	
SR04-D05	Discrete	2/21/2013	1105	Soil	1	x					WE80	
SR04-D06	Duplicate	2/21/2013	1055	Soil	1	x					WE80	Field duplicate of SR04-D03

Sample ID	Sample Type (Composite [1] or Discrete)	Sample Date	Sample Time	Matrix	# of Jars	Analyses: Total Metals (4oz jar #1)	pH	SPLP Metals (8 oz jar)	TCLP Metals (8 oz jar)	Archive	Lab SDG No.	Comments
SR05-C01	Composite	2/21/2013	1621	Soil	1	x					WE81	
SR05-C02	Composite	2/21/2013	1630	Soil	1	x					WE81	
SR05-C03	Composite	2/22/2013	941	Soil	1	x					WE81	
SR05-C01-D	Discrete	2/21/2013	1603	Soil	1					x	WE84	
SR05-C02-D	Discrete	2/21/2013	1625	Soil	1					x	WE84	
SR05-C03-D	Discrete	2/22/2013	0919	Soil	1					x	WE84	
SR05-D01	Discrete	2/21/2013	1507	Soil	1	x					WE81	
SR05-D02	Discrete	2/21/2013	1552	Soil	1	x					WE81	
SR05-D03	Discrete	2/21/2013	1519	Soil	1	x					WE81	
SR05-D04	Discrete	2/21/2013	1533	Soil	1	x					WE81	
SR05-D05	Discrete	2/21/2013	1543	Soil	1	x					WE81	
SR05-D06	Duplicate	2/21/2013	1537	Soil	1	x					WE81	Field duplicate of SR05-D01
SR06-C01	Composite	2/22/2013	1237	Soil	1	x					WE81	
SR06-C02	Composite	2/22/2013	1302	Soil	1	x					WE81	
SR06-C03	Composite	2/22/2013	1324	Soil	1	x					WE81	
SR06-C01-D	Discrete	2/22/2013	1227	Soil	1					x	WE84	
SR06-C02-D	Discrete	2/22/2013	1245	Soil	1					x	WE84	
SR06-C03-D	Discrete	2/22/2013	1310	Soil	1					x	WE84	
SR06-D01	Discrete	2/22/2013	1100	Soil	1	x					WE81	
SR06-D02	Discrete	2/22/2013	1115	Soil	1	x					WE81	
SR06-D03	Discrete	2/22/2013	1138	Soil	1	x					WE81	
SR06-D04	Discrete	2/22/2013	1205	Soil	1	x					WE81	
SR06-D05	Discrete	2/22/2013	1218	Soil	1	x					WE81	
SR06-D06	Duplicate	2/22/2013	1144	Soil	1	x					WE81	Field duplicate of SR06-D03
SR06 Composite	Composite	2/22/2013		Soil	5				x		WI50	Samples SR06-D01, SR06-D02, SR06-D03, SR06-D04, and SR06-D05 were composited at the laboratory. The composite sample was analyzed for Hg by TCLP.

Table C-1 - Soil Sample Location and Analysis Summary

Sample ID	Sample Type (Composite [1] or Discrete)	Sample Date	Sample Time	Matrix	# of Jars	Analyses: Total Metals (4oz jar #1)	Analyses: pH	Analyses: SPLP Metals (8 oz jar)	Analyses: TCLP Metals (8 oz jar)	Analyses: Archive	Lab SDG No.	Comments
SR07-C01	Composite	2/20/2013	1727	Soil	1	x					WE82	
SR07-C02	Composite	2/20/2013	1736	Soil	1	x					WE82	
SR07-C01-D	Discrete	2/20/2013	1725	Soil	1					x	WE84	
SR07-C02-D	Discrete	2/20/2013	1730	Soil	1					x	WE84	
SR07-D01	Discrete	2/20/2013	1557	Soil	1	x					WE81	
SR07-D02	Discrete	2/20/2013	1607	Soil	1	x					WE81	
SR07-D03	Discrete	2/20/2013	1616	Soil	1	x					WE81	
SR07-D04	Discrete	2/20/2013	1629	Soil	1	x					WE81	
SR07-D05	Discrete	2/20/2013	1640	Soil	1	x					WE81	
SR07-D06	Duplicate	2/20/2013	1627	Soil	1	x					WE81	Field duplicate of SR07-D01
SR08-C01	Composite	2/19/2013	1632	Soil	1	x					WE82	
SR08-C02	Composite	2/19/2013	1708	Soil	1	x					WE82	
SR08-C03	Composite	2/20/2013	0829	Soil	1	x					WE82	
SR08-C01-D	Discrete	2/19/2013	1643	Soil	1					x	WE84	
SR08-C02-D	Discrete	2/19/2013	1659	Soil	1					x	WE84	
SR08-C03-D	Discrete	2/20/2013	0800	Soil	1					x	WE84	
SR08-D01	Discrete	2/19/2013	1507	Soil	1	x	x				WE82	
SR08-D02	Discrete	2/19/2013	1520	Soil	1	x					WE82	
SR08-D03	Discrete	2/19/2013	1532	Soil	1	x					WE82	
SR08-D04	Discrete	2/19/2013	1610	Soil	1	x					WE82	
SR08-D05	Discrete	2/19/2013	1551	Soil	1	x					WE82	
SR08-D06	Duplicate	2/19/2013	1602	Soil	1	x					WE82	Field duplicate of SR08-D03
	73 Discrete Soil		Total Analyses			**103**	**3**	**2**	**3**	**23**		

73 Discrete Soil
8 Duplicate Sample
26 Composite Soil
107 Total Soil Samples

1. Ten-point composite

LABORATORY REPORTS
ARI
(See attached DVD)

APPENDIX D
HUMAN HEALTH AND TERRESTRIAL ECOLOGICAL EVALUATION

Appendix D. Human Health and Ecological Risk Assessments

1.0 Introduction

A human health risk assessment and terrestrial ecological evaluation (TEE) were prepared to support remedial decision making for the remedial investigation/feasibility study (RI/FS) for the Saddle Rock Park (Site) in Wenatchee, Washington. The human health risk assessment was prepared following Model Toxics Control Act (MTCA) section WAC 173-340-708 and the TEE was prepared following MTCA sections WAC 173-340-7490 through 7494.

This appendix forms part of the RI/FS report for the Site. Detailed information on Site characteristics, mining history, and the nature and extent of contamination are provided in the main body of the RI/FS report. Some information contained in the main body of the RI/FS report has been included in this appendix for descriptive purposes.

1.1 Site Description

The Saddle Rock Park (Site) is a 325-acre property located on the outskirts of the City of Wenatchee (City) in Chelan County, Washington (Figure A-1). The Site is owned by the City and protected from development by a conservation easement held by the Chelan-Douglas Land Trust (CDLT). For the past 100 years, the Site was used primarily as a community recreation area. The City purchased the Site in 2011 and is managing it as a public park.

The Site is characterized by a dynamic topography that includes steep slopes and rock outcrops. The elevation is approximately 980 feet above mean sea level (MSL) at the northeast margin of the Site and increases to 2,080 feet above MSL on the west side of the property. Vegetation is generally sparse, especially in rocky areas, and consists of shrubs, grasses, and a few trees. Several trails on the Site are visible on aerial photographs including one graded road previously used by motorized vehicles (now banned) that is now heavily traveled by hikers and horseback riders, and several unimproved hiking trails that support less foot traffic.

The Site does not contain any surface water features. In addition, there are no wells on the Site. However, groundwater was encountered at a depth of 340 feet on a nearby property.

According to the real estate excise tax affidavit for the Site, the land use code is "91 - Undeveloped land," and the property is exempt from property tax per chapter 84.36 RCW. The areas to the north and east of the Site are zoned as Residential Single Family, Residential Low Density, and Office Mixed Use. Land immediately west of the Site is privately owned and transitions into Bureau of Land Management and Okanogan-Wenatchee National Forest land to the west.

There is a long documented history of prospecting and mining activity at the Site and the surrounding area. These mining activities are believed to be the source of eight areas of concern (AOCs) identified by the Washington State Department of Ecology (Ecology). These eight AOCs are suspected waste rock piles (WRPs) of which five are associated with observed shallow adits or explorations. The eight AOCs are distributed across the Site (Figure A-2) and range in size from approximately 198 square feet to 12,569 square feet. They occupy an area of approximately 33,387 square feet (0.77 acres) and contain an estimated 6,056 cubic yards of waste rock. The WRPs contain elevated levels of several metals.[1] Soils in areas downslope of the toes of the WRPs (DWRPs) also contain elevated levels of several metals.

1.2 Report Organization

This appendix is organized into the following sections:

- Human Health Risk Assessment (Section 2.0) – describes human use of the Site, the potential exposure pathways of humans to mining-related metals in soil, identifies constituents of potential concern (COPCs), and provides a quantitative evaluation of the risks/hazards associated with exposure to these COPCs
- Terrestrial Ecological Evaluation (Section 3.0) – identifies complete ecological exposure pathways to mining-related metals in soil, identifies constituents of potential ecological concern (COPECs), and provides a quantitative evaluation of the hazards associated with exposure to these COPECs
- Summary and Conclusions (Section 4.0) – integrates results of the human health risk assessment and TEE with their respective uncertainty analyses to draw conclusions about potential exposure and risks/hazards
- References (Section 5.0)

[1] For the purpose of this appendix, all metals and metalloids analyzed in Site soil samples are called metals.

2.0 Human Health Risk Assessment

This human health risk assessment is organized into the following sections:

- Exposure Pathways Evaluation (Section 2.1)
- Constituents of Potential Concern (Section 2.2)
- Exposure Assessment (Section 2.3)
- Toxicity Assessment (Section 2.4)
- Risk Characterization (Section 2.5)
- Uncertainty Analysis (Section 2.6)

2.1 Exposure Pathways Evaluation

As described in Section 1.1, the current and future land use for the Site is a public park managed by the City of Wenatchee. The Site is protected from development by a conservation easement held by the CDLT.

The Site borders the City of Wenatchee and is a popular recreational destination for City residents and possibly visitors from other locations. The areas to the north and east of the Site are zoned as Residential Single Family, Residential Low Density, and Office Mixed Use. The Dry Gulch Reserve is located west of the Site and is managed under a CDLT conservation easement. The elevation increases moving west of the Site and enters the forested habitat of the Okanogan-Wenatchee National Forest. Day use of Site trails by hikers, joggers, bicyclists, and horseback riders are the principal human exposure scenarios. There are currently no toilet or water facilities at the Site

The City is now working to identify priorities for improving and maintaining the Site. However, any intrusive soil activities associated with improvement/maintenance of the Site are expected to be of relatively short duration and may not even include coming into contact with elevated concentrations of metals associated with the WRPs. Therefore, a worker exposure scenario is not considered in this risk assessment.

Figure A-3 shows the human health conceptual site model (CSM). The CSM shows the potential sources of contamination, release/transport mechanisms, exposure media, receptors, and exposure routes. The primary sources of contamination include the eight WRPs. These source areas contain elevated levels of some metals. Results of the synthetic precipitation leaching procedure (SPLP) analysis of soil samples from the WRPs indicate a low potential for metals to leach from the WRPs to underlying soil (see Section 6.1.2 of RI/FS report). However, water and wind erosion may act to transport smaller sized particles from the WRP to adjacent soils. It is likely these particles would remain entrained in the upper soil surface.

Metals in the WRPs may be released to the soil where they may be taken up by plants and soil biota. Metals accumulating in plants and soil biota may be consumed by wildlife and accumulate in their tissues. However, harvesting of plants and animals from the Site is expected to be prohibited because of its use as a public park. There are no surface water resources or groundwater wells on the Site, so exposure through the drinking water pathway is incomplete.

Recreational visitors may be exposed to mining-related metals through incidental ingestion of soil. However, the WRP themselves are relatively barren (Figure A-4) and would be unlikely to attract recreational visitors. The inhalation pathway of exposure is considered to be a minor pathway because most metals are not volatile and the areas of the WRPs are considered too small to significantly contribute to the wind-borne particulate load. Also, dermal uptake of metals contained in soil is generally considered to be a minor pathway.

2.2 Constituents of Potential Concern

Constituents of potential concern (COPCs) were identified using three criteria:

- A constituent had to be detected at a frequency of greater than 5 percent
- The soil reasonable maximum exposure point concentration (EPC) for a constituent had to exceed MTCA Method B cleanup level (soil ingestion only)
- The Site soil EPC had to exceed the soil natural background concentration

Background soil and waste rock pile data are provided in Tables 1 and 3, respectively, of the RI/FS. Soil EPCs were calculated using all the Site data from the WRP and DWRP areas. The EPC was the lesser of the 95 percent upper confidence limit (UCL) and the maximum detected concentration. The UCLs were calculated using EPA's ProUCL statistical software.[2] ProUCL output files are provided in Attachment A-1 showing calculated UCLs. A summary statistics table including the UCLs and EPCs is provided at the front of Attachment A-1.

The MTCA Method B levels are based on a residential child exposure scenario. This scenario assumes a child lives on the site and incidentally ingests 200 mg of soil 365 days per year over a 6-year period. This conservative exposure scenario is expected to be protective of an adult residential exposure scenario and other unrestricted land uses.

[2] Version 4.1.01 is available online at http://www.epa.gov/osp/hstl/tsc/software.htm.

Background comparisons were made to test the hypothesis that the mean/median concentrations of metals were less than or equal to the mean/median concentrations in samples from natural background areas. The software and statistical methods recommended in EPA's ProUCL statistical software package were used to make the background comparisons. Nonparametric hypothesis testing methods were used for making the background comparisons. Nonparametric methods were selected because:

- They can be used on data sets with normal and non-normal distributions.
- They have good performance for a wide variety of data distributions.
- They are not unduly affected by outlier observations.
- They can handle data sets with nondetect values.

Following EPA's ProUCL recommendations, the nonparametric Wilcoxon-Mann-Whitney (WMW) test was used when less than 40 percent of the samples from either the Site or background data sets contained nondetect values. A two-sample Gehan test was used when forty percent or more of the samples from either the Site or background areas were nondetect values ("with NDs" mode). The Gehan test was also used when multiple detection limits were present in either the Site or background data sets. The Gehan test was used for selenium and silver. ProUCL output files for all site soils are provided in Attachment A-1. ProUCL output files for background comparisons are provided in Attachment A-2.

Results of COPC screening are shown in Table A-1. These results indicate that arsenic is the only COPC and will be carried into the detailed risk assessment.

2.3 Exposure Assessment

Default exposure values for developing Method B cleanup levels are provided in MTCA Equation 740-1 for noncarcinogens and Equation 740-2 for carcinogens. The only COPC for the Site is arsenic which exhibits both noncarcinogenic and carcinogenic effects. Therefore, Equations 740-1 and 740-2 will form the basis for estimating risks and hazards.

One of the exposure factors used in Equations 740-1 and 740-2 is exposure frequency (EF). Exposure frequency is an estimate of the number of days per year a person comes into contact with contaminants present in site soil. The default Method B exposure frequency is 1, or 365 days per year based on residential land use. However, people do not reside on the Saddle Rock Park Site and a recreational visitor is the most likely user and the most highly exposed receptor. No site-specific data were available to help determine the exposure frequency of recreational users of the Site. Use is expected to vary with weather and season. For example, Site use is expected to be lower during the colder months than during the warmer months. Best professional judgment was used to estimate the maximum likely exposure frequency. Use was assumed to be greatest in months with mean temperatures above 50° F (i.e., April through October.[3] The reasonable maximum use of the Site was estimated to be 104 days per year.[4] This equates to an exposure frequency of 0.28 (104 days of use/ 365 days per year).

In addition, it is not realistic to assume that a recreational visitor spends 100 percent of their time in the WRP and DWRP areas. In the absence of park-specific usage information, the fraction of time (FT) a recreational visitor would spend on the WRP and DWRP areas was estimated as the proportion of the Site occupied by the WRP and DWRP areas. The WRPs cover an approximate area of 0.77 acres. Although the surface area covered by the DWRP areas is not precisely known, it is not expected to exceed the area of the WRPs. For purposes of this risk assessment, the areas covered by the WRP and DWRP are assumed to be 1 acre each. Therefore, FT was estimated to be 0.006 (i.e., 2 acres/325 acres). The FT exposure factor was integrated into Equations 740-1 and 740-2.

2.4 Toxicity Assessment

The toxicity values for arsenic were obtained from EPA's Integrated Risk Information System (IRIS)[5] and are consistent with the toxicity values from Ecology on their Cleanup Levels and Risk Calculations (CLARC) website.[6] The arsenic toxicity values are:

- Oral reference dose (RfDo) = 0.0003 mg/kg/day
- Oral cancer potency factor (CPFo) = 1.5 kg-day/mg

2.5 Risk Characterization

Human health soil screening levels (SSLs) were calculated for arsenic using MTCA Equation 740-1 for noncarcinogenic effects and Equation 740-2 for carcinogenic effects. The standard equations were modified by using an adjusted exposure factor (EF) and adding the fraction of time (FT) factor as described in Section 2.3. The SSL calculations are shown in Table A-2.

The arsenic SSLs are 1,429 mg/kg for noncarcinogenic effects and 397 mg/kg for carcinogenic effects. Since the arsenic EPC for the combined WRP and DWRP areas (220.9 mg/kg) is less than either SSL, it is concluded that arsenic does not pose a hazard or risk to recreational visitors to the Site.

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[3] Wikipedia http://en.wikipedia.org/wiki/Wenatchee,_Washington
[4] Assumes a reasonable maximum use of the Site is 3 days/week from April through October and 1 day/week from November through March.
[5] Available on-line at http://toxnet.nlm.nih.gov/.
[6] Available online at https://fortress.wa.gov/ecy/clarc/CLARCHome.aspx.

2.6 Uncertainty Analysis

There are a number of uncertainties associated with the risk assessment of the Saddle Rock Park Site. First, it is considered highly conservative that a park recreational user (defined here as a child in MTCA Equations 740-1 and 740-2) would incidentally ingest 200 mg of soil per day for 104 days per year for 6 years. Adult recreational users (i.e., joggers, hikers, horseback riders) would likely have significantly lower soil ingestion rates than a residential child. An exposure frequency of 104 days per year may also be quite conservative given the occurrence of other nearby recreational areas (e.g., Wenatchee National Forest, Wenatchee Confluence State Park, Lincoln Rock State Park, Peshastin Pinnacles State Park).

The fraction of time a recreational visitor may spend on the WRP and DWRP areas is also an important source of uncertainty. The actual time spent on the WRP and DWRP areas will depend on a number of factors (e.g., distance to an established path, steepness of the local terrain, location of adjacent features of interest). It is possible that visitors interested in old mining sites may seek out the adits, but once the adits are permanently closed, this type of visitation is expected to cease. Many people are expected to find the WRPs barren and uninviting and would spend little if any time there.

Cancer and noncancer toxicity values from EPA's IRIS were used to evaluate the potential risks and hazards associated with exposure to arsenic constituents at the Site. Since risk at low exposure levels cannot be measured directly by animal experiments or by epidemiologic studies, a number of mathematical models and procedures have been developed for use in extrapolating from high to low doses, which are most similar to potential human exposures from constituents in the environment. While different extrapolation models or procedures may reasonably fit the observed data, they may lead to large differences in the projected risk at low doses. The uncertainty associated with these toxicity values is addressed by incorporating conservative assumptions and modifying factors into the cancer and noncancer toxicity values. The cumulative effect of these conservative toxicity assumptions is to create conservative (i.e., health-protective) risk estimates.

3.0 Terrestrial Ecological Evaluation

This terrestrial ecological evaluation (TEE) is organized into the following sections:

- Purpose and Evaluation Framework (Section 3.1)
- Exclusions Evaluation (Section 3.2)
- Simplified TEE Qualification Evaluation (Section 3.3)
- Site-specific TEE (Section 3.4)

3.1 Purpose and Evaluation Framework

This TEE evaluates potential hazards to terrestrial ecological receptors from residual constituent concentrations present in soil at the Site. The MTCA TEE framework for evaluating constituent concentrations in soil includes three tiers (Figure A-5). Tier 1 (Exclusions from Evaluation in the Terrestrial Ecological Evaluation) consists of a set of criteria that are used to determine if a site can be excluded from further consideration. If results of the Tier 1 assessment indicate the site requires further evaluation, criteria are provided to determine if it should be evaluated using either Tier 2 or Tier 3 procedures. Tier 2 (Simplified TEE) consists of an evaluation of potential ecological exposures, an exposure pathway analysis, and a comparison of constituent concentrations in site soil to default screening concentrations protective of plants and/or animals. If the site passes all Tier 2 criteria (i.e., environmental hazard are not expected to be present), no further evaluation is required. If the site does not pass Tier 2 criteria, it can either proceed toward a feasibility study or a Tier 3 evaluation. Tier 3 (Site-Specific TEE) consists of a detailed ecological evaluation. MTCA provides a general framework for conducting a Tier 3 evaluation, but because of the nature of a site-specific evaluation, MTCA does not provide explicit details for the evaluation.

3.2 Exclusions Evaluation

The first tier in the TEE process is the exclusions evaluation (Figure A-5). MTCA provides four criteria for determining that no further evaluation is required. If any of the four criteria are met, it can be concluded that no further evaluation is required because ecological exposure pathways are incomplete (or *de minimis*) or constituent concentrations are below a level of concern. The four criteria are:

- Criterion 1: All affected soil is, or will be, located below the point of compliance.
- Criterion 2: All affected soil is, or will be, covered by buildings, paved roads, pavement, or other physical barriers that will prevent ecological exposure to the contaminated soil.

- Criterion 3: Undeveloped land on or within 500 feet of the site is less than a quarter of an acre if any highly-toxic constituents are detected in soil, or less than 1.5 acres if highly toxic constituents are not detected in soil.
- Criterion 4: Concentrations of constituents in the soil do not exceed natural background levels.

Criterion 1 assesses whether ecological exposure to constituents in soil will be prohibited because constituents are present only in deep soils. A no further evaluation conclusion may be reached at sites where all detected constituents occur below the conditional point of compliance when institutional controls are in place to prevent excavation of soil below six feet bgs. A review of the soil analytical data for the Site (see Tables 1 and 3 of the RI/FS report) shows that constituents are detected in soil samples collected from within the conditional point of compliance. It is concluded that soil at the Site is affected by constituents within the conditional point of compliance and ecological exposure pathways are potentially complete.

Criterion 2 assesses whether ecological exposure to constituents in soil will be prohibited by a physical barrier. Although physical barriers typically include buildings and areas paved with asphalt or concrete, areas of compacted soil/gravel substrate (e.g., gravel parking lot) may also provide an effective ecological exposure barrier. There are no physical barriers prohibiting ecological exposure either on the WRPs or DWRPs. It is concluded that soil at the Site affected by constituents within the conditional point of compliance is not covered by a physical barrier and ecological exposure pathways are potentially complete.

Criterion 3 assesses whether the site is so small that it is unlikely to pose an ecological hazard because of limited ecological exposure to constituents present in the soil. MTCA provides two sub-criteria dependent upon the type of constituents found at the site. For sites with high priority organic constituents, the criterion is a quarter of an acre of contiguous undeveloped land on or within 500 feet of any area of the site. For sites not affected by high-priority organic constituents, the criterion is 1.5 acres of contiguous undeveloped land on or within 500 feet of any area of the site. Since none of the high priority organic constituents were associated with Site, the 1.5 acres criterion is applicable. The Site contains 325 acres of native vegetation. It is concluded that the Site is of sufficient size that constituents in soil may pose a potential ecological hazard.

Criterion 4 assesses whether constituents in soil pose a *de minimis* ecological hazard because concentrations are below natural background levels. A comparison of site-specific background concentrations presented in Table 4 of the main body of the RI/FS report to Site soil sample concentrations in Table 3 of the main body of the RI/FS report shows that concentrations in many samples are above background. It is concluded that concentrations of some constituents detected in soil at the Site exceed background.

Since none of the four exclusion criteria are met, it is concluded that the Site does not qualify for an exclusion from conducting a more detailed TEE.

3.3 Simplified TEE Qualification Evaluation

Since the Saddle Rock Park Site does not qualify for an exclusion from the TEE process (see Section 3.2), the next step is to decide whether the Site qualifies for a simplified TEE (Figure A-5). MTCA provides four criteria for evaluating whether a site qualifies for a simplified TEE. If any of the four criteria is met, it is concluded that the site does not qualify for a simplified TEE and a site-specific TEE must be performed. The four criteria are:

- Criterion 1: The site is located on, or directly adjacent to, an area where management or land use plans will maintain or restore native or semi-native vegetation.
- Criterion 2: The site is used by (a) a threatened or endangered species (T&E species), (b) a Washington State wildlife priority species or species of concern, or (c) a Washington State endangered, threatened, or sensitive plant species.
- Criterion 3: The site is located on a property that contains at least ten acres of native vegetation within 500 feet of the site.
- Criterion 4: Ecology determines that the site may present a hazard to significant wildlife populations.

Criterion 1 assesses the potential for significant ecological resources to become exposed to constituents present in soil. Since the Site is being managed by the City as a public park and is protected from development by a conservation easement held by the CDLT, it is clear that land use plans include the maintenance or restoration of native or semi-native vegetation. Furthermore, land use plans for adjacent areas (i.e., Dry Gulch Reserve) also include the maintenance of native vegetation.[7] It is concluded that the Site meets criterion 1.

Criterion 2 assesses the potential for exposure of T&E or otherwise listed sensitive species to become exposed to constituents present in soil. A formal request for information regarding the occurrence of T&E species on or adjacent to the Site has not been made. However, information available on-line from the U.S. Fish and Wildlife Service[8] indicates that three federally endangered species and five federally threatened species that live and use terrestrial habitats occur in Chelan County. In addition, a Washington State Department of Transportation

[7] http://www.cdlandtrust.org/what-we-do/land-conservation/wenatchee-foothills/dry-gulch.
[8] http://www.fws.gov/wafwo/speciesmap_new.html

website[9] shows that these species may occur on or near the Site. It is concluded that the Site meets criterion 2.

Criterion 3 assesses the potential for significant ecological resources to become exposed to constituents present in soil. Since the Site contains more than ten acres of native vegetation, it is concluded the Site meets criterion 3.

Based upon meeting criteria 1, 2, and 3 it is concluded that the Site requires a site-specific TEE (Tier 3) to assess ecological hazards.

3.4 Site-specific Terrestrial Ecological Evaluation

The site-specific TEE for the Site is organized into five sections:

- Problem Formulation – identifies constituents of potential ecological concern (COPECs), identifies complete exposure pathways, identifies receptors of concern, and describes potential toxic effects from COPECs
- Exposure Assessment – identifies exposure areas, describes how reasonable maximum exposure point concentrations (EPCs) are calculated, identifies appropriate bioaccumulation factors (BAFs), and identifies appropriate wildlife exposure factors
- Toxicity Assessment – identifies toxicity values to assess hazards from COPECs
- Hazard Characterization – describes how hazards are calculated and provides quantitative hazard estimates
- Uncertainty Analysis – describes major uncertainties associated with the ecological hazard evaluation

3.4.1 Problem Formulation

3.4.1.1 Ecological Setting

The Site falls within the Wenatchee Foothills project area which forms a scenic backdrop for the City of Wenatchee. The vision for the area as expressed in the Wenatchee Foothills Community Strategy document[10] includes:

- The Wenatchee Foothills are a well-managed community resource that provide an extensive network of trails, trailheads, and access points as well as scenic views and vistas for the public to enjoy.

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[9] http://www.wsdot.wa.gov/Environment/Biology/bio_usfw.htm
[10] http://cloud.tpl.org/pubs/convis_wa_wenatchee_foothills.pdf

- The landscape is home to healthy wildlife populations supported by a diversity of native plants and natural lands.
- There is well-planned development that accentuates the natural character of the Foothills.

The Wenatchee Foothills Community Strategy document describes the habitats and wildlife as:

> "The shrub-steppe environment of the Wenatchee Foothills is one of limited water, hot summers, cold winters, and gusty winds. Plant communities are characterized by flowers such as balsamroot, lupine, and yarrow and common shrub-sized plants such as sagebrush and bitterbrush. Higher elevations are scattered with stands of ponderosa pine and Douglas fir and lower elevations and draws are dotted with thickets of Douglas maple and wild cherry. Meadowlark, quail, and hawks are among the numerous birds living in the landscape along with snakes, lizards, and coyotes. Elk, big-horn sheep, turkeys and cougars are also occasionally seen in the area. During winter, mule deer depend on the lower elevations of the Wenatchee Foothills for winter forage."

Major ecosystem types found on the Site include inter-mountain basin big sagebrush shrubland and inter-mountain basin big sagebrush steppe. A significant portion of the Site is designated as containing high value mule deer winter range.

The WRPs are almost devoid of vegetation and provide little habitat for soil biota or wildlife (Figure A-4). Several ponderosa pine trees occur on the WRPs, but these appear to have been growing in the area prior to mining activities and were subsequently inundated by the waste rock. The DWRPs support vegetation typical of the area surrounding the WRPs.

Federally endangered and threatened species that occur within the Site area include:

- Wenatchee Mountains checker mallow (*Sidalacea oregano* var *calva*) (endangered)
- Showy stickseed (*Hackelia ventusta*) (endangered)
- Gray wolf (*Canis lupus*) (endangered)
- Canada lynx (*Lynx Canadensis*) (threatened)
- Grizzly bear (*Ursus arctos horribilis*) (threatened)
- Marbeled murrelet (*Brachyramphus marmoratus*) (threatened)
- Northern spotted owl (*Strix occidentalis caurina*) (threatened)
- Uts ladies'-tresses (*Spiranthes diluvialis*) (threatened)

3.4.1.2 Constituents of Potential Ecological Concern

Constituents of potential ecological concern (COPECs) were identified using three criteria:

- A constituent had to be detected at a frequency of greater than 5 percent
- The soil reasonable maximum exposure point concentration (EPC) for a constituent had to exceed an ecological indicator soil concentration (EISC) provided in MTCA Table 749-3
- The soil EPC had to exceed the soil natural background concentration

Soil EPCs were calculated using all the Site data from the WRPs and DWRPs. The EPC was the lesser of the 95 percent upper confidence limit (UCL) and the maximum detected concentration. The UCLs were calculated using EPA's ProUCL statistical software.[11] ProUCL output files are provided in Attachment A-1. The EPCs are shown in summary statistics tables at the front of Attachment A-1.

Background comparisons were made as described in Section 2.2. tProUCL output files for background comparisons are provided in Attachment A-2.

Results of COPEC screening are shown in Table A-3. These results indicate arsenic, mercury, selenium, and silver are COPECs and were carried into the detailed hazard assessment in the site-specific TEE.

3.4.1.3 Exposure Pathways Evaluation

An ecological conceptual site model (CSM) for the Saddle Rock Park Site is shown in Figure A-6. The CSM shows the potential sources of contamination, release/transport mechanisms, exposure media, receptors, and exposure routes.

The primary sources of contamination include the eight WRPs. These source areas contain elevated levels of some metals. Results of the synthetic precipitation leaching procedure (SPLP) analysis of soil samples from the WRPs indicate a low potential for metals to leach from the WRPs to underlying soil (see Section 6.1.2 of RI/FS report). However, water and wind erosion may act to transport smaller grain-sized particles from the WRP to adjacent soils. It is likely these particles would remain entrained in the upper soil surface.

Metals in the WRP may be released to the adjacent soil and may be taken-up by plants and soil biota. Therefore, exposure media include soil, plants, and soil biota. Terrestrial ecological receptors include plants, soil biota, and wildlife. Plants are potentially exposed through direct dermal contact with the soil. Soil biota are potentially exposed through direct dermal contact with soil, ingestion of soil, and ingestion of plant and soil biota. Wildlife is potentially exposed through ingestion of plants and soil biota, and incidental ingestion of soil.

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[11] Version 4.1.01 is available online at http://www.epa.gov/osp/hstl/tsc/software.htm.

3.4.1.4 Receptors of Concern

The ecological goal for the site-specific TEE described in Section 3.4.1.6 includes the protection of plants, soil biota, and wildlife. Consequently, the receptors of concern are plants, soil biota, and wildlife.

MTCA identifies plants and soil biota as general classes of receptors and does not identify any specific species as surrogate receptors. On the other hand, MTCA identifies three surrogate wildlife receptor species, the shrew, robin, and vole. These three species are representative of two feeding guilds—insectivores (shrew and robin) and herbivores (vole). The assumption in using these three receptor species is that they will be protective of all other wildlife species because they are potentially highly exposed to soil-borne contaminants. This is because they have relatively small home ranges and relatively high food and soil ingestion rates. Although these three species may not occupy the Site, they are protective of similar species that do occupy the Site.

3.4.1.5 Potential Toxic Affects

The COPECs for the Site include arsenic, mercury, selenium, and silver. These COPECs may affect plants, soil biota, and wildlife in a variety of ways. For plants, the primary effects are reduced growth and decreased seed germination. For soil biota primary affects include reduced survival, growth, and reproduction, although little information is available on the effects of silver on soil biota. These COPECs can cause reduced survival, growth, and reproduction in birds and mammals. Certain plants have naturally high levels of selenium which adversely affects grazing animals.

Several on-line sources of ecotoxicological information describe the effects of COPECs. These should be reviewed for more detailed descriptions of ecotoxicological information.

- Contaminant Hazard Review Reports by the U.S. Fish and Wildlife Service available at http://www.pwrc.usgs.gov/infobase/eisler/reviews.cfm
- Environmental Contaminants Encyclopedia by the National Park Service available at http://www.nature.nps.gov/hazardssafety/toxic/index.cfm
- Toxicity profiles in the Risk Assessment Information System by the U.S. Department of Energy available at http://rais.ornl.gov/tools/tox_profiles.html
- Toxicity profiles on the Ecological Toxicity Information website for U.S. EPA Region 5 available at http://www.epa.gov/R5Super/ecology/html/toxprofiles.htm#as

- Toxicity Literature Online (TOXLINE) by the U.S. National Library of Medicine includes ecotoxicology information and is available at http://toxnet.nlm.nih.gov/cgi-bin/sis/htmlgen?TOXLINE
- Ecotoxicological Profiles for Selected Metals and Other Inorganic Chemicals by the U.S. Department of Energy Oak Ridge National Laboratory available at http://www.esd.ornl.gov/programs/ecorisk/guidance_docs.html

3.4.1.6 Ecological Goals and Point of Compliance

MTCA uses land use to help determine the appropriate ecological goal for the TEE (WAC 173-340-7490(3)). For industrial or commercial properties, the ecological goal is the protection of wildlife (i.e., birds and mammals). For all other land uses, the ecological goal is protection of plants, soil biota (i.e., invertebrates), and wildlife. Since the Site is zoned as "Undeveloped Land" and neither industrial nor commercial uses apply, the goal of this site-specific TEE is the protection of plants, soil biota and wildlife. Typically, the goal is to protect populations of organisms from significant adverse effects where adverse effects are effects that impair reproduction, growth, or survival. For species protected under the endangered species act, protection is extended to individuals of a species.

The standard point of compliance for a TEE extends from the soil surface to a depth of 15 feet (WAC 173-340-7490(4)). MTCA also allows the use of a conditional point of compliance which represents the typical bioactive soil layer extending from 0- to 6-feet below ground surface. The conditional point of compliance represents a conservative estimate of the maximum depth of rooting and burrowing of soil biota and wildlife. However, site-specific conditions may limit the bioactive soil layer to less than the default bioactive layer of 0- to 6-feet. MTCA provides for the development of site-specific points of compliance for the TEE based upon analysis of the biological and physical conditions present at the site. A conditional point of compliance was selected for the Saddle Rock Park Site.

3.4.2 Exposure Assessment

This exposure assessment is organized into four sections:

- Identification of exposure areas
- Calculation of exposure point concentrations for soil
- Identification of bioaccumulation factors for estimating accumulation of COPECs from soil into plants and soil biota
- Identification of wildlife exposure factors for use in exposure models

3.4.2.1 Exposure Areas

Three exposure areas are identified for this site-specific TEE, the Site as a whole, the WRPs, and DWRPs.

The Site exposure area is defined by the property boundary as covering 325 acres including the WRPs and DWRPs exposure areas. Most of this exposure area is relatively undisturbed and consists of a low density grass/shrub plant community with some trees. It provides reasonably good habitat quality for a variety of biota. Plant and soil biota populations live within the Site and are exposed to elevated metals concentrations associated with the WRPs and DWRPs exposure areas, as well as metals concentrations in areas unimpacted by the WRPs. Wildlife move freely within the Site exposure area and are also exposed to areas with and without soil impacted by the WRPs.

The WRP exposure area covers approximately 0.77 acres. The WRPs are almost devoid of vegetation and provide limited resources for soil biota and wildlife. The WRPs also have the highest metals concentrations in soil.

The DWRPs covers an as yet undetermined area, but is expected to be less than 1 acre given the WRPs themselves cover less than 1 acre. Habitat quality is reasonably good, but this exposure area is impacted by migration of metals from the WRPs.

3.4.2.2 Exposure Point Concentrations

For the WRP and DWRP exposure areas, the reasonable maximum exposure point concentrations (EPCs) were calculated using the methodologies described in Section 3.4.1.2. Only soil samples collected from within each of the exposure areas were used to derive EPCs for that exposure area.

For the Site exposure area, an area-weighted approach was used to derive the EPCs. First, EPCs were calculated for the WRP exposure area, DWRP exposure area, and background area (i.e., those areas of the Site not affected by the WRPs). Then the Site exposure area EPC was calculated using Equation A-1:

Equation A-1:

$$EPC_{Site} = \frac{\left[\left(AREA_{WRP} \times EPC_{WRP}\right) + \left(AREA_{DWRP} \times EPC_{DWRP}\right) + \left(AREA_{Background} \times EPC_{Background}\right)\right]}{AREA_{total}}$$

Where:

EPC_{Site} = metal EPC for the Site exposure area (mg/kg)

$AREA_{WRP}$ = area covered by the WRPs (acres); assumed to be 1 acre
EPC_{WRP} = metal EPC for the WRP (mg/kg)
$AREA_{DWRP}$ = area covered by the DWRP (acres); assumed to be 1 acre
EPC_{DWRP} = metal EPC for the DWRP (mg/kg)
$AREA_{Background}$ = area covered by the background area (acres); assumed to be 323 acre
$EPC_{Background}$ = metal EPC for background (mg/kg)
$AREA_{Total}$ = total area of the Site (acres); assumed to be 325 acres

ProUCL output files showing the UCLs for the WRP and DWRP exposure areas, and background area are provided in Attachment A-3. The EPCs and area-weighted EPC calculations are shown in tables at the front of Attachment A-3

3.4.2.3 Bioaccumulation Factors

The U.S. Environmental Protection Agency (EPA) has developed ecological soil screening levels (EcoSSLs) for use in screening hazardous waste sites across the nation. The bioaccumulation factors (BAFs) provided in the EcoSSLs are considered state-of-the-art and will be used in this site-specific TEE. EcoSSLs have been developed for arsenic, selenium, and silver, but not mercury. EcoSSL BAFs (EPA 2007a) are shown in Table A-4.

EPA (2007a) used earthworms as a surrogate for soil biota to derive BAFs (Table A-4). This was also done in MTCA (Table 749-5) because sufficient published data exists to derive BAFs for earthworms, but this is not the case for other soil biota.

Also, three of the bioaccumulation factors shown in Table A-4 are actually BAFs (the ratio of concentration in tissue divided by the concentration in soil), while the three other bioaccumulation factors are regression equations. Bioaccumulation regressions for metals are considered superior to BAF because the bioaccumulation of metals is not constant over a range of soil concentrations. BAFs were used by EPA to estimate bioaccumulation when regressions could not be derived. The use of regression equations to estimate bioaccumulation complicates the development of EISCs in the site-specific TEE in that separate EISCs will be developed for each ecological exposure area. This is discussed further in Section 3.4.4.

3.4.2.4 Wildlife Exposure Factors

EPA also developed wildlife exposure factors to support the development of the EcoSSLs (EPA 2007a). The wildlife exposure factors provided in the EcoSSLs are considered state-of-the-art and will be used in this site-specific TEE.

The MTCA TEE process uses the vole, shrew, and robin to assess hazards to wildlife. EPA used a wider variety of wildlife receptors which included the vole, shrew, and American woodcock. The robin and woodcock have similar feeding strategies; both consume earthworms and other invertebrates. In fact, the food and soil ingestion rates for the woodcock (EPA 2007a) are slightly higher than those for the robin (MTCA Table 749-4). Therefore, the exposure factors for the woodcock will be used in this site-specific TEE.

Wildlife exposure factors are shown in Table A-5. Exposure factors from both the EcoSSLs and MTCA (Table 749-4) are used because EPA did not provide values for the proportion of contaminated food in diet (P) or the gut absorption factor (RGAF).

3.4.3 Toxicity Assessment

EPA has also developed toxicity values to support the development of the EcoSSLs. The toxicity values provided in the EcoSSLs are considered state-of-the-art and will be used in this site-specific TEE.

EPA developed EcoSSL protective of plants and soil biota for arsenic (EPA 2005), selenium (2007b), and silver (2006), but not for mercury. EPA (2003a) conducted a comprehensive literature search to identify and acquire potentially relevant toxicology literature for use in setting EcoSSLs for plants and soil invertebrates. Once the literature was assembled, the following process was used to derive EcoSSLs for plants and soil invertebrates (EPA 2003b):

- Toxicity studies were reviewed and scored using nine experimental quality criteria. Each criterion was scored 0, 1, or 2 with 2 being the highest score. A minimum score of 10 was required to conclude the study was acceptable.
- A minimum of three acceptable toxicity values were required to derive an EcoSSL.
- Only toxicity data for ecologically relevant endpoints was used. Endpoint preference was reproduction > population > growth. However, most of the plant toxicity studies used the endpoint of biomass production.
- If data for more than one toxicity parameter were reported for a study, a preferred toxicity value was selected based on the following hierarchy: effects concentration 20 (EC20) > maximum allowable threshold concentration (MATC) > effects concentration 10 (EC10), where EC20 and EC10 are effect concentrations for 20 and 10 percent of the population and the MATC is the maximum acceptable threshold concentration. The MATC was calculated as the geometric mean of the No Observed Adverse Effect Concentrations (NOAEC) and the LOAEC.
- The EcoSSL was calculated as the geometric mean of at least three acceptable toxicity values.

EPA used toxicity studies on earthworms, potworms, springtails, and nematodes to characterize adverse effects on soil invertebrates. Virtually all of the plant toxicity studies were conducted using agronomic crops (lettuce, radish, beans, wheat, etc.).

The EcoSSLs for plants and earthworms are considered biologically equivalent to the MTCA EISCs for plants and soil biota and are shown in Table A-4. Insufficient data were available to derive soil biota toxicity values for arsenic and silver.

The toxicological data used by EPA to derive the wildlife toxicity reference values (TRVs) is relatively current, comprehensive, and is state of the art. EPA conducted comprehensive literature surveys and identified ecotoxicity publications meeting specific scientific criteria for use in deriving TRVs for birds and mammals (EPA 2003c). A preliminary review of each article was conducted to determine if the article contains data suitable for TRV derivation. For example, studies based on acute exposure, reporting results for dead animals, using mixtures of constituents, studies lacking experimental controls, studies not reporting a test duration, and studies reporting data from research not conducted by the author were deemed unsuitable. Each study was then reviewed in detail and scored using ten data quality criteria (EPA 2007a). Total scores range from 0 to 100 and a minimum score of 66 was required for acceptance of the study. Finally, no-observed-adverse-effect-level (NOAEL) and lowest-observed-adverse-effect-level (LOAEL) TRVs were derived for each study and expressed as a daily dose of constituent (mg/kg/d).

Bird and mammal toxicity data were available for arsenic (EPA 2005), selenium (EPA 2007b), and silver (EPA 2006). Only bird and mammal TRVs based on LOAEL toxicity data were used to derive the TRVs for this site-specific TEE. This approach is consistent with MTCA methodology (WAC 173-340-7493(4)(a)). Toxicity data for growth, reproduction, and survival endpoints were used. A minimum of three acceptable toxicity values were needed to derive an alternative TRV consistent with EPA EcoSSL methodology (EPA 2003c, 2007a). The tenth percentile value of the LOAELs was selected as the alternative TRV. The tenth percentile value is considered sufficiently protective and reduces uncertainties associated with toxicity values occurring at the extremes of the data distribution (i.e., data outliers). The mammal and bird TRVs derived from this process are shown in Table A-6 and the toxicity data used to derive those values are provided in Attachment A- 4.

3.4.4 Hazard Characterization

Hazards are assessed by comparing the soil EPCs for the WRP, downslope WRP, and Site exposure areas to EISCs for plants, soil biota, and wildlife. The EISCs for plants and soil biota are presented in Table A-6 for arsenic, selenium, and silver. Since EPA did not develop an EcoSSL for mercury, the plant and soil biota EISCs in MTCA (Table 749-3) will be used.

The wildlife EISCs for arsenic, selenium, and silver were derived using bioaccumulation factors presented in Table A-4, exposure factors presented in Table A-5, and toxicity values presented in Table A-6. The standard MTCA (Table 749-4) wildlife exposure models were used to derive the site-specific wildlife EISCs and the detailed models are presented in Attachment A-5. Since EPA did not derive EcoSSLs for mercury, the food and soil ingestion rates from the EcoSSLs were used along with default MTCA BAFs and toxicity values (MTCA Table 749-5) to derive wildlife EISCs.

Hazard quotients (HQs) are used to help interpret hazards. HQs are calculated by dividing the soil EPC by the EISC for each COPEC. An HQ greater than one (1) suggests a potential ecological hazard.

HQs for the WRP, DWRP, and SITE exposure areas are shown in Table A-7. For the WRP exposure area the largest HQ was for mercury for soil biota (HQ = 82). HQs also exceeded 10 for plants for arsenic (HQ = 15) and mercury (HQ = 27). Arsenic had HQs greater than 1 and less than 7 for the shrew, robin, and vole. Mercury had an HQ of 2 for the robin.

HQs were lower in the DWRP exposure area. The highest HQ was for mercury for soil biota (HQ = 10). Plant HQ were above one for arsenic (HQ = 8), mercury (HQ = 4), and selenium (HQ = 2). The only wildlife HQ above one was from arsenic for the shrew and robin (HQ = 3). Although, the depth of soil affected by metals migrating from the WRP area to the DWRP area has not been determined, it is expected to be limited to the upper foot of soil. This is because results of SPLP analyses indicate low leachability of metals from the WRPs, so the most likely transport mechanism is erosion of particulates from the WRP area to the DWRP area. These particles will likely become entrained in the upper foot of soil in the DWRP area.

HQs were still lower for the SITE exposure area. The only HQs above 1 were for arsenic in plants (HQ = 3) and selenium in plants (HQ = 2). However, a review Attachment A-3 shows the EPC for arsenic background is 52.02 mg/kg and the EPC for the Site is 52.99 mg/kg. Therefore, it can be safely concluded that arsenic concentrations in the Site area are not elevated above background. The detection frequency for selenium in soil samples is 53 percent in WRPs, 13 percent in DWRPs, and 0 percent in background. The maximum reported detection limit for selenium in background is 0.9 mg/kg (range 0.5 to 0.9 mg/kg) and the Site EPC is 0.9 mg/kg indicating the selenium soil concentrations in the Site exposure area are not elevated above background.[12] These results indicate that ecological hazards from metals associated with the

[12] It is also interesting to note that while the selenium EPC for the Site exposure area (0.9 mg/kg) is above the plant SSL obtained from EPA's EcoSSL document (0.52 mg/kg), the selenium EPC is below the MTCA plant EISCs of 1.0 mg/kg.

WRPs are below a level of concern for populations of plants and animals when considering an area weighted exposure scenario.

3.4.5 Uncertainty Analysis

A qualitative summary of principal uncertainties associated with the site-specific TEE for the Saddle Rock Park Site are presented in Table A-8. Best professional judgment was used in the direction and magnitude of uncertainty. The direction of uncertainty was categorized as overestimating hazards, underestimating hazards, or unknown. The magnitude of uncertainty was categorized as low, medium, or high.

The use of generic soil-based toxicity values for plants and soil biota (i.e., MTCA EISCs or EcoSSLs) is a major source of uncertainty. Applying soil-based toxicity values will often show unacceptable hazards. This is because these values are often based on exposing test plants and soil biota to highly bioavailable forms of the constituents under laboratory conditions. The comparison of tissue-based toxicity values to site-specific tissue data often shows acceptable hazards when soil-based values show unacceptable hazards. This is because the site-specific bioavailability of the constituents is often lower than that in the laboratory toxicity tests.

Metal concentrations on the WRPs may be toxic to plants and or soil biota. However, an important contributing factor to the lack of vegetation, and probably soil biota as well, is the physical/chemical properties of the material. Waste rock is typically coarse grained and very low in organic matter and essential nutrients. The coarse-grained texture of the material translates to a low water holding capacity. In an arid area like the Site, water is a limiting factor for plants and soil biota.

At mine waste sites, waste materials often have depressed pH values. The pH can affect the bioavailability of metals. For example, arsenic is typically more tightly bound at low soil pH and is therefore less bioavailable. Other metals may become more bioavailable at low soil pH.

Use of generic bioaccumulation factors obtained from the literature (e.g., MTCA BAFs and EcoSSL BAFs) are another important source of uncertainty in characterizing hazards to wildlife. As discussed above, the bioavailability of metals at specific sites can often very significantly from the values published in the literature. Although the direction of this uncertainty is unknown for the Saddle Rock Park Site, the magnitude of uncertainty is expected to be moderate.

A conditional point of compliance (POC) of 0-6 feet has been assumed for the Site. For the DWRP exposure area, soils samples were collected from the upper 6 inches because it is believed that particulates eroding from the WRPs will become entrained in this stratum.

However, it is assumed that plants, soil biota, and wildlife will be exposed to metals present in soil throughout the conditional POC. This exposure can happen through direct contact with deeper soils (i.e., plant rooting, burrowing soil biota, burrowing wildlife) or through mixing of the soil over time through bioturbation. In either case, a more appropriate estimate of exposure of ecological receptors to metals present in the soil would be to include samples from throughout the conditional POC. The high-biased sampling done on the DWRP exposure area will overestimate exposure of ecological receptors to metals present in soil within the conditional POC. Although WRPs SR-02, SR-03, and SR-04 have maximum depths approaching or exceeding 6 feet, the depths of the SR-01, SR-05, SR-06, SR-07, and SR-08 are estimated to range from 1.5 to 2.5 feet. It is likely that exposure estimates for the WRPs with depth less than 6 feet may also be overestimated.

Another significant uncertainty is the estimate of population impacts. The overall objective of this ecological hazard assessment is to protect populations of organisms that may come into contact with mining-related metals. Although the definition of a population varies greatly among scientists and resource managers, we can assume the populations of interest for the Saddle Rock Park Site are defined as occurring within the boundaries of the Site. Since the total area impacted by the WRPs is less than 2 acres and the Site covers an area of 325 acres, less than 0.6 percent of the Site is potentially impacted by mining-related metals. Casual observations indicate the plant populations and community that inhabit the unimpacted portions of the Site appear to be comparable to plant populations and communities in surrounding areas. Although no observations of soil biota populations and communities were made, it is safe to assume that if they are occupying the unimpacted portions of the Site they should be comparable to populations and communities in the surrounding areas. Also, even if 0.6 percent of a population of plants or soil biota suffer mortality due to exposure to metals, the remaining 99.4 percent of the population should be more than sufficient to maintain population viability.

Wildlife is more mobile than plants and soil biota. They can move around the Site in search of food and resting/breeding areas. They are likely to avoid the WRPs because of the lack of suitable habitat. They are also unlikely to become exposed to metals associated with the WRPs because there is no forage and little invertebrate prey present there. The DWRP areas do provide habitats comparable to those found on the rest of the Site, but the DWRP areas also have lower metals concentrations. Therefore, it is highly unlikely that metals in WRP and DWRP areas would pose a hazard to local wildlife populations.

Federally threatened and endangered species do potentially inhabit the Site and surrounding areas. These include both plant and wildlife species. Listed species are protected down to the individual level. It is highly unlikely that the WRPs would provide suitable habitat to listed plants species. The DWRP area could potentially support listed plant species that would be exposed to elevated levels of metals. However, elevated metals concentrations in the DWRP area are expected to be limited to the upper foot of soil and many plants have root systems that go deeper than 1 foot. Therefore, plants growing in the DWRP area would be exposed to both elevated metals in the upper foot and lower levels at depth. This would act to reduce exposure. Individuals of listed wildlife populations have large home ranges and would be little exposed to elevated metals levels associated with the WRPs.

4.0 Summary and Conclusions

4.1 Human Health Risks and Hazards

The Saddle Rock Park Site consists of 325 acres and is managed as a public park by the City of Wenatchee. The Site is relatively undeveloped consisting of old jeep trails that are used by hikers, joggers, and bicyclists. The Site historically contained several small mining operations which resulted in eight waste rock piles (WRPs) source areas covering an estimated area of 0.77 acres. The WRPs contain elevated levels of several metals which have migrated onto adjacent soils located downslope of the toes of the WRPs (DWRP areas). Risks and hazards to humans from potential exposure to elevated metals concentration at the WRP and DWRP areas were evaluated using methods consistent with MTCA. The recreational visitor was identified as the maximally exposed individual and this exposure scenario was used to characterize hazards and risks at the Site. Potential exposure for the recreational visitor was characterized as minor (*de minimis*) based upon site-specific estimates of exposure frequency and the fraction of time spent on these areas. Consequently, hazards and risks to human health were assessed and were found to be below a level of concern. Uncertainties associated with this health assessment are unlikely to underestimate risks or hazards.

4.2 Ecological Hazards

The 325-acre Saddle Rock Park Site encompasses significant amounts of inter-mountain basin big sagebrush shrubland and inter-mountain basin big sagebrush steppe ecosystem types which are home to a variety of plants and animals. Although it is located on the western border of the City of Wenatchee, many areas located to the north, west, and south of the Site are protected and contain high value habitats. A significant portion of the Site is designated as containing high value mule deer winter range. Several endangered or threatened species occur within the area, although none have been confirmed as occurring on the Site. Eight small waste rock piles (WRPs), five of which appear to be derived from historic mining operations, cover an area of approximately 0.77 acres and adjacent lands located downslope of the WRP (DWRPs) have been impacted by migration of metals from the WRPs. The WRPs contain little vegetation and therefore the habitat quality is low. The hazards of elevated metals concentrations in soil to terrestrial plants and animals on the WRPs and DWRPs were evaluated using methods consistent with MTCA terrestrial ecological evaluation (TEE) process.

Hazards to plants and animals were assessed by comparing ecologically protective soil screening levels (SSLs) for plants, soil biota, and wildlife to reasonable maximum exposure point concentrations (EPCs) for soil. EPCs were derived for three potential ecological exposure areas: the WRPs, DWRPs, and the Site (includes the WRPs, DWRPs, and the entire 325-acre Site). Results of the assessment for the WRP and DWRP exposure areas show potential hazards exist from arsenic, mercury, and selenium to one or more receptor groups (i.e., plants, soil biota, and wildlife). However, hazards were either below a level of concern or soil concentrations were comparable to background for the Site exposure area for all receptor groups. The overall goal of the TEE process is protection of populations of plants and animals. These populations occupy relatively large areas while the areas containing elevated levels of metals (i.e., WRPs and DWRPs) are relatively small (estimated to be less than 2 acres). Therefore, only a small portion of the populations of sessile organisms (i.e., plants and to some degree soil biota) will be impacted by elevated metals levels. Likewise, only a small portion of the populations of mobile wildlife with individual small home ranges (i.e., vole or shrew) will be impacted by elevated metals levels. Populations of highly mobile wildlife (i.e., birds and mammals) will spend only a fraction of their time in contact with the WRPs and DWRPs. Based on the goal of the protection of populations of plants and animals, results for the Site exposure area are considered most appropriate and it is concluded that the elevated levels of metals at the WRPs and DWRPs exposure area do not pose an unacceptable ecological hazard. Uncertainties associated with this TEE are unlikely to underestimate ecological hazards.

5.0 References

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U.S. Environmental Protection Agency (EPA). 2003b. Attachment 3-2. Guidance for Developing Ecological Soil Screening Levels (Eco-SSLs), Eco-SSL Standard Operating Procedure (SOP) #2: Plant and Soil Invertebrate Literature Evaluation, Data Extraction, and Eco-SSL Calculation. OSWER Directive 92857-55. Available on-line at http://www.epa.gov/ecotox/ecossl/.

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Table A-1 Identification of Constituents of Potential Concern

Constituent	Detection Frequency	EPC (mg/kg)	Site > Background?	MTCA Method B Soil Ingestion [a]	COPC?	Rational
Aluminum	100	12,037	No	80,000	No	Below background and Method B level
Antimony	0	--	--	32	No	Not detected
Arsenic	100	220.9	Yes	0.67	Yes	Above background and Method B level
Barium	100	122.8	No	16,000	No	Below background and Method B level
Chromium	100	7.42	No	120,000 (240) [b]	No	Below background and Method B level
Iron	100	25,145	No	56,000	No	Below background and Method B level
Lead	100	14.45	No	250 [c]	No	Below background and Method A level
Manganese	100	274.3	No	11,200	No	Below background and Method B level
Mercury	100	6.01	Yes	8 [d]	No	Below Method B level
Selenium	42	1.326	Yes	400	No	Below Method B level
Silver	94	9.242	Yes	400	No	Below Method B level
Vanadium	100	23.69	No	5.6	No	Below background

[a] WAC 173-340-740(3). MTCA Method B unrestricted land use soil cleanup standards. For carcinogenic constituents, the value presented is the

[b] The value is for chromium III and the value in parenthesis is for chromium VI.

[c] A Method B value is not available for lead. The lead value is the Method A level.

[d] A Method B value for elemental mercury is not available. This value is the lowest of Method B values for mercuric chloride (24 mg/kg) and methyl mercury (8 mg/kg).

EPC - reasonable maximum exposure point concentration for the WRP and DWRP areas.

COPC - constituent of potential concern

Highlighted constituents are identified as COPCs.

Table A-2 Calculation of Soil Screening Levels for Arsenic

Noncancer Soil Screening Level (mg/kg) = (RfDo xABW x UCF x HQ x AT)/(SIR x AB1 x EF x ED x FT)

Where:	Value
RfDo = Oral reference dose for arsenic (mg/kg-day)	0.00003
ABW = Average body weight over the exposure duration (kg)	16
UCF = Unit conversion factor (mg/kg)	1,000,000
SIR = Soil ingestion rate (mg/day)	200
AB1 = Gastrointestinal absorption fraction (unitless)	1
EF = Exposure frequency (unitless)	0.28
HQ = Hazard quotient (unitless)	1
AT = Averaging time (years)	6
ED = Exposure duration (years)	6
FT = Fraction of time spent on WRP and DWRP areas (unitless)	0.006

Arsenic Noncancer Soil Screening Level (mg/kg) = 1429

Cancer Soil Screening Level (mg/kg) = (Risk x ABW x AT x UCF)/(CPFo x SIR x AB1 x EF x ED x FT)

Where:	Value
RISK = Acceptable cancer risk level (unitless)	0.000001
ABW = Average body weight over the exposure duration (kg)	16
AT = Averaging time (years)	75
UCF = Unit conversion factor (1,000,000 mg/kg)	1,000,000
CPFo = Oral Carcinogenic Potency Factor for arsenic (kg-day/mg)	1.5
SIR = Soil ingestion rate (mg/day)	200
AB1 = Gastrointestinal absorption fraction (unitless)	1
ED = Exposure duration (years)	6
EF = Exposure frequency (unitless)	0.28
FT = Fraction of time spent on WRP and DWRP areas (unitless)	0.006

Arsenic Cancer Soil Screening Level (mg/kg) = 397

Table A-3 Identification of Constituents of Potential Ecological Concern

Constituent	Detection Frequency	Soil EPC (mg/kg)	Site > Background?	MTCA EISCs (mg/kg) Plants	Soil Biota	Wildlife	COPEC?	Rational
Aluminum	100	12,037	No	50	--	--	No	Below background
Antimony	0			5	--	--	No	Not detected
Arsenic	100	220.9	Yes	10	60	132	Yes	Above background and EPC > all EISCs
Barium	100	122.8	No	500	--	102	No	Below background
Chromium	100	7.42	No	42	42	67	No	Below background and EPC < all EISCs
Iron	100	25,145	No	--	--	--	No	Below background
Lead	100	14.45	No	50	500	118	No	Below background and EPC < all EISCs
Manganese	100	274.3	No	1,100	--	1,500	No	Below background and EPC < all EISCs
Mercury	100	6.01	Yes	0.3	0.1	5.5	Yes	Above background and EPC > all EISCs
Selenium	42	1.326	Yes	1	70	0.3	Yes	Above background and EPC > EISCs for plants and wildlife
Silver	94	9.242	Yes	2	--	--	Yes	Above background and EPC > plant EISC
Vanadium	100	23.69	No	2	--	--	No	Below background

Highlighted constituents are identifed and COPECs.

Table A-4. EcoSSL Bioaccumulation Factors

Constituent	Soil to Plants	Soil to Earthworms
Arsenic	Cp = 0.03752 * Cs	ln(Ce) = 0.706 * ln(Cs) - 1.421
Selenium	ln(Cp) = 1.104 * ln(Cs) - 0.677	ln(Ce) = 0.733 * ln(Cs) - 0.075
Silver	Cp = 0.014 * Cs	Ce = 2.045 * Cs

Cp = concentration in plants (mg/kg dry weight)
Cs = concentrations in soil (mg/kg dry weight)
Ce = concentration in earthworms (mg/kg)

Table A-5. Wildlife Exposure Factors

Factor	Units	Shrew	Robin	Vole	Source
Food Ingestion Rate (FIR)	kg dry food/kg body weight/d	0.209	0.214	0.0875	EPA (2007)
Proportion of Contaminated Food in Diet (P)	unitless	0.5	0.52	1	MTCA Table 749-4
Soil Ingestion Rate (SIR) [1]	kg dry soil/kg body weight/d	0.00627	0.0351	0.0028	EPA (2007)
Gut Absorption Factor (RGAF) [2]	unitless	1	1	1	MTCA Table 749-5

[1] EPA (2007) expressed the soil ingestion as the 90th percentile of the percent soil in the diet (vole = 3.2%, shrew = 3.0%, woodcock = 16.4%). These were converted to a soil ingestion rate by multiplying the food ingestion rate by the percent soil in the diet.

[2] The gut absorption factor is a constituent-specific factor that estimates the absorption of a constituent from soil relative to its absoprtion from food. Although it is likely that a significant proportion of the metas will be tightly bound to soil and not absorbed by the gut, the assumption was made that 100% of the arsenic, mercury, selenium, and silver present in the soil will be absorbed.

Table A-6. Toxicity Values

Constituent	SSL Plants (mg/kg in soil)	SSL Soil Biota (mg/kg in soil)	TRV Mammals (mg/kg BW/d)	TRV Birds (mg/kg BW/d)
Arsenic	18	NA	0.672	1.902
Selenium	0.52	4.1	0.239	0.291
Silver	560	NA	74.2	65.5

NA - not available, insufficient data to derive value
BW - body weight
d - day
SSL - soil screening level
TRV - toxicity reference value

Table A-7 Ecological Hazard Quotients

WRP Exposure Area

Consituent	Soil EPC (mg/kg)	EISCs (mg/kg)					Hazard Quotients				
		Plant	Soil Biota	Shrew	Robin	Vole	Plant	Soil Biota	Shrew	Robin	Vole
Arsenic	262.1	18	NA	60	47	110	15	NA	4	6	2
Mercury	8.188	0.3	0.1	19.8	4.9	212.2	27	82	0	2	0
Selenium	1.582	0.52	4.1	3	2	5	3	0	1	1	0
Silver	9.133	560	NA	337	249	18435	0	NA	0	0	0

DWRP Exposure Area

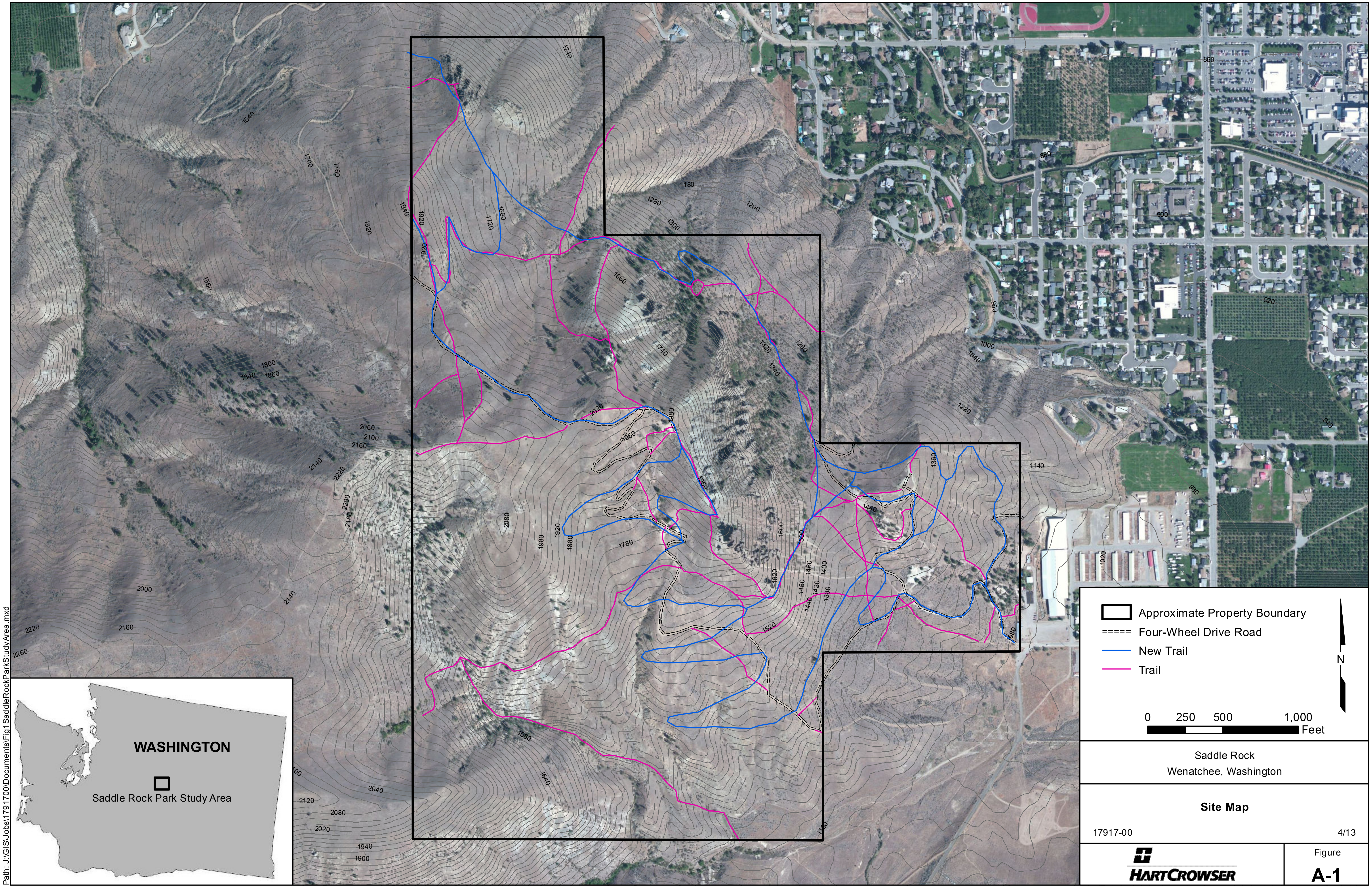
Consituent	Soil EPC (mg/kg)	EISCs (mg/kg)					Hazard Quotients				
		Plant	Soil Biota	Shrew	Robin	Vole	Plant	Soil Biota	Shrew	Robin	Vole
Arsenic	146.1	18	NA	56	46	110	8	NA	3	3	1
Mercury	1.22	0.3	0.1	19.8	4.9	212.2	4	12	0	0	0
Selenium	0.83	0.52	4.1	2	2	5	2	0	0	0	0
Silver	5.658	560	NA	337	249	18435	0	NA	0	0	0

SITE Exposure Area

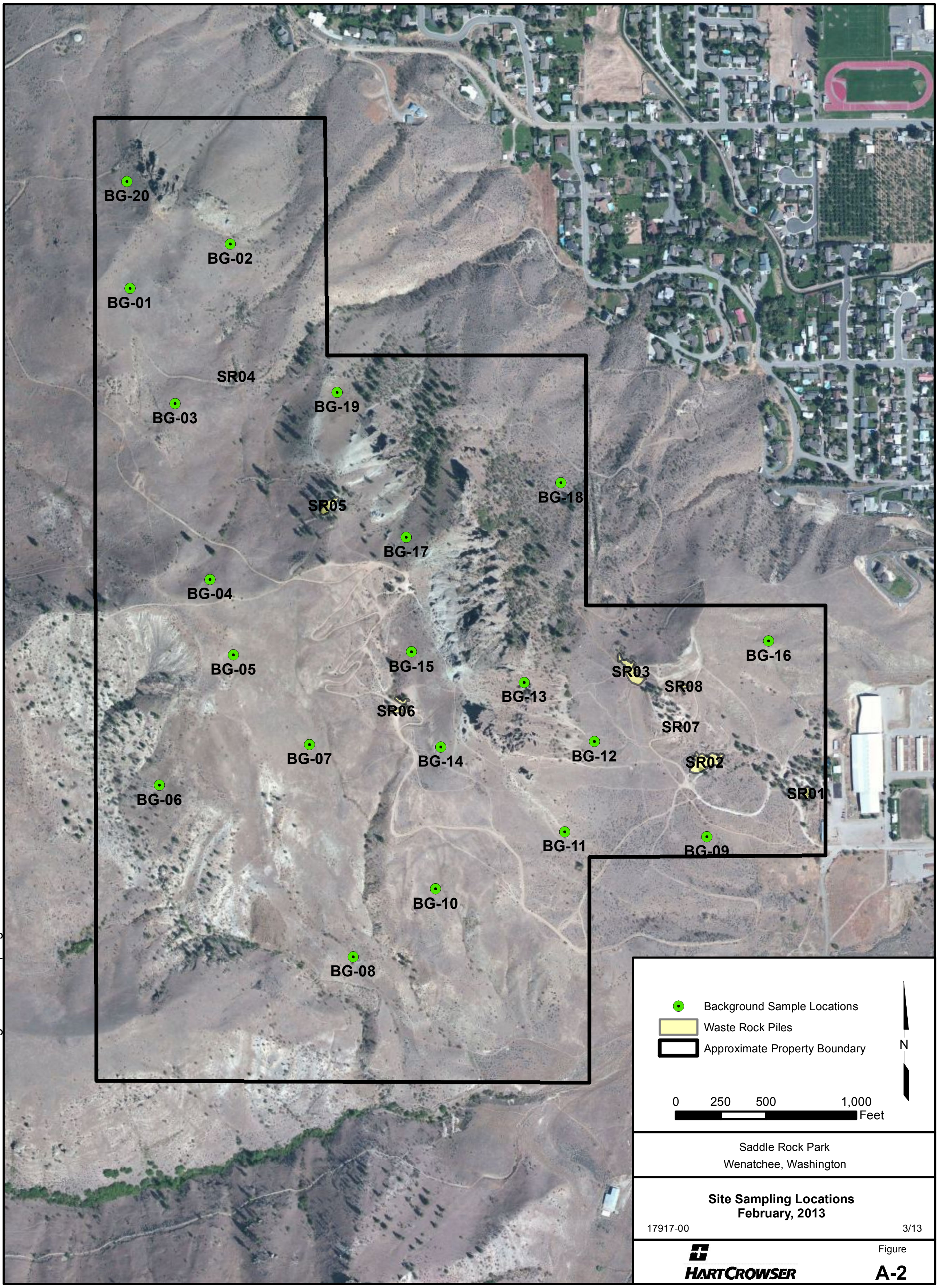
Consituent	Soil EPC (mg/kg)	EISCs (mg/kg)					Hazard Quotients				
		Plant	Soil Biota	Shrew	Robin	Vole	Plant	Soil Biota	Shrew	Robin	Vole
Arsenic	52.99	18	NA	48	44	110	3	NA	1	1	0
Mercury	0.07	0.3	0.1	19.8	4.9	212.2	0	1	0	0	0
Selenium	0.9	0.52	4.1	2	2	5	2	0	0	0	0
Silver	0.32	560	NA	337	249	18435	0	NA	0	0	0

Table A-8 Summary of Uncertainties

Source	Direction	Magnitude
Characterization of Nature and Extent of Contamination	Unknown	Low
Toxicity Values for Plants and Soil Biota	Over	High
Toxicity Values for Wildlife	Unknown	Low
Bioaccumulation Factors	Unknown	Moderate
Exposure in the DWRP Exposure Area	Over	High
Population Level Impacts	Over	High



Path: J:\GIS\Jobs\1791700\Documents\Fig1SaddleRockParkStudyArea.mxd



Path: J:\GIS\Jobs\1791700\Documents\FigA2SiteSamplingLocations.mxd

Saddle Rock Park
Wenatchee, Washington

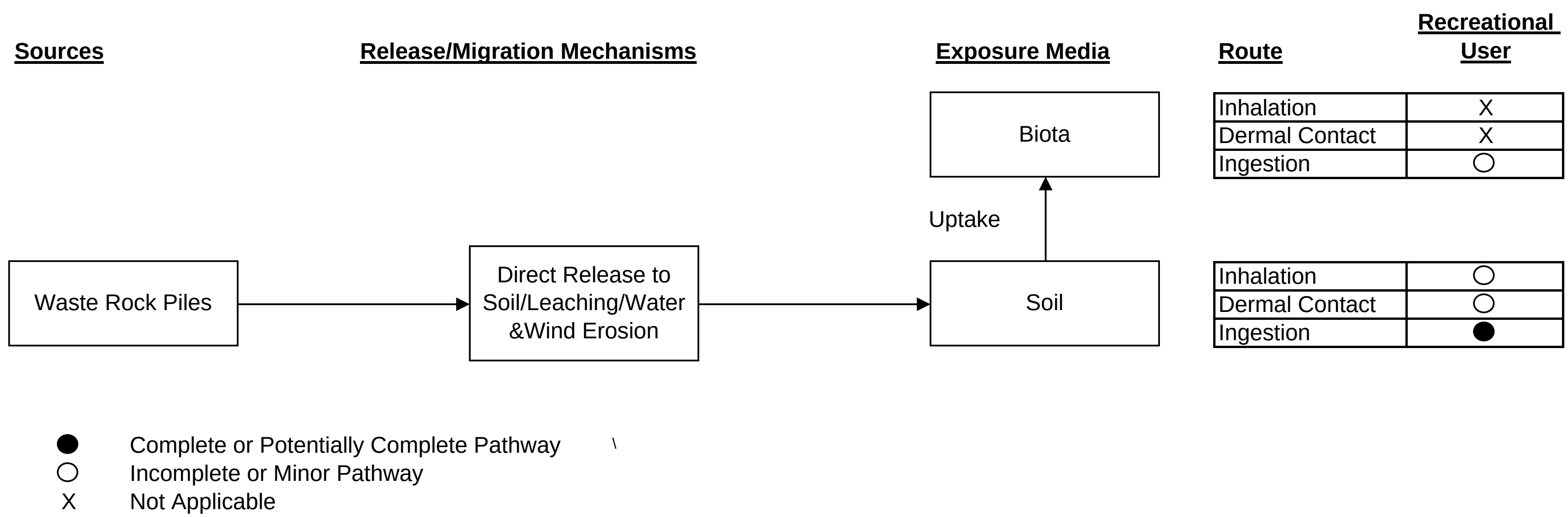
Site Sampling Locations
February, 2013

17917-00 3/13

HARTCROWSER

Figure
A-2

Figure A-3. Human Health Conceptual Site Model



Photograph 1 – Outcrop and waste rock material at SR-01.

Photograph 3 – Flags marking a ten-point composite sample beyond the toe of waste rock pile at SR-01

Figure A-4 Site Photographs

Photograph 4 – Waste rock at SR-02. The rail protruding from the soil may be a remnant of historical mine workings.

Photograph 6 – Collecting a discrete sample from the waste rock pile at SR-02.

Figure A-4 Site Photographs (continued)

Photograph 7 – Area where discrete samples were collected at SR-03.

Photograph 8 – Area where discrete samples were collected at SR-04.

Figure A-4 Site Photographs (continued)

Photograph 10 – Area where discrete samples were collected at SR-05.

Photograph 11 – Overview of SR6. Discrete samples were collected from the sheer slope beneath the exposed tree roots, the hiking path in the foreground of this photograph, and material slumped onto the slope beneath the path (not visible in this photograph).

Figure A-4 Site Photographs (continued)

Photograph 12 – Area where discrete samples were collected at SR-07.

Photograph 14 – Waste rock at SR-08.

Figure A-4 Site Photographs (continued)

Figure A-5. MTCA Terrestrial Ecological Evaluation Framework

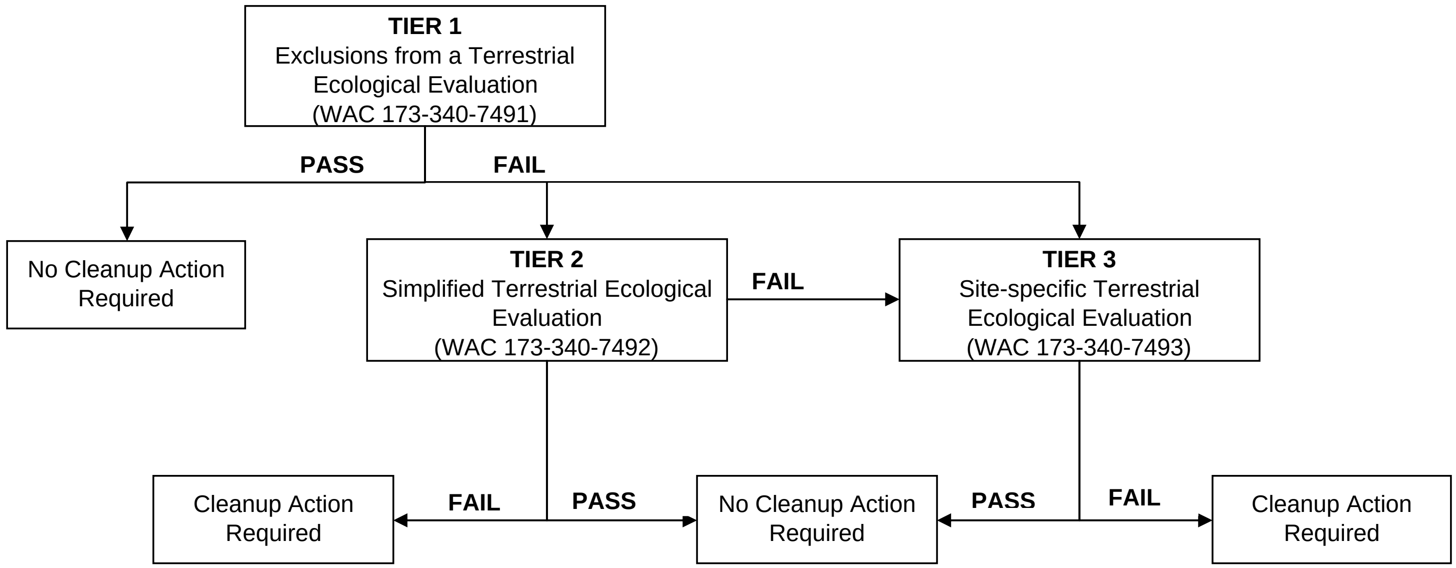
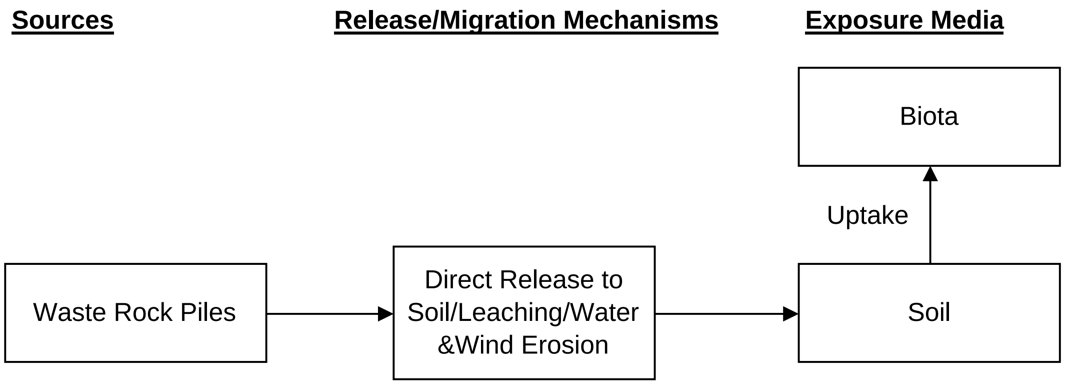


Figure A-6. Ecological Conceptual Site Model



Biota:

Route	**Plants**	**Soil Biota**	**Widlife**
Inhalation	X	X	X
Dermal Contact	X	X	X
Ingestion	X	●	●

Soil:

Route	**Plants**	**Soil Biota**	**Widlife**
Inhalation	X	X	○
Dermal Contact	●	●	○
Ingestion	X	●	●

● Complete or Potentially Complete Pathway
○ Incomplete or Minor Pathway
X Not Applicable

Attachment A-1 - ProUCL Output Files - UCLs All Site Soils Data

From File: C:\Users\admin\Desktop\site bkgd comparisons\soil bkdg dataset.wst
Site Soil Dataset

Summary Statistics for Raw Data Sets with NDs using Detected Data Only

						Raw Statistics using Detected Observations							
Variable	Num Ds	NumNDs	% NDs	Minimum	Maximum	Mean	Median	SD	MAD/0.675	Skewness	CV	UCL	EPC
Aluminum	81	0	0.00%	1270	21400	9318	8350	5616	7176	0.388	0.603	12037	12037
Antimony	0	81	100.00%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A		
Arsenic	81	0	0.00%	9	1290	188.5	136	182.6	108.2	3.231	0.969	220.9	220.9
Barium	81	0	0.00%	17.2	267	112.8	112	54.11	60.49	0.484	0.48	122.8	122.8
Chromium	81	0	0.00%	1	21	6.496	5.7	4.405	4.596	0.874	0.678	7.42	7.42
Iron	81	0	0.00%	2330	42600	20841	21400	8887	8451	-0.00345	0.426	25145	25145
Lead	81	0	0.00%	2.9	59.1	13.04	12	7.645	4.448	3.067	0.586	14.45	14.45
Manganese	81	0	0.00%	2.5	943	215.8	163	233.9	216.5	1.373	1.083	274.3	274.3
Mercury	81	0	0.00%	0.02	47.2	2.3	0.169	7.659	0.176	4.118	3.329	6.01	6.01
Selenium	34	47	58.02%	0.6	3.8	1.879	1.5	0.986	1.038	0.526	0.525	1.326	1.326
Silver	76	5	6.17%	0.3	29.4	6.7	5.7	6.052	6.301	1.108	0.903	9.242	9.242
Vanadium	81	0	0.00%	1.2	105	17.1	18.2	13.62	9.785	3.293	0.796	23.69	23.69

From File: C:\Users\admin\Desktop\site bkgd comparisons\soil bkdg dataset.wst
Background Soil Dataset

Summary Statistics for Raw Data Sets with NDs using Detected Data Only

						Raw Statistics using Detected Observations					
Variable	Num Ds	NumNDs	% NDs	Minimum	Maximum	Mean	Median	SD	MAD/0.675	Skewness	CV
Aluminum	22	0	0.00%	7250	24600	16889	18000	4397	3484	-0.484	0.26
Antimony	0	22	100.00%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Arsenic	22	0	0.00%	2.8	181	16.42	5.9	38.34	1.853	4.175	2.335
Barium	22	0	0.00%	69.5	175	122	125	29.3	31.13	-0.0628	0.24
Chromium	22	0	0.00%	5.3	18	12.42	12.8	3.814	4.299	-0.336	0.307
Iron	22	0	0.00%	16000	34000	23082	22100	4866	4077	0.868	0.211
Lead	22	0	0.00%	4	31.1	11.29	9.95	5.431	3.781	2.494	0.481
Manganese	22	0	0.00%	305	781	534.8	497	157.4	173.5	0.26	0.294
Mercury	19	3	13.64%	0.01	0.07	0.0272	0.02	0.0169	0.0133	1.426	0.623
Selenium	0	22	100.00%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Silver	4	18	81.82%	0.2	0.6	0.375	0.35	0.206	0.222	0.2	0.55
Vanadium	22	0	0.00%	21.8	57.1	32.57	30.35	9.169	7.116	1.167	0.282

Num Ds - number of samples with detected values
Num NDs - number of samples with nondetected values
% NDs - percent of samples with nondetected values
Minimum - minimum detected value (mg/kg)
Maximum - maximum detected value (mg/kg)
Mean - mean concentrations (mg/kg)
Median - median concentration (mg/kg)
SD - standard deviation (mg/kg)
MAD/0.675 - mean absolute deviation divided by 0.675 (a robust estimate of variability)
Skewness - skewness statistic
CV - coefficient of variation (mg/kg)
UCL - 95 percent upper confidence limit (mg/kg)
EPC - reasonable maximum exposure point concentration (mg/kg)

General UCL Statistics for Data Sets with Non-Detects

User Selected Options

From File	C:\Users\admin\Desktop\site bkgd comparisons\soil bkdg dataset.wst
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Aluminum

General Statistics

Number of Valid Observations	81	Number of Distinct Observations	74

Raw Statistics		**Log-transformed Statistics**	
Minimum	1270	Minimum of Log Data	7.147
Maximum	21400	Maximum of Log Data	9.971
Mean	9318	Mean of log Data	8.914
Geometric Mean	7435	SD of log Data	0.731
Median	8350		
SD	5616		
Std. Error of Mean	624		
Coefficient of Variation	0.603		
Skewness	0.388		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Lilliefors Test Statistic	0.139	Lilliefors Test Statistic	0.117
Lilliefors Critical Value	0.0984	Lilliefors Critical Value	0.0984
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	10356	95% H-UCL	11454
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	13474
95% Adjusted-CLT UCL (Chen-1995)	10373	97.5% Chebyshev (MVUE) UCL	15120
95% Modified-t UCL (Johnson-1978)	10360	99% Chebyshev (MVUE) UCL	18352
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	2.289	Data do not follow a Discernable Distribution (0.05)	
Theta Star	4071		
MLE of Mean	9318		
MLE of Standard Deviation	6159		
nu star	370.8		
Approximate Chi Square Value (.05)	327.2	**Nonparametric Statistics**	
Adjusted Level of Significance	0.047	95% CLT UCL	10344
Adjusted Chi Square Value	326.4	95% Jackknife UCL	10356
		95% Standard Bootstrap UCL	10331
Anderson-Darling Test Statistic	1.248	95% Bootstrap-t UCL	10392
Anderson-Darling 5% Critical Value	0.762	95% Hall's Bootstrap UCL	10416
Kolmogorov-Smirnov Test Statistic	0.112	95% Percentile Bootstrap UCL	10323
Kolmogorov-Smirnov 5% Critical Value	0.1	95% BCA Bootstrap UCL	10319
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	12037
		97.5% Chebyshev(Mean, Sd) UCL	13214
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	15526
95% Approximate Gamma UCL (Use when n >= 40)	10560		
95% Adjusted Gamma UCL (Use when n < 40)	10584		
Potential UCL to Use		Use 95% Chebyshev (Mean, Sd) UCL	12037

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Antimony

General Statistics			
Number of Valid Data	81	Number of Detected Data	0
Number of Distinct Detected Data	0	Number of Non-Detect Data	81
		Percent Non-Detects	100.00%

Warning: All observations are Non-Detects (NDs), therefore all statistics and estimates should also be NDs!
Specifically, sample mean, UCLs, UPLs, and other statistics are also NDs lying below the largest detection limit!
The Project Team may decide to use alternative site specific values to estimate environmental parameters (e.g., EPC, BTV).

The data set for variable Sb was not processed!

Arsenic

General Statistics

Number of Valid Observations	81	Number of Distinct Observations	78

Raw Statistics		Log-transformed Statistics	
Minimum	9	Minimum of Log Data	2.197
Maximum	1290	Maximum of Log Data	7.162
Mean	188.5	Mean of log Data	4.868
Geometric Mean	130.1	SD of log Data	0.915
Median	136		
SD	182.6		
Std. Error of Mean	20.29		
Coefficient of Variation	0.969		
Skewness	3.231		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Lilliefors Test Statistic	0.164	Lilliefors Test Statistic	0.0594
Lilliefors Critical Value	0.0984	Lilliefors Critical Value	0.0984
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	222.2	95% H-UCL	246.4
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	297.6
95% Adjusted-CLT UCL (Chen-1995)	229.6	97.5% Chebyshev (MVUE) UCL	341.4
95% Modified-t UCL (Johnson-1978)	223.4	99% Chebyshev (MVUE) UCL	427.6

Gamma Distribution Test		Data Distribution	
k star (bias corrected)	1.447	Data appear Gamma Distributed at 5% Significance Level	
Theta Star	130.2		
MLE of Mean	188.5		
MLE of Standard Deviation	156.7		
nu star	234.4		
Approximate Chi Square Value (.05)	200	**Nonparametric Statistics**	
Adjusted Level of Significance	0.047	95% CLT UCL	221.8
Adjusted Chi Square Value	199.4	95% Jackknife UCL	222.2
		95% Standard Bootstrap UCL	221.6
Anderson-Darling Test Statistic	0.324	95% Bootstrap-t UCL	232.6
Anderson-Darling 5% Critical Value	0.771	95% Hall's Bootstrap UCL	247.5
Kolmogorov-Smirnov Test Statistic	0.0598	95% Percentile Bootstrap UCL	223.9
Kolmogorov-Smirnov 5% Critical Value	0.101	95% BCA Bootstrap UCL	234.9
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	276.9
		97.5% Chebyshev(Mean, Sd) UCL	315.2
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	390.3
95% Approximate Gamma UCL (Use when n >= 40)	220.9		
95% Adjusted Gamma UCL (Use when n < 40)	221.5		

Potential UCL to Use		Use 95% Approximate Gamma UCL	220.9

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Barium

General Statistics

Number of Valid Observations	81	Number of Distinct Observations	70

Raw Statistics		Log-transformed Statistics	
Minimum	17.2	Minimum of Log Data	2.845
Maximum	267	Maximum of Log Data	5.587
Mean	112.8	Mean of log Data	4.589
Geometric Mean	98.43	SD of log Data	0.567
Median	112		
SD	54.11		
Std. Error of Mean	6.012		
Coefficient of Variation	0.48		
Skewness	0.484		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Lilliefors Test Statistic	0.0763	Lilliefors Test Statistic	0.126
Lilliefors Critical Value	0.0984	Lilliefors Critical Value	0.0984
Data appear Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	122.8	95% H-UCL	130.3
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	149.2
95% Adjusted-CLT UCL (Chen-1995)	123	97.5% Chebyshev (MVUE) UCL	163.9
95% Modified-t UCL (Johnson-1978)	122.9	99% Chebyshev (MVUE) UCL	192.7
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	3.693	Data appear Normal at 5% Significance Level	
Theta Star	30.54		
MLE of Mean	112.8		
MLE of Standard Deviation	58.7		
nu star	598.3		
Approximate Chi Square Value (.05)	542.6	**Nonparametric Statistics**	
Adjusted Level of Significance	0.047	95% CLT UCL	122.7
Adjusted Chi Square Value	541.6	95% Jackknife UCL	122.8
		95% Standard Bootstrap UCL	122.7
Anderson-Darling Test Statistic	0.56	95% Bootstrap-t UCL	123.9
Anderson-Darling 5% Critical Value	0.757	95% Hall's Bootstrap UCL	123.2
Kolmogorov-Smirnov Test Statistic	0.0957	95% Percentile Bootstrap UCL	122.3
Kolmogorov-Smirnov 5% Critical Value	0.0997	95% BCA Bootstrap UCL	123.2
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	139
		97.5% Chebyshev(Mean, Sd) UCL	150.3
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	172.6
95% Approximate Gamma UCL (Use when n >= 40)	124.4		
95% Adjusted Gamma UCL (Use when n < 40)	124.6		
Potential UCL to Use		Use 95% Student's-t UCL	122.8

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Chromium

General Statistics

Number of Valid Observations	81	Number of Distinct Observations	64

Raw Statistics		**Log-transformed Statistics**	
Minimum	1	Minimum of Log Data	0
Maximum	21	Maximum of Log Data	3.045
Mean	6.496	Mean of log Data	1.616
Geometric Mean	5.031	SD of log Data	0.759
Median	5.7		
SD	4.405		
Std. Error of Mean	0.489		
Coefficient of Variation	0.678		
Skewness	0.874		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Lilliefors Test Statistic	0.112	Lilliefors Test Statistic	0.0911
Lilliefors Critical Value	0.0984	Lilliefors Critical Value	0.0984
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	7.311	95% H-UCL	7.98
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	9.433
95% Adjusted-CLT UCL (Chen-1995)	7.352	97.5% Chebyshev (MVUE) UCL	10.62
95% Modified-t UCL (Johnson-1978)	7.319	99% Chebyshev (MVUE) UCL	12.96
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	2.038	Data appear Gamma Distributed at 5% Significance Level	
Theta Star	3.188		
MLE of Mean	6.496		
MLE of Standard Deviation	4.551		
nu star	330.2		
Approximate Chi Square Value (.05)	289.1	**Nonparametric Statistics**	
Adjusted Level of Significance	0.047	95% CLT UCL	7.301
Adjusted Chi Square Value	288.4	95% Jackknife UCL	7.311
		95% Standard Bootstrap UCL	7.295
Anderson-Darling Test Statistic	0.65	95% Bootstrap-t UCL	7.339
Anderson-Darling 5% Critical Value	0.763	95% Hall's Bootstrap UCL	7.356
Kolmogorov-Smirnov Test Statistic	0.0777	95% Percentile Bootstrap UCL	7.322
Kolmogorov-Smirnov 5% Critical Value	0.1	95% BCA Bootstrap UCL	7.326
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	8.63
		97.5% Chebyshev(Mean, Sd) UCL	9.553
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	11.37
95% Approximate Gamma UCL (Use when n >= 40)	7.42		
95% Adjusted Gamma UCL (Use when n < 40)	7.438		
Potential UCL to Use		Use 95% Approximate Gamma UCL	7.42

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Iron

General Statistics

Number of Valid Observations	81	Number of Distinct Observations	71
Raw Statistics		**Log-transformed Statistics**	
Minimum	2330	Minimum of Log Data	7.754
Maximum	42600	Maximum of Log Data	10.66
Mean	20841	Mean of log Data	9.814
Geometric Mean	18284	SD of log Data	0.588
Median	21400		
SD	8887		
Std. Error of Mean	987.4		
Coefficient of Variation	0.426		
Skewness	-0.00345		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Lilliefors Test Statistic	0.108	Lilliefors Test Statistic	0.195
Lilliefors Critical Value	0.0984	Lilliefors Critical Value	0.0984
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	22485	95% H-UCL	24626
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	28315
95% Adjusted-CLT UCL (Chen-1995)	22465	97.5% Chebyshev (MVUE) UCL	31185
95% Modified-t UCL (Johnson-1978)	22484	99% Chebyshev (MVUE) UCL	36821
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	3.84	Data do not follow a Discernable Distribution (0.05)	
Theta Star	5427		
MLE of Mean	20841		
MLE of Standard Deviation	10636		
nu star	622.1		
Approximate Chi Square Value (.05)	565.2	**Nonparametric Statistics**	
Adjusted Level of Significance	0.047	95% CLT UCL	22465
Adjusted Chi Square Value	564.2	95% Jackknife UCL	22485
		95% Standard Bootstrap UCL	22446
Anderson-Darling Test Statistic	2.192	95% Bootstrap-t UCL	22480
Anderson-Darling 5% Critical Value	0.756	95% Hall's Bootstrap UCL	22449
Kolmogorov-Smirnov Test Statistic	0.174	95% Percentile Bootstrap UCL	22470
Kolmogorov-Smirnov 5% Critical Value	0.0997	95% BCA Bootstrap UCL	22507
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	25145
		97.5% Chebyshev(Mean, Sd) UCL	27008
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	30666
95% Approximate Gamma UCL (Use when n >= 40)	22938		
95% Adjusted Gamma UCL (Use when n < 40)	22977		
Potential UCL to Use		Use 95% Chebyshev (Mean, Sd) UCL	25145

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Note: For highly negative-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.

Lead

General Statistics

Number of Valid Observations	81	Number of Distinct Observations	71

Raw Statistics		**Log-transformed Statistics**	
Minimum	2.9	Minimum of Log Data	1.065
Maximum	59.1	Maximum of Log Data	4.079
Mean	13.04	Mean of log Data	2.441
Geometric Mean	11.49	SD of log Data	0.502
Median	12		
SD	7.645		
Std. Error of Mean	0.849		
Coefficient of Variation	0.586		
Skewness	3.067		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Lilliefors Test Statistic	0.183	Lilliefors Test Statistic	0.0793
Lilliefors Critical Value	0.0984	Lilliefors Critical Value	0.0984
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	14.46	95% H-UCL	14.45
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	16.34
95% Adjusted-CLT UCL (Chen-1995)	14.75	97.5% Chebyshev (MVUE) UCL	17.78
95% Modified-t UCL (Johnson-1978)	14.51	99% Chebyshev (MVUE) UCL	20.61
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	3.951	Data appear Lognormal at 5% Significance Level	
Theta Star	3.302		
MLE of Mean	13.04		
MLE of Standard Deviation	6.563		
nu star	640		
Approximate Chi Square Value (.05)	582.3	**Nonparametric Statistics**	
Adjusted Level of Significance	0.047	95% CLT UCL	14.44
Adjusted Chi Square Value	581.3	95% Jackknife UCL	14.46
		95% Standard Bootstrap UCL	14.48
Anderson-Darling Test Statistic	0.955	95% Bootstrap-t UCL	14.94
Anderson-Darling 5% Critical Value	0.756	95% Hall's Bootstrap UCL	15.47
Kolmogorov-Smirnov Test Statistic	0.11	95% Percentile Bootstrap UCL	14.61
Kolmogorov-Smirnov 5% Critical Value	0.0996	95% BCA Bootstrap UCL	14.81
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	16.75
		97.5% Chebyshev(Mean, Sd) UCL	18.35
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	21.5
95% Approximate Gamma UCL (Use when n >= 40)	14.34		
95% Adjusted Gamma UCL (Use when n < 40)	14.36		
Potential UCL to Use		Use 95% H-UCL	14.45

ProUCL computes and outputs H-statistic based UCLs for historical reasons only.
H-statistic often results in unstable (both high and low) values of UCL95 as shown in examples in the Technical Guide.
It is therefore recommended to avoid the use of H-statistic based 95% UCLs.
Use of nonparametric methods are preferred to compute UCL95 for skewed data sets which do not follow a gamma distribution.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Manganese

General Statistics

Number of Valid Observations	81	Number of Distinct Observations	77

Raw Statistics		Log-transformed Statistics	
Minimum	2.5	Minimum of Log Data	0.916
Maximum	943	Maximum of Log Data	6.849
Mean	215.8	Mean of log Data	4.486
Geometric Mean	88.75	SD of log Data	1.622
Median	163		
SD	233.9		
Std. Error of Mean	25.98		
Coefficient of Variation	1.083		
Skewness	1.373		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Lilliefors Test Statistic	0.181	Lilliefors Test Statistic	0.152
Lilliefors Critical Value	0.0984	Lilliefors Critical Value	0.0984
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	259.1	95% H-UCL	559.7
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	674
95% Adjusted-CLT UCL (Chen-1995)	262.8	97.5% Chebyshev (MVUE) UCL	827.6
95% Modified-t UCL (Johnson-1978)	259.7	99% Chebyshev (MVUE) UCL	1129

Gamma Distribution Test		Data Distribution	
k star (bias corrected)	0.665	Data Follow Appr. Gamma Distribution at 5% Significance Level	
Theta Star	324.4		
MLE of Mean	215.8		
MLE of Standard Deviation	264.6		
nu star	107.8		
Approximate Chi Square Value (.05)	84.84	**Nonparametric Statistics**	
Adjusted Level of Significance	0.047	95% CLT UCL	258.6
Adjusted Chi Square Value	84.47	95% Jackknife UCL	259.1
		95% Standard Bootstrap UCL	258.3
Anderson-Darling Test Statistic	1.078	95% Bootstrap-t UCL	262.2
Anderson-Darling 5% Critical Value	0.8	95% Hall's Bootstrap UCL	260.5
Kolmogorov-Smirnov Test Statistic	0.1	95% Percentile Bootstrap UCL	258.2
Kolmogorov-Smirnov 5% Critical Value	0.104	95% BCA Bootstrap UCL	259.8
Data follow Appr. Gamma Distribution at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	329.1
		97.5% Chebyshev(Mean, Sd) UCL	378.1
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	474.4
95% Approximate Gamma UCL (Use when n >= 40)	274.3		
95% Adjusted Gamma UCL (Use when n < 40)	275.5		

Potential UCL to Use		Use 95% Approximate Gamma UCL	274.3

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Mercury

General Statistics

Number of Valid Observations	81	Number of Distinct Observations	67

Raw Statistics		**Log-transformed Statistics**	
Minimum	0.02	Minimum of Log Data	-3.912
Maximum	47.2	Maximum of Log Data	3.854
Mean	2.3	Mean of log Data	-1.554
Geometric Mean	0.211	SD of log Data	1.75
Median	0.169		
SD	7.659		
Std. Error of Mean	0.851		
Coefficient of Variation	3.329		
Skewness	4.118		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Lilliefors Test Statistic	0.471	Lilliefors Test Statistic	0.128
Lilliefors Critical Value	0.0984	Lilliefors Critical Value	0.0984
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	3.716	95% H-UCL	1.776
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	2.091
95% Adjusted-CLT UCL (Chen-1995)	4.116	97.5% Chebyshev (MVUE) UCL	2.591
95% Modified-t UCL (Johnson-1978)	3.781	99% Chebyshev (MVUE) UCL	3.575
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	0.288	Data do not follow a Discernable Distribution (0.05)	
Theta Star	7.989		
MLE of Mean	2.3		
MLE of Standard Deviation	4.287		
nu star	46.64		
Approximate Chi Square Value (.05)	31.97	**Nonparametric Statistics**	
Adjusted Level of Significance	0.047	95% CLT UCL	3.7
Adjusted Chi Square Value	31.75	95% Jackknife UCL	3.716
		95% Standard Bootstrap UCL	3.691
Anderson-Darling Test Statistic	12.9	95% Bootstrap-t UCL	4.549
Anderson-Darling 5% Critical Value	0.87	95% Hall's Bootstrap UCL	3.889
Kolmogorov-Smirnov Test Statistic	0.325	95% Percentile Bootstrap UCL	3.782
Kolmogorov-Smirnov 5% Critical Value	0.108	95% BCA Bootstrap UCL	4.019
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	6.01
		97.5% Chebyshev(Mean, Sd) UCL	7.615
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	10.77
95% Approximate Gamma UCL (Use when n >= 40)	3.356		
95% Adjusted Gamma UCL (Use when n < 40)	3.379		
Potential UCL to Use		Use 95% Chebyshev (Mean, Sd) UCL	6.01

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Selenium

General Statistics			
Number of Valid Data	81	Number of Detected Data	34
Number of Distinct Detected Data	21	Number of Non-Detect Data	47
		Percent Non-Detects	58.02%
Raw Statistics		**Log-transformed Statistics**	
Minimum Detected	0.6	Minimum Detected	-0.511
Maximum Detected	3.8	Maximum Detected	1.335
Mean of Detected	1.879	Mean of Detected	0.488
SD of Detected	0.986	SD of Detected	0.555
Minimum Non-Detect	0.5	Minimum Non-Detect	-0.693
Maximum Non-Detect	2	Maximum Non-Detect	0.693
Note: Data have multiple DLs - Use of KM Method is recommended		Number treated as Non-Detect	68
For all methods (except KM, DL/2, and ROS Methods),		Number treated as Detected	13
Observations < Largest ND are treated as NDs		Single DL Non-Detect Percentage	83.95%
UCL Statistics			
Normal Distribution Test with Detected Values Only		**Lognormal Distribution Test with Detected Values Only**	
Shapiro Wilk Test Statistic	0.895	Shapiro Wilk Test Statistic	0.928
5% Shapiro Wilk Critical Value	0.933	5% Shapiro Wilk Critical Value	0.933
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	1.022	Mean	-0.413
SD	0.992	SD	0.929
95% DL/2 (t) UCL	1.205	95% H-Stat (DL/2) UCL	1.276
Maximum Likelihood Estimate(MLE) Method		Log ROS Method	
Mean	0.351	Mean in Log Scale	-0.336
SD	1.695	SD in Log Scale	0.896
95% MLE (t) UCL	0.665	Mean in Original Scale	1.052
95% MLE (Tiku) UCL	1.245	SD in Original Scale	0.968
		95% t UCL	1.231
		95% Percentile Bootstrap UCL	1.235
		95% BCA Bootstrap UCL	1.239
		95% H UCL	1.322
Gamma Distribution Test with Detected Values Only		**Data Distribution Test with Detected Values Only**	
k star (bias corrected)	3.363	Data Follow Appr. Gamma Distribution at 5% Significance Level	
Theta Star	0.559		
nu star	228.7		
A-D Test Statistic	0.801	**Nonparametric Statistics**	
5% A-D Critical Value	0.752	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.752	Mean	1.157
5% K-S Critical Value	0.152	SD	0.888
Data follow Appr. Gamma Distribution at 5% Significance Level		SE of Mean	0.101
		95% KM (t) UCL	1.326
Assuming Gamma Distribution		95% KM (z) UCL	1.324
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	1.298
Minimum	0.000001	95% KM (bootstrap t) UCL	1.32
Maximum	3.8	95% KM (BCA) UCL	1.414
Mean	0.825	95% KM (Percentile Bootstrap) UCL	1.359
Median	0.000001	95% KM (Chebyshev) UCL	1.598
SD	1.123	97.5% KM (Chebyshev) UCL	1.789
k star	0.116	99% KM (Chebyshev) UCL	2.163
Theta star	7.082		
Nu star	18.86	**Potential UCLs to Use**	
AppChi2	10.02	95% KM (t) UCL	1.326
95% Gamma Approximate UCL (Use when n >= 40)	1.553		
95% Adjusted Gamma UCL (Use when n < 40)	1.571		

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

Silver

General Statistics

Number of Valid Data	81	Number of Detected Data	76
Number of Distinct Detected Data	55	Number of Non-Detect Data	5
		Percent Non-Detects	6.17%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.3	Minimum Detected	-1.204
Maximum Detected	29.4	Maximum Detected	3.381
Mean of Detected	6.7	Mean of Detected	1.341
SD of Detected	6.052	SD of Detected	1.214
Minimum Non-Detect	0.2	Minimum Non-Detect	-1.609
Maximum Non-Detect	0.2	Maximum Non-Detect	-1.609

UCL Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Lilliefors Test Statistic	0.156	Lilliefors Test Statistic	0.166
5% Lilliefors Critical Value	0.102	5% Lilliefors Critical Value	0.102
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	6.293	Mean	1.116
SD	6.074	SD	1.47
95% DL/2 (t) UCL	7.416	95% H-Stat (DL/2) UCL	14.06
Maximum Likelihood Estimate(MLE) Method		Log ROS Method	
Mean	6.088	Mean in Log Scale	1.169
SD	6.334	SD in Log Scale	1.357
95% MLE (t) UCL	7.259	Mean in Original Scale	6.302
95% MLE (Tiku) UCL	7.212	SD in Original Scale	6.064
		95% t UCL	7.423
		95% Percentile Bootstrap UCL	7.438
		95% BCA Bootstrap UCL	7.525
		95% H UCL	11.99

Gamma Distribution Test with Detected Values Only		Data Distribution Test with Detected Values Only	
k star (bias corrected)	0.993	Data do not follow a Discernable Distribution (0.05)	
Theta Star	6.744		
nu star	151		
A-D Test Statistic	1.384	**Nonparametric Statistics**	
5% A-D Critical Value	0.781	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.781	Mean	6.305
5% K-S Critical Value	0.105	SD	6.024
Data not Gamma Distributed at 5% Significance Level		SE of Mean	0.674
		95% KM (t) UCL	7.426
Assuming Gamma Distribution		95% KM (z) UCL	7.413
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	7.426
Minimum	0.000001	95% KM (bootstrap t) UCL	7.532
Maximum	29.4	95% KM (BCA) UCL	7.44
Mean	6.286	95% KM (Percentile Bootstrap) UCL	7.427
Median	4.7	95% KM (Chebyshev) UCL	9.242
SD	6.08	97.5% KM (Chebyshev) UCL	10.51
k star	0.442	99% KM (Chebyshev) UCL	13.01
Theta star	14.22		
Nu star	71.61	**Potential UCLs to Use**	
AppChi2	53.12	95% KM (Chebyshev) UCL	9.242
95% Gamma Approximate UCL (Use when n >= 40)	8.474		
95% Adjusted Gamma UCL (Use when n < 40)	8.52		

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

Vanadium

General Statistics

Number of Valid Observations	81	Number of Distinct Observations	71
Raw Statistics		**Log-transformed Statistics**	
Minimum	1.2	Minimum of Log Data	0.182
Maximum	105	Maximum of Log Data	4.654
Mean	17.1	Mean of log Data	2.497
Geometric Mean	12.14	SD of log Data	0.949
Median	18.2		
SD	13.62		
Std. Error of Mean	1.513		
Coefficient of Variation	0.796		
Skewness	3.293		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Lilliefors Test Statistic	0.124	Lilliefors Test Statistic	0.234
Lilliefors Critical Value	0.0984	Lilliefors Critical Value	0.0984
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	19.62	95% H-UCL	24.03
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	29.14
95% Adjusted-CLT UCL (Chen-1995)	20.18	97.5% Chebyshev (MVUE) UCL	33.56
95% Modified-t UCL (Johnson-1978)	19.71	99% Chebyshev (MVUE) UCL	42.26
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	1.557	Data do not follow a Discernable Distribution (0.05)	
Theta Star	10.98		
MLE of Mean	17.1		
MLE of Standard Deviation	13.7		
nu star	252.2		
Approximate Chi Square Value (.05)	216.4	**Nonparametric Statistics**	
Adjusted Level of Significance	0.047	95% CLT UCL	19.59
Adjusted Chi Square Value	215.8	95% Jackknife UCL	19.62
		95% Standard Bootstrap UCL	19.54
Anderson-Darling Test Statistic	3.219	95% Bootstrap-t UCL	20.43
Anderson-Darling 5% Critical Value	0.769	95% Hall's Bootstrap UCL	22.16
Kolmogorov-Smirnov Test Statistic	0.193	95% Percentile Bootstrap UCL	19.87
Kolmogorov-Smirnov 5% Critical Value	0.101	95% BCA Bootstrap UCL	20
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	23.69
		97.5% Chebyshev(Mean, Sd) UCL	26.55
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	32.15
95% Approximate Gamma UCL (Use when n >= 40)	19.92		
95% Adjusted Gamma UCL (Use when n < 40)	19.98		
Potential UCL to Use		Use 95% Chebyshev (Mean, Sd) UCL	23.69

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Attachment A-2 ProUCL Output Files – Background Comparisons

From File: C:\Users\admin\Desktop\site bkgd comparisons\soil bkdg dataset.wst
Site Soil Dataset

Summary Statistics for Raw Data Sets with NDs using Detected Data Only

						Raw Statistics using Detected Observations					
Variable	Num Ds	NumNDs	% NDs	Minimum	Maximum	Mean	Median	SD	MAD/0.675	Skewness	CV
Aluminum	81	0	0.00%	1270	21400	9318	8350	5616	7176	0.388	0.603
Antimony	0	81	100.00%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Arsenic	81	0	0.00%	9	1290	188.5	136	182.6	108.2	3.231	0.969
Barium	81	0	0.00%	17.2	267	112.8	112	54.11	60.49	0.484	0.48
Chromium	81	0	0.00%	1	21	6.496	5.7	4.405	4.596	0.874	0.678
Iron	81	0	0.00%	2330	42600	20841	21400	8887	8451	-0.00345	0.426
Lead	81	0	0.00%	2.9	59.1	13.04	12	7.645	4.448	3.067	0.586
Manganese	81	0	0.00%	2.5	943	215.8	163	233.9	216.5	1.373	1.083
Mercury	81	0	0.00%	0.02	47.2	2.3	0.169	7.659	0.176	4.118	3.329
Selenium	34	47	58.02%	0.6	3.8	1.879	1.5	0.986	1.038	0.526	0.525
Silver	76	5	6.17%	0.3	29.4	6.7	5.7	6.052	6.301	1.108	0.903
Vanadium	81	0	0.00%	1.2	105	17.1	18.2	13.62	9.785	3.293	0.796

From File: C:\Users\admin\Desktop\site bkgd comparisons\soil bkdg dataset.wst
Background Soil Dataset

Summary Statistics for Raw Data Sets with NDs using Detected Data Only

						Raw Statistics using Detected Observations					
Variable	Num Ds	NumNDs	% NDs	Minimum	Maximum	Mean	Median	SD	MAD/0.675	Skewness	CV
Aluminum	22	0	0.00%	7250	24600	16889	18000	4397	3484	-0.484	0.26
Antimony	0	22	100.00%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Arsenic	22	0	0.00%	2.8	181	16.42	5.9	38.34	1.853	4.175	2.335
Barium	22	0	0.00%	69.5	175	122	125	29.3	31.13	-0.0628	0.24
Chromium	22	0	0.00%	5.3	18	12.42	12.8	3.814	4.299	-0.336	0.307
Iron	22	0	0.00%	16000	34000	23082	22100	4866	4077	0.868	0.211
Lead	22	0	0.00%	4	31.1	11.29	9.95	5.431	3.781	2.494	0.481
Manganese	22	0	0.00%	305	781	534.8	497	157.4	173.5	0.26	0.294
Mercury	19	3	13.64%	0.01	0.07	0.0272	0.02	0.0169	0.0133	1.426	0.623
Selenium	0	22	100.00%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Silver	4	18	81.82%	0.2	0.6	0.375	0.35	0.206	0.222	0.2	0.55
Vanadium	22	0	0.00%	21.8	57.1	32.57	30.35	9.169	7.116	1.167	0.282

Num Ds - number of samples with detected values
Num NDs - number of samples with nondetected values
% NDs - percent of samples with nondetected values
Minimum - minimum detected value (mg/kg)
Maximum - maximum detected value (mg/kg)
Mean - mean concentrations (mg/kg)
Median - median concentration (mg/kg)
SD - standard deviation (mg/kg)
MAD/0.675 - mean absolute deviation divided by 0.675 (a robust estimate of variability)
Skewness - skewness statistic
CV - coefficient of variation (mg/kg)

Wilcoxon-Mann-Whitney Site vs Background Comparison Test for Data Sets with Non-Detects

User Selected Options

From File	C:\Users\admin\Desktop\soil bkdg dataset.wst
Full Precision	OFF
Confidence Coefficient	95%
Substantial Difference (S)	0
Selected Null Hypothesis	Site or AOC Mean/Median Less Than or Equal to Background Mean/Median (Form 1)
Alternative Hypothesis	Site or AOC Mean/Median Greater Than Background Mean/Median

Area of Concern Data: Aluminum-site
Background Data: Aluminum-background

Raw Statistics

	Site	Background
Number of Valid Data	81	22
Number of Non-Detect Data	0	0
Number of Detect Data	81	22
Minimum Non-Detect	N/A	N/A
Maximum Non-Detect	N/A	N/A
Percent Non detects	0.00%	0.00%
Minimum Detected	1270	7250
Maximum Detected	21400	24600
Mean of Detected Data	9318	16889
Median of Detected Data	8350	18000
SD of Detected Data	5616	4397

Wilcoxon-Mann-Whitney Site vs Background Test
Wilcoxon-Mann-Whitney (WMW) Test

H0: Mean/Median of Site or AOC <= Mean/Median of Background

Site Rank Sum W-Stat	3579
WMW Test U-Stat	-5.098
WMW Critical Value (0.050)	1.645
P-Value	1

Conclusion with Alpha = 0.05
Do Not Reject H0, Conclude Site <= Background
P-Value >= alpha (0.05)

Wilcoxon-Mann-Whitney Site vs Background Comparison Test for Data Sets with Non-Detects

User Selected Options

From File	C:\Users\admin\Desktop\soil bkdg dataset.wst
Full Precision	OFF
Confidence Coefficient	95%
Substantial Difference (S)	0
Selected Null Hypothesis	Site or AOC Mean/Median Less Than or Equal to Background Mean/Median (Form 1)
Alternative Hypothesis	Site or AOC Mean/Median Greater Than Background Mean/Median

Area of Concern Data: Antimony - site
Background Data: Antimony - background

Raw Statistics

	Site	Background
Number of Valid Data	81	22
Number of Non-Detect Data	81	22
Number of Detect Data	0	0
Minimum Non-Detect	0.2	0.2
Maximum Non-Detect	0.3	0.4
Percent Non detects	100.00%	100.00%
Minimum Detected	N/A	N/A
Maximum Detected	N/A	N/A
Mean of Detected Data	N/A	N/A
Median of Detected Data	N/A	N/A
SD of Detected Data	N/A	N/A

Wilcoxon-Mann-Whitney Site vs Background Test
All observations <= 0.4 (Max DL) are ranked the same
Wilcoxon-Mann-Whitney (WMW) Test

H0: Mean/Median of Site or AOC <= Mean/Median of Background

Site Rank Sum W-Stat	4212
WMW Test U-Stat	-0.00402
WMW Critical Value (0.050)	1.645
P-Value	0.502

Conclusion with Alpha = 0.05
Do Not Reject H0, Conclude Site <= Background
P-Value >= alpha (0.05)

Wilcoxon-Mann-Whitney Site vs Background Comparison Test for Data Sets with Non-Detects

User Selected Options

From File	C:\Users\admin\Desktop\soil bkdg dataset.wst
Full Precision	OFF
Confidence Coefficient	95%
Substantial Difference (S)	0
Selected Null Hypothesis	Site or AOC Mean/Median Less Than or Equal to Background Mean/Median (Form 1)
Alternative Hypothesis	Site or AOC Mean/Median Greater Than Background Mean/Median

Area of Concern Data: Arsenic - site
Background Data: Arsenic - background

Raw Statistics

	Site	Background
Number of Valid Data	81	22
Number of Non-Detect Data	0	0
Number of Detect Data	81	22
Minimum Non-Detect	N/A	N/A
Maximum Non-Detect	N/A	N/A
Percent Non detects	0.00%	0.00%
Minimum Detected	9	2.8
Maximum Detected	1290	181
Mean of Detected Data	188.5	16.42
Median of Detected Data	136	5.9
SD of Detected Data	182.6	38.34

Wilcoxon-Mann-Whitney Site vs Background Test
Wilcoxon-Mann-Whitney (WMW) Test

H0: Mean/Median of Site or AOC <= Mean/Median of Background

Site Rank Sum W-Stat	5039
WMW Test U-Stat	6.647
WMW Critical Value (0.050)	1.645
P-Value	1.5E-11

Conclusion with Alpha = 0.05
Reject H0, Conclude Site > Background
P-Value < alpha (0.05)

Wilcoxon-Mann-Whitney Site vs Background Comparison Test for Data Sets with Non-Detects

User Selected Options

From File	C:\Users\admin\Desktop\soil bkdg dataset.wst
Full Precision	OFF
Confidence Coefficient	95%
Substantial Difference (S)	0
Selected Null Hypothesis	Site or AOC Mean/Median Less Than or Equal to Background Mean/Median (Form 1)
Alternative Hypothesis	Site or AOC Mean/Median Greater Than Background Mean/Median

Area of Concern Data: Barium - site
Background Data: Barium - background

Raw Statistics

	Site	Background
Number of Valid Data	81	22
Number of Non-Detect Data	0	0
Number of Detect Data	81	22
Minimum Non-Detect	N/A	N/A
Maximum Non-Detect	N/A	N/A
Percent Non detects	0.00%	0.00%
Minimum Detected	17.2	69.5
Maximum Detected	267	175
Mean of Detected Data	112.8	122
Median of Detected Data	112	125
SD of Detected Data	54.11	29.3

Wilcoxon-Mann-Whitney Site vs Background Test
Wilcoxon-Mann-Whitney (WMW) Test

H0: Mean/Median of Site or AOC <= Mean/Median of Background

Site Rank Sum W-Stat	4063
WMW Test U-Stat	-1.207
WMW Critical Value (0.050)	1.645
P-Value	0.886

Conclusion with Alpha = 0.05
Do Not Reject H0, Conclude Site <= Background
P-Value >= alpha (0.05)

Wilcoxon-Mann-Whitney Site vs Background Comparison Test for Data Sets with Non-Detects

User Selected Options

From File	C:\Users\admin\Desktop\soil bkdg dataset.wst
Full Precision	OFF
Confidence Coefficient	95%
Substantial Difference (S)	0
Selected Null Hypothesis	Site or AOC Mean/Median Less Than or Equal to Background Mean/Median (Form 1)
Alternative Hypothesis	Site or AOC Mean/Median Greater Than Background Mean/Median

Area of Concern Data: Chromium -site
Background Data: Chromium - background

Raw Statistics

	Site	Background
Number of Valid Data	81	22
Number of Non-Detect Data	0	0
Number of Detect Data	81	22
Minimum Non-Detect	N/A	N/A
Maximum Non-Detect	N/A	N/A
Percent Non detects	0.00%	0.00%
Minimum Detected	1	5.3
Maximum Detected	21	18
Mean of Detected Data	6.496	12.42
Median of Detected Data	5.7	12.8
SD of Detected Data	4.405	3.814

Wilcoxon-Mann-Whitney Site vs Background Test
Wilcoxon-Mann-Whitney (WMW) Test

H0: Mean/Median of Site or AOC <= Mean/Median of Background

Site Rank Sum W-Stat	3593
WMW Test U-Stat	-4.985
WMW Critical Value (0.050)	1.645
P-Value	1

Conclusion with Alpha = 0.05
Do Not Reject H0, Conclude Site <= Background
P-Value >= alpha (0.05)

Wilcoxon-Mann-Whitney Site vs Background Comparison Test for Data Sets with Non-Detects

User Selected Options

From File	C:\Users\admin\Desktop\soil bkdg dataset.wst
Full Precision	OFF
Confidence Coefficient	95%
Substantial Difference (S)	0
Selected Null Hypothesis	Site or AOC Mean/Median Less Than or Equal to Background Mean/Median (Form 1)
Alternative Hypothesis	Site or AOC Mean/Median Greater Than Background Mean/Median

Area of Concern Data: Iron - site
Background Data: Iron - background

Raw Statistics

	Site	Background
Number of Valid Data	81	22
Number of Non-Detect Data	0	0
Number of Detect Data	81	22
Minimum Non-Detect	N/A	N/A
Maximum Non-Detect	N/A	N/A
Percent Non detects	0.00%	0.00%
Minimum Detected	2330	16000
Maximum Detected	42600	34000
Mean of Detected Data	20841	23082
Median of Detected Data	21400	22100
SD of Detected Data	8887	4866

Wilcoxon-Mann-Whitney Site vs Background Test
Wilcoxon-Mann-Whitney (WMW) Test

H0: Mean/Median of Site or AOC <= Mean/Median of Background

Site Rank Sum W-Stat	4095
WMW Test U-Stat	-0.95
WMW Critical Value (0.050)	1.645
P-Value	0.829

Conclusion with Alpha = 0.05
Do Not Reject H0, Conclude Site <= Background
P-Value >= alpha (0.05)

Wilcoxon-Mann-Whitney Site vs Background Comparison Test for Data Sets with Non-Detects

User Selected Options

From File	C:\Users\admin\Desktop\soil bkdg dataset.wst
Full Precision	OFF
Confidence Coefficient	95%
Substantial Difference (S)	0
Selected Null Hypothesis	Site or AOC Mean/Median Less Than or Equal to Background Mean/Median (Form 1)
Alternative Hypothesis	Site or AOC Mean/Median Greater Than Background Mean/Median

Area of Concern Data: Lead - site
Background Data: Lead - background

Raw Statistics

	Site	Background
Number of Valid Data	81	22
Number of Non-Detect Data	0	0
Number of Detect Data	81	22
Minimum Non-Detect	N/A	N/A
Maximum Non-Detect	N/A	N/A
Percent Non detects	0.00%	0.00%
Minimum Detected	2.9	4
Maximum Detected	59.1	31.1
Mean of Detected Data	13.04	11.29
Median of Detected Data	12	9.95
SD of Detected Data	7.645	5.431

Wilcoxon-Mann-Whitney Site vs Background Test
Wilcoxon-Mann-Whitney (WMW) Test

H0: Mean/Median of Site or AOC <= Mean/Median of Background

Site Rank Sum W-Stat	4361
WMW Test U-Stat	1.195
WMW Critical Value (0.050)	1.645
P-Value	0.116

Conclusion with Alpha = 0.05
Do Not Reject H0, Conclude Site <= Background
P-Value >= alpha (0.05)

Wilcoxon-Mann-Whitney Site vs Background Comparison Test for Data Sets with Non-Detects

User Selected Options

From File	C:\Users\admin\Desktop\soil bkdg dataset.wst
Full Precision	OFF
Confidence Coefficient	95%
Substantial Difference (S)	0
Selected Null Hypothesis	Site or AOC Mean/Median Less Than or Equal to Background Mean/Median (Form 1)
Alternative Hypothesis	Site or AOC Mean/Median Greater Than Background Mean/Median

Area of Concern Data: Manganese - site
Background Data: Manganese - background

Raw Statistics

	Site	Background
Number of Valid Data	81	22
Number of Non-Detect Data	0	0
Number of Detect Data	81	22
Minimum Non-Detect	N/A	N/A
Maximum Non-Detect	N/A	N/A
Percent Non detects	0.00%	0.00%
Minimum Detected	2.5	305
Maximum Detected	943	781
Mean of Detected Data	215.8	534.8
Median of Detected Data	163	497
SD of Detected Data	233.9	157.4

Wilcoxon-Mann-Whitney Site vs Background Test
Wilcoxon-Mann-Whitney (WMW) Test

H0: Mean/Median of Site or AOC <= Mean/Median of Background

Site Rank Sum W-Stat	3549
WMW Test U-Stat	-5.339
WMW Critical Value (0.050)	1.645
P-Value	1

Conclusion with Alpha = 0.05
Do Not Reject H0, Conclude Site <= Background
P-Value >= alpha (0.05)

Wilcoxon-Mann-Whitney Site vs Background Comparison Test for Data Sets with Non-Detects

User Selected Options

From File	C:\Users\admin\Desktop\soil bkdg dataset.wst
Full Precision	OFF
Confidence Coefficient	95%
Substantial Difference (S)	0
Selected Null Hypothesis	Site or AOC Mean/Median Less Than or Equal to Background Mean/Median (Form 1)
Alternative Hypothesis	Site or AOC Mean/Median Greater Than Background Mean/Median

Area of Concern Data: Mercury - site
Background Data: Mercury - background

Raw Statistics

	Site	Background
Number of Valid Data	81	22
Number of Non-Detect Data	0	3
Number of Detect Data	81	19
Minimum Non-Detect	N/A	0.01
Maximum Non-Detect	N/A	0.01
Percent Non detects	0.00%	13.64%
Minimum Detected	0.02	0.01
Maximum Detected	47.2	0.07
Mean of Detected Data	2.3	0.0272
Median of Detected Data	0.169	0.02
SD of Detected Data	7.659	0.0169

Wilcoxon-Mann-Whitney Site vs Background Test
Wilcoxon-Mann-Whitney (WMW) Test

H0: Mean/Median of Site or AOC <= Mean/Median of Background

Site Rank Sum W-Stat	5008
WMW Test U-Stat	6.397
WMW Critical Value (0.050)	1.645
P-Value	7.92E-11

Conclusion with Alpha = 0.05
Reject H0, Conclude Site > Background
P-Value < alpha (0.05)

Gehan Site vs Background Comparison Hypothesis Test for Data Sets with Non-Detects

User Selected Options

From File	C:\Users\admin\Desktop\site bkgd comparisons\soil bkdg dataset.wst
Full Precision	OFF
Confidence Coefficient	95%
Substantial Difference	0
Selected Null Hypothesis	Site or AOC Mean/Median Less Than or Equal to Background Mean/Median (Form 1)
Alternative Hypothesis	Site or AOC Mean/Median Greater Than Background Mean/Median

Area of Concern Data: Selenium - site
Background Data: Selenium - background

Raw Statistics

	Site	Background
Number of Valid Data	81	22
Number of Non-Detect Data	47	22
Number of Detect Data	34	0
Minimum Non-Detect	0.5	0.5
Maximum Non-Detect	2	0.9
Percent Non detects	58.02%	100.00%
Minimum Detected	0.6	N/A
Maximum Detected	3.8	N/A
Mean of Detected Data	1.879	N/A
Median of Detected Data	1.5	N/A
SD of Detected Data	0.986	N/A

Site vs Background Gehan Test

H0: Mean/Median of Site or AOC <= Mean/Median of background

Gehan z Test Value	3.764
Critical z (0.95)	1.645
P-Value	8.36E-05

Conclusion with Alpha = 0.05
Reject H0, Conclude Site > Background
P-Value < alpha (0.05)

Gehan Site vs Background Comparison Hypothesis Test for Data Sets with Non-Detects

User Selected Options

From File	C:\Users\admin\Desktop\site bkgd comparisons\soil bkdg dataset.wst
Full Precision	OFF
Confidence Coefficient	95%
Substantial Difference	0
Selected Null Hypothesis	Site or AOC Mean/Median Less Than or Equal to Background Mean/Median (Form 1)
Alternative Hypothesis	Site or AOC Mean/Median Greater Than Background Mean/Median

Area of Concern Data: Silver - site
Background Data: Silver - background

Raw Statistics

	Site	Background
Number of Valid Data	81	22
Number of Non-Detect Data	5	18
Number of Detect Data	76	4
Minimum Non-Detect	0.2	0.2
Maximum Non-Detect	0.2	0.4
Percent Non detects	6.17%	81.82%
Minimum Detected	0.3	0.2
Maximum Detected	29.4	0.6
Mean of Detected Data	6.7	0.375
Median of Detected Data	5.7	0.35
SD of Detected Data	6.052	0.206

Site vs Background Gehan Test

H0: Mean/Median of Site or AOC <= Mean/Median of background

Gehan z Test Value	6.574
Critical z (0.95)	1.645
P-Value	2.45E-11

Conclusion with Alpha = 0.05
Reject H0, Conclude Site > Background
P-Value < alpha (0.05)

Wilcoxon-Mann-Whitney Site vs Background Comparison Test for Data Sets with Non-Detects

User Selected Options

From File	C:\Users\admin\Desktop\soil bkdg dataset.wst
Full Precision	OFF
Confidence Coefficient	95%
Substantial Difference (S)	0
Selected Null Hypothesis	Site or AOC Mean/Median Less Than or Equal to Background Mean/Median (Form 1)
Alternative Hypothesis	Site or AOC Mean/Median Greater Than Background Mean/Median

Area of Concern Data: Vanadium - site
Background Data: Vanadium - background

Raw Statistics

	Site	Background
Number of Valid Data	81	22
Number of Non-Detect Data	0	0
Number of Detect Data	81	22
Minimum Non-Detect	N/A	N/A
Maximum Non-Detect	N/A	N/A
Percent Non detects	0.00%	0.00%
Minimum Detected	1.2	21.8
Maximum Detected	105	57.1
Mean of Detected Data	17.1	32.57
Median of Detected Data	18.2	30.35
SD of Detected Data	13.62	9.169

Wilcoxon-Mann-Whitney Site vs Background Test
Wilcoxon-Mann-Whitney (WMW) Test

H0: Mean/Median of Site or AOC <= Mean/Median of Background

Site Rank Sum W-Stat	3497
WMW Test U-Stat	-5.761
WMW Critical Value (0.050)	1.645
P-Value	1

Conclusion with Alpha = 0.05
Do Not Reject H0, Conclude Site <= Background
P-Value >= alpha (0.05)

Attachment A-3 ProUCL Output Files - UCLs for WRPs, Downslope WRPs, and Background; Area-weighted EPC for Site Exposure Area

From File: C:\Users\admin\Desktop\soil bkdg dataset.wst

Summary Statistics for Raw Data Sets with NDs using Detected Data Only

Area	Variable	Num Ds	NumNDs	% NDs	Minimum	Maximum	Mean	Median	SD	MAD/0.675	Skewness	CV	UCL	EPC
						Raw Statistics using Detected Observations								
WRPs	Aluminum	58	0	0.00%	1270	18500	7346	7035	4891	4055	0.956	0.666	8543	8543
WRPs	Antimony	0	58	100.00%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
WRPs	Arsenic	58	0	0.00%	31.2	1290	222.2	173	198.9	126	3.115	0.895	262.1	262.1
WRPs	Barium	58	0	0.00%	17.2	267	101.8	86.8	55.45	52.85	0.794	0.545	115.6	115.6
WRPs	Chromium	58	0	0.00%	1	21	5.259	3.7	4.19	3.039	1.577	0.797	6.209	6.209
WRPs	Iron	58	0	0.00%	2330	42600	20396	21050	10267	11490	0.121	0.503	22650	22650
WRPs	Lead	58	0	0.00%	2.9	59.1	13.73	12.55	8.718	5.411	2.685	0.635	15.58	15.58
WRPs	Manganese	58	0	0.00%	2.5	943	143.7	57.2	221.5	70.72	2.537	1.541	196.3	196.3
WRPs	Mercury	58	0	0.00%	0.025	47.2	3.075	0.215	8.934	0.244	3.413	2.906	8.188	8.188
WRPs	Selenium	31	27	46.55%	0.6	3.8	1.961	1.5	0.987	1.038	0.422	0.503	1.582	1.582
WRPs	Silver	53	5	8.62%	0.4	29.4	8.436	8.9	6.18	6.672	0.873	0.733	9.133	9.133
WRPs	Vanadium	58	0	0.00%	1.2	105	14.68	11.9	15.15	12.38	3.805	1.032	23.35	23.35
DWRPs	Aluminum	23	0	0.00%	6580	21400	14289	15000	4075	4003	-0.408	0.285	15748	15748
DWRPs	Antimony	0	23	100.00%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
DWRPs	Arsenic	23	0	0.00%	9	298	103.3	71	90.34	70.13	1.019	0.874	146.4	146.4
DWRPs	Barium	23	0	0.00%	68.1	238	140.6	138	39.47	23.72	0.85	0.281	154.7	154.7
DWRPs	Chromium	23	0	0.00%	5.3	15.8	9.617	8.6	3.296	3.706	0.465	0.343	10.8	10.8
DWRPs	Iron	23	0	0.00%	15400	28300	21965	21500	3499	3262	-0.314	0.159	23218	23218
DWRPs	Lead	23	0	0.00%	7.6	22.8	11.32	10.7	3.358	2.224	1.997	0.297	12.49	12.49
DWRPs	Manganese	23	0	0.00%	177	794	397.7	342	153.1	134.9	0.828	0.385	452.5	452.5
DWRPs	Mercury	23	0	0.00%	0.02	4.61	0.348	0.1	0.959	0.0904	4.378	2.759	1.22	1.22
DWRPs	Selenium	3	20	86.96%	0.7	1.6	1.033	0.8	0.493	0.148	1.652	0.477	0.83	0.83
DWRPs	Silver	23	0	0.00%	0.3	12.7	2.7	1.2	3.254	1.186	1.846	1.205	5.658	5.658
DWRPs	Vanadium	23	0	0.00%	16.1	31.5	23.18	22.5	5.067	6.523	0.288	0.219	25	25
Background	Aluminum	22	0	0.00%	7250	24600	16889	18000	4397	3484	-0.484	0.26	18502	18502
Background	Antimony	0	22	100.00%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Background	Arsenic	22	0	0.00%	2.8	181	16.42	5.9	38.34	1.853	4.175	2.335	52.05	52.05
Background	Barium	22	0	0.00%	69.5	175	122	125	29.3	31.13	-0.0628	0.24	132.8	132.8
Background	Chromium	22	0	0.00%	5.3	18	12.42	12.8	3.814	4.299	-0.336	0.307	13.82	13.82
Background	Iron	22	0	0.00%	16000	34000	23082	22100	4866	4077	0.868	0.211	24867	24867
Background	Lead	22	0	0.00%	4	31.1	11.29	9.95	5.431	3.781	2.494	0.481	13.22	13.22
Background	Manganese	22	0	0.00%	305	781	534.8	497	157.4	173.5	0.26	0.294	592.6	592.6
Background	Mercury	19	3	13.64%	0.01	0.07	0.0272	0.02	0.0169	0.0133	1.426	0.623	0.0405	0.0405
Background	Selenium	0	22	100.00%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	ND	N/A
Background	Silver	4	18	81.82%	0.2	0.6	0.375	0.35	0.206	0.222	0.2	0.55	0.275	0.275
Background	Vanadium	22	0	0.00%	21.8	57.1	32.57	30.35	9.169	7.116	1.167	0.282	36.01	36.01

Num Ds - number of samples with detected values

Num NDs - number of samples with nondetected values

% NDs - percent of samples with nondetected values

Minimum - minimum detected value (mg/kg)

Maximum - maximum detected value (mg/kg)

Mean - mean concentrations (mg/kg)

Median - median concentration (mg/kg)

SD - standard deviation (mg/kg)

MAD/0.675 - mean absolute deviation divided by 0.675 (a robust estimate of variability)

Skewness - skewness statistic

CV - coefficient of variation (mg/kg)

UCL - 95 percent upper confidence limit (mg/kg)

EPC - reasonable maximum exposure point concentration (mg/kg)

N/A - not available

Site Exposure Area

Area-weighted EPC Calculations

$$EPC_{Site} = \frac{\left[\left(AREA_{WRP} \times EPC_{WRP}\right) + \left(AREA_{drainage\ WRP} \times EPC_{drainage\ WRP}\right) + \left(AREA_{Background} \times EPC_{Background}\right)\right]}{AREA_{total}}$$

Constituent	EPC site (mg/kg)	AREA WRP (acres)	EPC WRP (mg/kg)	AREA DWRP (acres)	EPC DWRPs (acres)	AREA background (acres)	EPC background (mg/kg)	AREA total (acres)
Aluminum	18462.88	1	8543	1	15748	323	18502	325
Antimony	0.40	1	0.3	1	0.3	323	0.4	325
Arsenic	52.99	1	262.1	1	146.4	323	52.05	325
Barium	132.81	1	115.6	1	154.7	323	132.8	325
Chromium	13.79	1	6.209	1	10.8	323	13.82	325
Iron	24855.10	1	22650	1	23218	323	24867	325
Lead	13.23	1	15.58	1	12.49	323	13.22	325
Manganese	590.95	1	196.3	1	452.5	323	592.6	325
Mercury	0.07	1	8.188	1	1.22	323	0.0405	325
Selenium	0.90	1	1.582	1	0.83	323	0.9	325
Silver	0.32	1	9.133	1	5.658	323	0.275	325
Vanadium	35.94	1	23.35	1	25	323	36.01	325

Note: Antimony was not detected in samples from any area, while selenium was not detected in samples from the background area. In these cases, the maximum detection limit value was used as the EPC.

General UCL Statistics for Data Sets with Non-Detects

User Selected Options

From File	C:\Users\admin\Desktop\soil bkdg dataset.wst
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Aluminum - WRP

General Statistics

Number of Valid Observations	58	Number of Distinct Observations	55
Number of Missing Values	1		

Raw Statistics		Log-transformed Statistics	
Minimum	1270	Minimum of Log Data	7.147
Maximum	18500	Maximum of Log Data	9.826
Mean	7346	Mean of log Data	8.673
Geometric Mean	5844	SD of log Data	0.708
Median	7035		
SD	4891		
Std. Error of Mean	642.3		
Coefficient of Variation	0.666		
Skewness	0.956		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Lilliefors Test Statistic	0.168	Lilliefors Test Statistic	0.124
Lilliefors Critical Value	0.116	Lilliefors Critical Value	0.116
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	8420	95% H-UCL	9096
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	10794
95% Adjusted-CLT UCL (Chen-1995)	8489	97.5% Chebyshev (MVUE) UCL	12233
95% Modified-t UCL (Johnson-1978)	8433	99% Chebyshev (MVUE) UCL	15060

Gamma Distribution Test		Data Distribution	
k star (bias corrected)	2.23	Data Follow Appr. Gamma Distribution at 5% Significance Level	
Theta Star	3295		
MLE of Mean	7346		
MLE of Standard Deviation	4920		
nu star	258.6		
Approximate Chi Square Value (.05)	222.4	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0459	95% CLT UCL	8402
Adjusted Chi Square Value	221.5	95% Jackknife UCL	8420
		95% Standard Bootstrap UCL	8380
Anderson-Darling Test Statistic	0.874	95% Bootstrap-t UCL	8541
Anderson-Darling 5% Critical Value	0.761	95% Hall's Bootstrap UCL	8488
Kolmogorov-Smirnov Test Statistic	0.103	95% Percentile Bootstrap UCL	8409
Kolmogorov-Smirnov 5% Critical Value	0.118	95% BCA Bootstrap UCL	8379
Data follow Appr. Gamma Distribution at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	10146
		97.5% Chebyshev(Mean, Sd) UCL	11357
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	13737
95% Approximate Gamma UCL (Use when n >= 40)	8543		
95% Adjusted Gamma UCL (Use when n < 40)	8576		

Potential UCL to Use		Use 95% Approximate Gamma UCL	8543

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Antimony - WRP

General Statistics

Number of Valid Data	58	Number of Detected Data	0
Number of Distinct Detected Data	0	Number of Non-Detect Data	58
Number of Missing Values	1	Percent Non-Detects	100.00%

Warning: All observations are Non-Detects (NDs), therefore all statistics and estimates should also be NDs!

Specifically, sample mean, UCLs, UPLs, and other statistics are also NDs lying below the largest detection limit!

The Project Team may decide to use alternative site specific values to estimate environmental parameters (e.g., EPC, BTV).

The data set for variable WRSb was not processed!

Arsenic - WRP

General Statistics

Number of Valid Observations	58	Number of Distinct Observations	55
Number of Missing Values	1		

Raw Statistics		Log-transformed Statistics	
Minimum	31.2	Minimum of Log Data	3.44
Maximum	1290	Maximum of Log Data	7.162
Mean	222.2	Mean of log Data	5.128
Geometric Mean	168.7	SD of log Data	0.732
Median	173		
SD	198.9		
Std. Error of Mean	26.12		
Coefficient of Variation	0.895		
Skewness	3.115		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Lilliefors Test Statistic	0.199	Lilliefors Test Statistic	0.0652
Lilliefors Critical Value	0.116	Lilliefors Critical Value	0.116
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	265.9	95% H-UCL	269.6
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	320.9
95% Adjusted-CLT UCL (Chen-1995)	276.6	97.5% Chebyshev (MVUE) UCL	364.9
95% Modified-t UCL (Johnson-1978)	267.7	99% Chebyshev (MVUE) UCL	451.3

Gamma Distribution Test		Data Distribution	
k star (bias corrected)	1.876	Data appear Gamma Distributed at 5% Significance Level	
Theta Star	118.4		
MLE of Mean	222.2		
MLE of Standard Deviation	162.2		
nu star	217.6		
Approximate Chi Square Value (.05)	184.5	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0459	95% CLT UCL	265.2
Adjusted Chi Square Value	183.7	95% Jackknife UCL	265.9
		95% Standard Bootstrap UCL	264.6
Anderson-Darling Test Statistic	0.742	95% Bootstrap-t UCL	282.2
Anderson-Darling 5% Critical Value	0.763	95% Hall's Bootstrap UCL	316.4
Kolmogorov-Smirnov Test Statistic	0.105	95% Percentile Bootstrap UCL	269
Kolmogorov-Smirnov 5% Critical Value	0.118	95% BCA Bootstrap UCL	275.6
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	336
		97.5% Chebyshev(Mean, Sd) UCL	385.3
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	482.1
95% Approximate Gamma UCL (Use when n >= 40)	262.1		
95% Adjusted Gamma UCL (Use when n < 40)	263.2		

Potential UCL to Use		Use 95% Approximate Gamma UCL	262.1

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Barium - WRPs

General Statistics

Number of Valid Observations	58	Number of Distinct Observations	56
Number of Missing Values	1		

Raw Statistics		Log-transformed Statistics	
Minimum	17.2	Minimum of Log Data	2.845
Maximum	267	Maximum of Log Data	5.587
Mean	101.8	Mean of log Data	4.463
Geometric Mean	86.71	SD of log Data	0.604
Median	86.8		
SD	55.45		
Std. Error of Mean	7.28		
Coefficient of Variation	0.545		
Skewness	0.794		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Lilliefors Test Statistic	0.118	Lilliefors Test Statistic	0.0843
Lilliefors Critical Value	0.116	Lilliefors Critical Value	0.116
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	114	95% H-UCL	121.7
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	142.1
95% Adjusted-CLT UCL (Chen-1995)	114.6	97.5% Chebyshev (MVUE) UCL	158.8
95% Modified-t UCL (Johnson-1978)	114.1	99% Chebyshev (MVUE) UCL	191.5

Gamma Distribution Test		Data Distribution	
k star (bias corrected)	3.116	Data appear Gamma Distributed at 5% Significance Level	
Theta Star	32.67		
MLE of Mean	101.8		
MLE of Standard Deviation	57.67		
nu star	361.4		
Approximate Chi Square Value (.05)	318.4	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0459	95% CLT UCL	113.8
Adjusted Chi Square Value	317.3	95% Jackknife UCL	114
		95% Standard Bootstrap UCL	113.9
Anderson-Darling Test Statistic	0.269	95% Bootstrap-t UCL	115.2
Anderson-Darling 5% Critical Value	0.757	95% Hall's Bootstrap UCL	114.9
Kolmogorov-Smirnov Test Statistic	0.0642	95% Percentile Bootstrap UCL	113.8
Kolmogorov-Smirnov 5% Critical Value	0.118	95% BCA Bootstrap UCL	114.7
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	133.5
		97.5% Chebyshev(Mean, Sd) UCL	147.3
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	174.2
95% Approximate Gamma UCL (Use when n >= 40)	115.6		
95% Adjusted Gamma UCL (Use when n < 40)	115.9		
Potential UCL to Use		Use 95% Approximate Gamma UCL	115.6

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Chromium - WRPs

General Statistics

Number of Valid Observations	58	Number of Distinct Observations	46
Number of Missing Values	1		

Raw Statistics		**Log-transformed Statistics**	
Minimum	1	Minimum of Log Data	0
Maximum	21	Maximum of Log Data	3.045
Mean	5.259	Mean of log Data	1.381
Geometric Mean	3.979	SD of log Data	0.753
Median	3.7		
SD	4.19		
Std. Error of Mean	0.55		
Coefficient of Variation	0.797		
Skewness	1.577		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Lilliefors Test Statistic	0.171	Lilliefors Test Statistic	0.0762
Lilliefors Critical Value	0.116	Lilliefors Critical Value	0.116
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	6.178	95% H-UCL	6.503
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	7.761
95% Adjusted-CLT UCL (Chen-1995)	6.285	97.5% Chebyshev (MVUE) UCL	8.848
95% Modified-t UCL (Johnson-1978)	6.197	99% Chebyshev (MVUE) UCL	10.98
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	1.855	Data Follow Appr. Gamma Distribution at 5% Significance Level	
Theta Star	2.835		
MLE of Mean	5.259		
MLE of Standard Deviation	3.861		
nu star	215.2		
Approximate Chi Square Value (.05)	182.2	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0459	95% CLT UCL	6.163
Adjusted Chi Square Value	181.5	95% Jackknife UCL	6.178
		95% Standard Bootstrap UCL	6.153
Anderson-Darling Test Statistic	0.833	95% Bootstrap-t UCL	6.429
Anderson-Darling 5% Critical Value	0.764	95% Hall's Bootstrap UCL	6.308
Kolmogorov-Smirnov Test Statistic	0.107	95% Percentile Bootstrap UCL	6.145
Kolmogorov-Smirnov 5% Critical Value	0.118	95% BCA Bootstrap UCL	6.209
Data follow Appr. Gamma Distribution at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	7.656
		97.5% Chebyshev(Mean, Sd) UCL	8.694
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	10.73
95% Approximate Gamma UCL (Use when n >= 40)	6.209		
95% Adjusted Gamma UCL (Use when n < 40)	6.236		
Potential UCL to Use		Use 95% Approximate Gamma UCL	6.209

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Iron - WRPs

General Statistics

Number of Valid Observations	58	Number of Distinct Observations	56
Number of Missing Values	1		

Raw Statistics		Log-transformed Statistics	
Minimum	2330	Minimum of Log Data	7.754
Maximum	42600	Maximum of Log Data	10.66
Mean	20396	Mean of log Data	9.746
Geometric Mean	17089	SD of log Data	0.677
Median	21050		
SD	10267		
Std. Error of Mean	1348		
Coefficient of Variation	0.503		
Skewness	0.121		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Lilliefors Test Statistic	0.0525	Lilliefors Test Statistic	0.147
Lilliefors Critical Value	0.116	Lilliefors Critical Value	0.116
Data appear Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	22650	95% H-UCL	25756
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	30431
95% Adjusted-CLT UCL (Chen-1995)	22636	97.5% Chebyshev (MVUE) UCL	34344
95% Modified-t UCL (Johnson-1978)	22653	99% Chebyshev (MVUE) UCL	42030

Gamma Distribution Test		Data Distribution	
k star (bias corrected)	2.84	Data appear Normal at 5% Significance Level	
Theta Star	7181		
MLE of Mean	20396		
MLE of Standard Deviation	12102		
nu star	329.5		
Approximate Chi Square Value (.05)	288.4	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0459	95% CLT UCL	22613
Adjusted Chi Square Value	287.5	95% Jackknife UCL	22650
		95% Standard Bootstrap UCL	22592
Anderson-Darling Test Statistic	0.942	95% Bootstrap-t UCL	22670
Anderson-Darling 5% Critical Value	0.758	95% Hall's Bootstrap UCL	22681
Kolmogorov-Smirnov Test Statistic	0.116	95% Percentile Bootstrap UCL	22556
Kolmogorov-Smirnov 5% Critical Value	0.118	95% BCA Bootstrap UCL	22568
Data follow Appr. Gamma Distribution at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	26272
		97.5% Chebyshev(Mean, Sd) UCL	28814
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	33809
95% Approximate Gamma UCL (Use when n >= 40)	23299		
95% Adjusted Gamma UCL (Use when n < 40)	23378		

Potential UCL to Use		Use 95% Student's-t UCL	22650

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Lead - WRPs

General Statistics

Number of Valid Observations	58	Number of Distinct Observations	55
Number of Missing Values	1		

Raw Statistics		Log-transformed Statistics	
Minimum	2.9	Minimum of Log Data	1.065
Maximum	59.1	Maximum of Log Data	4.079
Mean	13.73	Mean of log Data	2.461
Geometric Mean	11.71	SD of log Data	0.571
Median	12.55		
SD	8.718		
Std. Error of Mean	1.145		
Coefficient of Variation	0.635		
Skewness	2.685		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Lilliefors Test Statistic	0.182	Lilliefors Test Statistic	0.101
Lilliefors Critical Value	0.116	Lilliefors Critical Value	0.116
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	15.64	95% H-UCL	15.97
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	18.54
95% Adjusted-CLT UCL (Chen-1995)	16.04	97.5% Chebyshev (MVUE) UCL	20.61
95% Modified-t UCL (Johnson-1978)	15.71	99% Chebyshev (MVUE) UCL	24.69

Gamma Distribution Test		Data Distribution	
k star (bias corrected)	3.148	Data appear Gamma Distributed at 5% Significance Level	
Theta Star	4.361		
MLE of Mean	13.73		
MLE of Standard Deviation	7.738		
nu star	365.2		
Approximate Chi Square Value (.05)	321.9	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0459	95% CLT UCL	15.61
Adjusted Chi Square Value	320.9	95% Jackknife UCL	15.64
		95% Standard Bootstrap UCL	15.63
Anderson-Darling Test Statistic	0.541	95% Bootstrap-t UCL	16.2
Anderson-Darling 5% Critical Value	0.756	95% Hall's Bootstrap UCL	17.12
Kolmogorov-Smirnov Test Statistic	0.104	95% Percentile Bootstrap UCL	15.7
Kolmogorov-Smirnov 5% Critical Value	0.118	95% BCA Bootstrap UCL	16.33
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	18.72
		97.5% Chebyshev(Mean, Sd) UCL	20.88
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	25.12
95% Approximate Gamma UCL (Use when n >= 40)	15.58		
95% Adjusted Gamma UCL (Use when n < 40)	15.63		
Potential UCL to Use		Use 95% Approximate Gamma UCL	15.58

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Manganese - WRPs

General Statistics

Number of Valid Observations	58	Number of Distinct Observations	55
Number of Missing Values	1		

Raw Statistics		Log-transformed Statistics	
Minimum	2.5	Minimum of Log Data	0.916
Maximum	943	Maximum of Log Data	6.849
Mean	143.7	Mean of log Data	3.919
Geometric Mean	50.33	SD of log Data	1.576
Median	57.2		
SD	221.5		
Std. Error of Mean	29.09		
Coefficient of Variation	1.541		
Skewness	2.537		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Lilliefors Test Statistic	0.262	Lilliefors Test Statistic	0.0916
Lilliefors Critical Value	0.116	Lilliefors Critical Value	0.116
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	192.4	95% H-UCL	341.4
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	371.7
95% Adjusted-CLT UCL (Chen-1995)	201.9	97.5% Chebyshev (MVUE) UCL	460.4
95% Modified-t UCL (Johnson-1978)	194	99% Chebyshev (MVUE) UCL	634.9

Gamma Distribution Test		Data Distribution	
k star (bias corrected)	0.571	Data Follow Appr. Gamma Distribution at 5% Significance Level	
Theta Star	251.6		
MLE of Mean	143.7		
MLE of Standard Deviation	190.2		
nu star	66.26		
Approximate Chi Square Value (.05)	48.53	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0459	95% CLT UCL	191.6
Adjusted Chi Square Value	48.14	95% Jackknife UCL	192.4
		95% Standard Bootstrap UCL	190.4
Anderson-Darling Test Statistic	1.247	95% Bootstrap-t UCL	204.9
Anderson-Darling 5% Critical Value	0.807	95% Hall's Bootstrap UCL	203.1
Kolmogorov-Smirnov Test Statistic	0.119	95% Percentile Bootstrap UCL	190.1
Kolmogorov-Smirnov 5% Critical Value	0.123	95% BCA Bootstrap UCL	202.6
Data follow Appr. Gamma Distribution at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	270.5
		97.5% Chebyshev(Mean, Sd) UCL	325.4
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	433.2
95% Approximate Gamma UCL (Use when n >= 40)	196.3		
95% Adjusted Gamma UCL (Use when n < 40)	197.8		
Potential UCL to Use		Use 95% Approximate Gamma UCL	196.3

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Mercury - WRPs

General Statistics

Number of Valid Observations	58	Number of Distinct Observations	52
Number of Missing Values	1		

Raw Statistics		Log-transformed Statistics	
Minimum	0.025	Minimum of Log Data	-3.689
Maximum	47.2	Maximum of Log Data	3.854
Mean	3.075	Mean of log Data	-1.283
Geometric Mean	0.277	SD of log Data	1.854
Median	0.215		
SD	8.934		
Std. Error of Mean	1.173		
Coefficient of Variation	2.906		
Skewness	3.413		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Lilliefors Test Statistic	0.484	Lilliefors Test Statistic	0.153
Lilliefors Critical Value	0.116	Lilliefors Critical Value	0.116
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	5.036	95% H-UCL	3.751
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	3.645
95% Adjusted-CLT UCL (Chen-1995)	5.566	97.5% Chebyshev (MVUE) UCL	4.601
95% Modified-t UCL (Johnson-1978)	5.124	99% Chebyshev (MVUE) UCL	6.479

Gamma Distribution Test		Data Distribution	
k star (bias corrected)	0.285	Data do not follow a Discernable Distribution (0.05)	
Theta Star	10.79		
MLE of Mean	3.075		
MLE of Standard Deviation	5.759		
nu star	33.06		
Approximate Chi Square Value (.05)	20.92	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0459	95% CLT UCL	5.004
Adjusted Chi Square Value	20.67	95% Jackknife UCL	5.036
		95% Standard Bootstrap UCL	4.985
Anderson-Darling Test Statistic	8.908	95% Bootstrap-t UCL	6.293
Anderson-Darling 5% Critical Value	0.868	95% Hall's Bootstrap UCL	5.221
Kolmogorov-Smirnov Test Statistic	0.345	95% Percentile Bootstrap UCL	5.26
Kolmogorov-Smirnov 5% Critical Value	0.127	95% BCA Bootstrap UCL	5.595
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	8.188
		97.5% Chebyshev(Mean, Sd) UCL	10.4
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	14.75
95% Approximate Gamma UCL (Use when n >= 40)	4.86		
95% Adjusted Gamma UCL (Use when n < 40)	4.918		

Potential UCL to Use		Use 95% Chebyshev (Mean, Sd) UCL	8.188

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Selenium - WRPs

General Statistics

Number of Valid Data	58	Number of Detected Data	31
Number of Distinct Detected Data	19	Number of Non-Detect Data	27
Number of Missing Values	1	Percent Non-Detects	46.55%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.6	Minimum Detected	-0.511
Maximum Detected	3.8	Maximum Detected	1.335
Mean of Detected	1.961	Mean of Detected	0.539
SD of Detected	0.987	SD of Detected	0.544
Minimum Non-Detect	0.5	Minimum Non-Detect	-0.693
Maximum Non-Detect	2	Maximum Non-Detect	0.693

Note: Data have multiple DLs - Use of KM Method is recommended
For all methods (except KM, DL/2, and ROS Methods),
Observations < Largest ND are treated as NDs

Number treated as Non-Detect	45
Number treated as Detected	13
Single DL Non-Detect Percentage	77.59%

UCL Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	0.904	Shapiro Wilk Test Statistic	0.928
5% Shapiro Wilk Critical Value	0.929	5% Shapiro Wilk Critical Value	0.929
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	1.263	Mean	-0.162
SD	1.063	SD	0.942
95% DL/2 (t) UCL	1.496	95% H-Stat (DL/2) UCL	1.76
Maximum Likelihood Estimate(MLE) Method		Log ROS Method	
Mean	0.881	Mean in Log Scale	-0.0185
SD	1.533	SD in Log Scale	0.784
95% MLE (t) UCL	1.217	Mean in Original Scale	1.315
95% MLE (Tiku) UCL	1.609	SD in Original Scale	1.018
		95% t UCL	1.538
		95% Percentile Bootstrap UCL	1.546
		95% BCA Bootstrap UCL	1.542
		95% H UCL	1.662

Gamma Distribution Test with Detected Values Only		Data Distribution Test with Detected Values Only	
k star (bias corrected)	3.527	Data Follow Appr. Gamma Distribution at 5% Significance Level	
Theta Star	0.556		
nu star	218.7		
A-D Test Statistic	0.784	Nonparametric Statistics	
5% A-D Critical Value	0.75	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.75	Mean	1.363
5% K-S Critical Value	0.158	SD	0.97
Data follow Appr. Gamma Distribution at 5% Significance Level		SE of Mean	0.131
		95% KM (t) UCL	1.582
Assuming Gamma Distribution		95% KM (z) UCL	1.578
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	1.557
Minimum	0.000001	95% KM (bootstrap t) UCL	1.581
Maximum	3.8	95% KM (BCA) UCL	1.631
Mean	1.113	95% KM (Percentile Bootstrap) UCL	1.603
Median	0.8	95% KM (Chebyshev) UCL	1.934
SD	1.2	97.5% KM (Chebyshev) UCL	2.181
k star	0.145	99% KM (Chebyshev) UCL	2.666
Theta star	7.696		
Nu star	16.77	Potential UCLs to Use	
AppChi2	8.51	95% KM (t) UCL	1.582
95% Gamma Approximate UCL (Use when n >= 40)	2.193		
95% Adjusted Gamma UCL (Use when n < 40)	2.233		

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

Silver - WRPs

General Statistics

Number of Valid Data	58	Number of Detected Data	53
Number of Distinct Detected Data	42	Number of Non-Detect Data	5
Number of Missing Values	1	Percent Non-Detects	8.62%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.4	Minimum Detected	-0.916
Maximum Detected	29.4	Maximum Detected	3.381
Mean of Detected	8.436	Mean of Detected	1.761
SD of Detected	6.18	SD of Detected	0.993
Minimum Non-Detect	0.2	Minimum Non-Detect	-1.609
Maximum Non-Detect	0.2	Maximum Non-Detect	-1.609

UCL Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Lilliefors Test Statistic	0.104	Lilliefors Test Statistic	0.215
5% Lilliefors Critical Value	0.122	5% Lilliefors Critical Value	0.122
Data appear Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	7.717	Mean	1.411
SD	6.357	SD	1.491
95% DL/2 (t) UCL	9.113	95% H-Stat (DL/2) UCL	23.04
Maximum Likelihood Estimate(MLE) Method		Log ROS Method	
Mean	7.427	Mean in Log Scale	1.573
SD	6.766	SD in Log Scale	1.135
95% MLE (t) UCL	8.913	Mean in Original Scale	7.768
95% MLE (Tiku) UCL	8.891	SD in Original Scale	6.298
		95% t UCL	9.15
		95% Percentile Bootstrap UCL	9.162
		95% BCA Bootstrap UCL	9.19
		95% H UCL	13.49

Gamma Distribution Test with Detected Values Only		Data Distribution Test with Detected Values Only	
k star (bias corrected)	1.42	Data appear Normal at 5% Significance Level	
Theta Star	5.942		
nu star	150.5		
A-D Test Statistic	1.326	**Nonparametric Statistics**	
5% A-D Critical Value	0.768	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.768	Mean	7.743
5% K-S Critical Value	0.124	SD	6.271
Data not Gamma Distributed at 5% Significance Level		SE of Mean	0.831
		95% KM (t) UCL	9.133
Assuming Gamma Distribution		95% KM (z) UCL	9.111
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	9.096
Minimum	0.000001	95% KM (bootstrap t) UCL	9.236
Maximum	29.4	95% KM (BCA) UCL	9.329
Mean	7.709	95% KM (Percentile Bootstrap) UCL	9.159
Median	8.2	95% KM (Chebyshev) UCL	11.37
SD	6.368	97.5% KM (Chebyshev) UCL	12.93
k star	0.395	99% KM (Chebyshev) UCL	16.01
Theta star	19.51		
Nu star	45.83	Potential UCLs to Use	
AppChi2	31.3	95% KM (t) UCL	9.133
95% Gamma Approximate UCL (Use when n >= 40)	11.29	95% KM (Percentile Bootstrap) UCL	9.159
95% Adjusted Gamma UCL (Use when n < 40)	11.4		

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

Vanadium - WRPs

General Statistics

Number of Valid Observations	58	Number of Distinct Observations	53
Number of Missing Values	1		

Raw Statistics		Log-transformed Statistics	
Minimum	1.2	Minimum of Log Data	0.182
Maximum	105	Maximum of Log Data	4.654
Mean	14.68	Mean of log Data	2.25
Geometric Mean	9.483	SD of log Data	1.013
Median	11.9		
SD	15.15		
Std. Error of Mean	1.989		
Coefficient of Variation	1.032		
Skewness	3.805		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Lilliefors Test Statistic	0.192	Lilliefors Test Statistic	0.17
Lilliefors Critical Value	0.116	Lilliefors Critical Value	0.116
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	18.01	95% H-UCL	21.76
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	26.41
95% Adjusted-CLT UCL (Chen-1995)	19.02	97.5% Chebyshev (MVUE) UCL	31.07
95% Modified-t UCL (Johnson-1978)	18.18	99% Chebyshev (MVUE) UCL	40.22
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	1.23	Data do not follow a Discernable Distribution (0.05)	
Theta Star	11.94		
MLE of Mean	14.68		
MLE of Standard Deviation	13.24		
nu star	142.6		
Approximate Chi Square Value (.05)	116	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0459	95% CLT UCL	17.96
Adjusted Chi Square Value	115.4	95% Jackknife UCL	18.01
		95% Standard Bootstrap UCL	17.95
Anderson-Darling Test Statistic	1.417	95% Bootstrap-t UCL	19.73
Anderson-Darling 5% Critical Value	0.773	95% Hall's Bootstrap UCL	33.97
Kolmogorov-Smirnov Test Statistic	0.132	95% Percentile Bootstrap UCL	18.02
Kolmogorov-Smirnov 5% Critical Value	0.119	95% BCA Bootstrap UCL	19.23
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	23.35
		97.5% Chebyshev(Mean, Sd) UCL	27.11
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	34.48
95% Approximate Gamma UCL (Use when n >= 40)	18.05		
95% Adjusted Gamma UCL (Use when n < 40)	18.15		
Potential UCL to Use		Use 95% Chebyshev (Mean, Sd) UCL	23.35

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

General UCL Statistics for Data Sets with Non-Detects

User Selected Options	
From File	C:\Users\admin\Desktop\soil bkdg dataset.wst
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Aluminum - DWRPs

General Statistics

Number of Valid Observations	23	Number of Distinct Observations	21

Raw Statistics		Log-transformed Statistics	
Minimum	6580	Minimum of Log Data	8.792
Maximum	21400	Maximum of Log Data	9.971
Mean	14289	Mean of log Data	9.521
Geometric Mean	13643	SD of log Data	0.326
Median	15000		
SD	4075		
Std. Error of Mean	849.7		
Coefficient of Variation	0.285		
Skewness	-0.408		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.953	Shapiro Wilk Test Statistic	0.904
Shapiro Wilk Critical Value	0.914	Shapiro Wilk Critical Value	0.914
Data appear Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	15748	95% H-UCL	16353
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	18685
95% Adjusted-CLT UCL (Chen-1995)	15609	97.5% Chebyshev (MVUE) UCL	20559
95% Modified-t UCL (Johnson-1978)	15736	99% Chebyshev (MVUE) UCL	24239
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	9.575	Data appear Normal at 5% Significance Level	
Theta Star	1492		
MLE of Mean	14289		
MLE of Standard Deviation	4618		
nu star	440.4		
Approximate Chi Square Value (.05)	392.8	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0389	95% CLT UCL	15687
Adjusted Chi Square Value	389.5	95% Jackknife UCL	15748
		95% Standard Bootstrap UCL	15700
Anderson-Darling Test Statistic	0.749	95% Bootstrap-t UCL	15651
Anderson-Darling 5% Critical Value	0.744	95% Hall's Bootstrap UCL	15625
Kolmogorov-Smirnov Test Statistic	0.168	95% Percentile Bootstrap UCL	15664
Kolmogorov-Smirnov 5% Critical Value	0.182	95% BCA Bootstrap UCL	15630
Data follow Appr. Gamma Distribution at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	17993
		97.5% Chebyshev(Mean, Sd) UCL	19595
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	22743
95% Approximate Gamma UCL (Use when n >= 40)	16023		
95% Adjusted Gamma UCL (Use when n < 40)	16157		
Potential UCL to Use		Use 95% Student's-t UCL	15748

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Note: For highly negative-skewed data, confidence limits
(e.g., Chen, Johnson, Lognormal, and Gamma) may not be
reliable. Chen's and Johnson's methods provide
adjustments for positvely skewed data sets.

Antimony - DWRPs

General Statistics			
Number of Valid Data	23	Number of Detected Data	0
Number of Distinct Detected Data	0	Number of Non-Detect Data	23
		Percent Non-Detects	100.00%

Warning: All observations are Non-Detects (NDs), therefore all statistics and estimates should also be NDs!

Specifically, sample mean, UCLs, UPLs, and other statistics are also NDs lying below the largest detection limit!

The Project Team may decide to use alternative site specific values to estimate environmental parameters (e.g., EPC, BTV).

The data set for variable Sbs was not processed!

Arsenic - DWRPs

General Statistics

Number of Valid Observations	23	Number of Distinct Observations	23

Raw Statistics		Log-transformed Statistics	
Minimum	9	Minimum of Log Data	2.197
Maximum	298	Maximum of Log Data	5.697
Mean	103.3	Mean of log Data	4.213
Geometric Mean	67.54	SD of log Data	1.013
Median	71		
SD	90.34		
Std. Error of Mean	18.84		
Coefficient of Variation	0.874		
Skewness	1.019		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.857	Shapiro Wilk Test Statistic	0.959
Shapiro Wilk Critical Value	0.914	Shapiro Wilk Critical Value	0.914
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	135.7	95% H-UCL	195.3
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	223.1
95% Adjusted-CLT UCL (Chen-1995)	138.6	97.5% Chebyshev (MVUE) UCL	272.4
95% Modified-t UCL (Johnson-1978)	136.4	99% Chebyshev (MVUE) UCL	369.2

Gamma Distribution Test		Data Distribution	
k star (bias corrected)	1.174	Data appear Gamma Distributed at 5% Significance Level	
Theta Star	87.99		
MLE of Mean	103.3		
MLE of Standard Deviation	95.36		
nu star	54.03		
Approximate Chi Square Value (.05)	38.14	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0389	95% CLT UCL	134.3
Adjusted Chi Square Value	37.17	95% Jackknife UCL	135.7
		95% Standard Bootstrap UCL	133.6
Anderson-Darling Test Statistic	0.326	95% Bootstrap-t UCL	141.9
Anderson-Darling 5% Critical Value	0.763	95% Hall's Bootstrap UCL	137.2
Kolmogorov-Smirnov Test Statistic	0.124	95% Percentile Bootstrap UCL	135.2
Kolmogorov-Smirnov 5% Critical Value	0.186	95% BCA Bootstrap UCL	137
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	185.4
		97.5% Chebyshev(Mean, Sd) UCL	221
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	290.8
95% Approximate Gamma UCL (Use when n >= 40)	146.4		
95% Adjusted Gamma UCL (Use when n < 40)	150.2		

Potential UCL to Use		Use 95% Approximate Gamma UCL	146.4

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Barium - DWRPs

General Statistics

Number of Valid Observations	23	Number of Distinct Observations	19

Raw Statistics		Log-transformed Statistics	
Minimum	68.1	Minimum of Log Data	4.221
Maximum	238	Maximum of Log Data	5.472
Mean	140.6	Mean of log Data	4.909
Geometric Mean	135.5	SD of log Data	0.277
Median	138		
SD	39.47		
Std. Error of Mean	8.231		
Coefficient of Variation	0.281		
Skewness	0.85		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.934	Shapiro Wilk Test Statistic	0.968
Shapiro Wilk Critical Value	0.914	Shapiro Wilk Critical Value	0.914
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	154.7	95% H-UCL	156.7
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	176.5
95% Adjusted-CLT UCL (Chen-1995)	155.7	97.5% Chebyshev (MVUE) UCL	192
95% Modified-t UCL (Johnson-1978)	154.9	99% Chebyshev (MVUE) UCL	222.5

Gamma Distribution Test		Data Distribution	
k star (bias corrected)	12.06	Data appear Normal at 5% Significance Level	
Theta Star	11.65		
MLE of Mean	140.6		
MLE of Standard Deviation	40.47		
nu star	554.9		
Approximate Chi Square Value (.05)	501.2	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0389	95% CLT UCL	154.1
Adjusted Chi Square Value	497.6	95% Jackknife UCL	154.7
		95% Standard Bootstrap UCL	153.8
Anderson-Darling Test Statistic	0.386	95% Bootstrap-t UCL	156.5
Anderson-Darling 5% Critical Value	0.743	95% Hall's Bootstrap UCL	157.6
Kolmogorov-Smirnov Test Statistic	0.158	95% Percentile Bootstrap UCL	154.7
Kolmogorov-Smirnov 5% Critical Value	0.181	95% BCA Bootstrap UCL	155.9
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	176.4
		97.5% Chebyshev(Mean, Sd) UCL	192
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	222.4
95% Approximate Gamma UCL (Use when n >= 40)	155.6		
95% Adjusted Gamma UCL (Use when n < 40)	156.7		

Potential UCL to Use		Use 95% Student's-t UCL	154.7

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Chromium - DWRPs

General Statistics

Number of Valid Observations	23	Number of Distinct Observations	21

Raw Statistics		**Log-transformed Statistics**	
Minimum	5.3	Minimum of Log Data	1.668
Maximum	15.8	Maximum of Log Data	2.76
Mean	9.617	Mean of log Data	2.207
Geometric Mean	9.089	SD of log Data	0.346
Median	8.6		
SD	3.296		
Std. Error of Mean	0.687		
Coefficient of Variation	0.343		
Skewness	0.465		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.933	Shapiro Wilk Test Statistic	0.951
Shapiro Wilk Critical Value	0.914	Shapiro Wilk Critical Value	0.914
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	10.8	95% H-UCL	11.06
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	12.7
95% Adjusted-CLT UCL (Chen-1995)	10.82	97.5% Chebyshev (MVUE) UCL	14.04
95% Modified-t UCL (Johnson-1978)	10.81	99% Chebyshev (MVUE) UCL	16.66
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	7.859	Data appear Normal at 5% Significance Level	
Theta Star	1.224		
MLE of Mean	9.617		
MLE of Standard Deviation	3.431		
nu star	361.5		
Approximate Chi Square Value (.05)	318.5	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0389	95% CLT UCL	10.75
Adjusted Chi Square Value	315.5	95% Jackknife UCL	10.8
		95% Standard Bootstrap UCL	10.72
Anderson-Darling Test Statistic	0.344	95% Bootstrap-t UCL	10.9
Anderson-Darling 5% Critical Value	0.745	95% Hall's Bootstrap UCL	10.8
Kolmogorov-Smirnov Test Statistic	0.108	95% Percentile Bootstrap UCL	10.74
Kolmogorov-Smirnov 5% Critical Value	0.182	95% BCA Bootstrap UCL	10.7
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	12.61
		97.5% Chebyshev(Mean, Sd) UCL	13.91
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	16.46
95% Approximate Gamma UCL (Use when n >= 40)	10.92		
95% Adjusted Gamma UCL (Use when n < 40)	11.02		
Potential UCL to Use		Use 95% Student's-t UCL	10.8

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Iron - DWRPs

General Statistics

Number of Valid Observations	23	Number of Distinct Observations	19

Raw Statistics		Log-transformed Statistics	
Minimum	15400	Minimum of Log Data	9.642
Maximum	28300	Maximum of Log Data	10.25
Mean	21965	Mean of log Data	9.984
Geometric Mean	21683	SD of log Data	0.168
Median	21500		
SD	3499		
Std. Error of Mean	729.6		
Coefficient of Variation	0.159		
Skewness	-0.314		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.929	Shapiro Wilk Test Statistic	0.9
Shapiro Wilk Critical Value	0.914	Shapiro Wilk Critical Value	0.914
Data appear Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	23218	95% H-UCL	23405
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	25339
95% Adjusted-CLT UCL (Chen-1995)	23114	97.5% Chebyshev (MVUE) UCL	26794
95% Modified-t UCL (Johnson-1978)	23210	99% Chebyshev (MVUE) UCL	29653
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	33.75	Data appear Normal at 5% Significance Level	
Theta Star	650.7		
MLE of Mean	21965		
MLE of Standard Deviation	3781		
nu star	1553		
Approximate Chi Square Value (.05)	1462	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0389	95% CLT UCL	23165
Adjusted Chi Square Value	1456	95% Jackknife UCL	23218
		95% Standard Bootstrap UCL	23150
Anderson-Darling Test Statistic	0.897	95% Bootstrap-t UCL	23171
Anderson-Darling 5% Critical Value	0.742	95% Hall's Bootstrap UCL	23166
Kolmogorov-Smirnov Test Statistic	0.237	95% Percentile Bootstrap UCL	23104
Kolmogorov-Smirnov 5% Critical Value	0.181	95% BCA Bootstrap UCL	23100
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	25145
		97.5% Chebyshev(Mean, Sd) UCL	26522
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	29225
95% Approximate Gamma UCL (Use when n >= 40)	23325		
95% Adjusted Gamma UCL (Use when n < 40)	23427		
Potential UCL to Use		Use 95% Student's-t UCL	23218

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Note: For highly negative-skewed data, confidence limits
(e.g., Chen, Johnson, Lognormal, and Gamma) may not be
reliable. Chen's and Johnson's methods provide
adjustments for positvely skewed data sets.

Lead - DWRPs

General Statistics

Number of Valid Observations	23	Number of Distinct Observations	22

Raw Statistics		Log-transformed Statistics	
Minimum	7.6	Minimum of Log Data	2.028
Maximum	22.8	Maximum of Log Data	3.127
Mean	11.32	Mean of log Data	2.392
Geometric Mean	10.94	SD of log Data	0.257
Median	10.7		
SD	3.358		
Std. Error of Mean	0.7		
Coefficient of Variation	0.297		
Skewness	1.997		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.824	Shapiro Wilk Test Statistic	0.934
Shapiro Wilk Critical Value	0.914	Shapiro Wilk Critical Value	0.914
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	12.52	95% H-UCL	12.47
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	13.95
95% Adjusted-CLT UCL (Chen-1995)	12.78	97.5% Chebyshev (MVUE) UCL	15.1
95% Modified-t UCL (Johnson-1978)	12.57	99% Chebyshev (MVUE) UCL	17.37
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	12.83	Data appear Gamma Distributed at 5% Significance Level	
Theta Star	0.882		
MLE of Mean	11.32		
MLE of Standard Deviation	3.159		
nu star	590.3		
Approximate Chi Square Value (.05)	535	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0389	95% CLT UCL	12.47
Adjusted Chi Square Value	531.1	95% Jackknife UCL	12.52
		95% Standard Bootstrap UCL	12.44
Anderson-Darling Test Statistic	0.58	95% Bootstrap-t UCL	12.96
Anderson-Darling 5% Critical Value	0.743	95% Hall's Bootstrap UCL	14.4
Kolmogorov-Smirnov Test Statistic	0.144	95% Percentile Bootstrap UCL	12.5
Kolmogorov-Smirnov 5% Critical Value	0.181	95% BCA Bootstrap UCL	12.86
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	14.37
		97.5% Chebyshev(Mean, Sd) UCL	15.69
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	18.28
95% Approximate Gamma UCL (Use when n >= 40)	12.49		
95% Adjusted Gamma UCL (Use when n < 40)	12.58		
Potential UCL to Use		Use 95% Approximate Gamma UCL	12.49

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Manganese - DWRPs

General Statistics

Number of Valid Observations	23	Number of Distinct Observations	22

Raw Statistics		Log-transformed Statistics	
Minimum	177	Minimum of Log Data	5.176
Maximum	794	Maximum of Log Data	6.677
Mean	397.7	Mean of log Data	5.917
Geometric Mean	371.1	SD of log Data	0.382
Median	342		
SD	153.1		
Std. Error of Mean	31.92		
Coefficient of Variation	0.385		
Skewness	0.828		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.934	Shapiro Wilk Test Statistic	0.971
Shapiro Wilk Critical Value	0.914	Shapiro Wilk Critical Value	0.914
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	452.5	95% H-UCL	465.2
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	539.3
95% Adjusted-CLT UCL (Chen-1995)	456.1	97.5% Chebyshev (MVUE) UCL	600.5
95% Modified-t UCL (Johnson-1978)	453.4	99% Chebyshev (MVUE) UCL	720.7
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	6.456	Data appear Normal at 5% Significance Level	
Theta Star	61.61		
MLE of Mean	397.7		
MLE of Standard Deviation	156.5		
nu star	297		
Approximate Chi Square Value (.05)	258	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0389	95% CLT UCL	450.2
Adjusted Chi Square Value	255.4	95% Jackknife UCL	452.5
		95% Standard Bootstrap UCL	448.8
Anderson-Darling Test Statistic	0.388	95% Bootstrap-t UCL	459.6
Anderson-Darling 5% Critical Value	0.745	95% Hall's Bootstrap UCL	458.3
Kolmogorov-Smirnov Test Statistic	0.171	95% Percentile Bootstrap UCL	449.7
Kolmogorov-Smirnov 5% Critical Value	0.182	95% BCA Bootstrap UCL	458.7
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	536.8
		97.5% Chebyshev(Mean, Sd) UCL	597
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	715.3
95% Approximate Gamma UCL (Use when n >= 40)	457.7		
95% Adjusted Gamma UCL (Use when n < 40)	462.4		
Potential UCL to Use		Use 95% Student's-t UCL	452.5

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Mercury - DWRPs

General Statistics

Number of Valid Observations	23	Number of Distinct Observations	22

Raw Statistics		Log-transformed Statistics	
Minimum	0.02	Minimum of Log Data	-3.912
Maximum	4.61	Maximum of Log Data	1.528
Mean	0.348	Mean of log Data	-2.237
Geometric Mean	0.107	SD of log Data	1.243
Median	0.1		
SD	0.959		
Std. Error of Mean	0.2		
Coefficient of Variation	2.759		
Skewness	4.378		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.344	Shapiro Wilk Test Statistic	0.883
Shapiro Wilk Critical Value	0.914	Shapiro Wilk Critical Value	0.914
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	0.691	95% H-UCL	0.493
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	0.51
95% Adjusted-CLT UCL (Chen-1995)	0.872	97.5% Chebyshev (MVUE) UCL	0.635
95% Modified-t UCL (Johnson-1978)	0.722	99% Chebyshev (MVUE) UCL	0.883

Gamma Distribution Test		Data Distribution	
k star (bias corrected)	0.492	Data do not follow a Discernable Distribution (0.05)	
Theta Star	0.706		
MLE of Mean	0.348		
MLE of Standard Deviation	0.496		
nu star	22.65		
Approximate Chi Square Value (.05)	12.82	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0389	95% CLT UCL	0.677
Adjusted Chi Square Value	12.29	95% Jackknife UCL	0.691
		95% Standard Bootstrap UCL	0.666
Anderson-Darling Test Statistic	2.804	95% Bootstrap-t UCL	3.674
Anderson-Darling 5% Critical Value	0.802	95% Hall's Bootstrap UCL	2.239
Kolmogorov-Smirnov Test Statistic	0.308	95% Percentile Bootstrap UCL	0.713
Kolmogorov-Smirnov 5% Critical Value	0.191	95% BCA Bootstrap UCL	1.073
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	1.22
		97.5% Chebyshev(Mean, Sd) UCL	1.597
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	2.338
95% Approximate Gamma UCL (Use when n >= 40)	0.614		
95% Adjusted Gamma UCL (Use when n < 40)	0.641		

Potential UCL to Use		Use 95% Chebyshev (Mean, Sd) UCL	1.22

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Selenium - DWRPs

General Statistics

Number of Valid Data	23	Number of Detected Data	3
Number of Distinct Detected Data	3	Number of Non-Detect Data	20
		Percent Non-Detects	86.96%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.7	Minimum Detected	-0.357
Maximum Detected	1.6	Maximum Detected	0.47
Mean of Detected	1.033	Mean of Detected	-0.0366
SD of Detected	0.493	SD of Detected	0.444
Minimum Non-Detect	0.5	Minimum Non-Detect	-0.693
Maximum Non-Detect	2	Maximum Non-Detect	0.693

Note: Data have multiple DLs - Use of KM Method is recommended	Number treated as Non-Detect	23
For all methods (except KM, DL/2, and ROS Methods),	Number treated as Detected	0
Observations < Largest ND are treated as NDs	Single DL Non-Detect Percentage	100.00%

Warning: There are only 3 Distinct Detected Values in this data set
The number of detected data may not be adequate enough to perform GOF tests, bootstrap, and ROS methods.
Those methods will return a 'N/A' value on your output display!

It is necessary to have 4 or more Distinct Values for bootstrap methods.
However, results obtained using 4 to 9 distinct values may not be reliable.
It is recommended to have 10 to 15 or more observations for accurate and meaningful results and estimates.

UCL Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	0.832	Shapiro Wilk Test Statistic	0.867
5% Shapiro Wilk Critical Value	0.767	5% Shapiro Wilk Critical Value	0.767
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	0.413	Mean	-1.047
SD	0.324	SD	0.503
95% DL/2 (t) UCL	0.529	95% H-Stat (DL/2) UCL	0.492
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE method failed to converge properly		Mean in Log Scale	-2.355
		SD in Log Scale	1.327
		Mean in Original Scale	0.224
		SD in Original Scale	0.363
		95% t UCL	0.354
		95% Percentile Bootstrap UCL	0.358
		95% BCA Bootstrap UCL	0.419
		95% H-UCL	0.533

Gamma Distribution Test with Detected Values Only		Data Distribution Test with Detected Values Only	
k star (bias corrected)	N/A	Data appear Normal at 5% Significance Level	
Theta Star	N/A		
nu star	N/A		
A-D Test Statistic	N/A	**Nonparametric Statistics**	
5% A-D Critical Value	N/A	Kaplan-Meier (KM) Method	
K-S Test Statistic	N/A	Mean	0.745
5% K-S Critical Value	N/A	SD	0.188
Data not Gamma Distributed at 5% Significance Level		SE of Mean	0.049
		95% KM (t) UCL	0.83
Assuming Gamma Distribution		95% KM (z) UCL	0.826
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	0.827
Minimum	N/A	95% KM (bootstrap t) UCL	1.011
Maximum	N/A	95% KM (BCA) UCL	1.6
Mean	N/A	95% KM (Percentile Bootstrap) UCL	1.6
Median	N/A	95% KM (Chebyshev) UCL	0.959

SD	N/A	97.5% KM (Chebyshev) UCL	1.051
k star	N/A	99% KM (Chebyshev) UCL	1.233
Theta star	N/A		
Nu star	N/A	**Potential UCLs to Use**	
AppChi2	N/A	95% KM (t) UCL	0.83
95% Gamma Approximate UCL (Use when n >= 40)	N/A	95% KM (Percentile Bootstrap) UCL	1.6
95% Adjusted Gamma UCL (Use when n < 40)	N/A		

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

Silver - DWRPs

General Statistics

Number of Valid Observations	23	Number of Distinct Observations	18

Raw Statistics		Log-transformed Statistics	
Minimum	0.3	Minimum of Log Data	-1.204
Maximum	12.7	Maximum of Log Data	2.542
Mean	2.7	Mean of log Data	0.372
Geometric Mean	1.45	SD of log Data	1.134
Median	1.2		
SD	3.254		
Std. Error of Mean	0.679		
Coefficient of Variation	1.205		
Skewness	1.846		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.743	Shapiro Wilk Test Statistic	0.937
Shapiro Wilk Critical Value	0.914	Shapiro Wilk Critical Value	0.914
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	3.865	95% H-UCL	5.304
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	5.789
95% Adjusted-CLT UCL (Chen-1995)	4.095	97.5% Chebyshev (MVUE) UCL	7.151
95% Modified-t UCL (Johnson-1978)	3.909	99% Chebyshev (MVUE) UCL	9.827

Gamma Distribution Test		Data Distribution	
k star (bias corrected)	0.843	Data appear Lognormal at 5% Significance Level	
Theta Star	3.204		
MLE of Mean	2.7		
MLE of Standard Deviation	2.941		
nu star	38.76		
Approximate Chi Square Value (.05)	25.5	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0389	95% CLT UCL	3.816
Adjusted Chi Square Value	24.72	95% Jackknife UCL	3.865
		95% Standard Bootstrap UCL	3.779
Anderson-Darling Test Statistic	0.929	95% Bootstrap-t UCL	4.31
Anderson-Darling 5% Critical Value	0.773	95% Hall's Bootstrap UCL	4.349
Kolmogorov-Smirnov Test Statistic	0.192	95% Percentile Bootstrap UCL	3.835
Kolmogorov-Smirnov 5% Critical Value	0.187	95% BCA Bootstrap UCL	4.061
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	5.658
		97.5% Chebyshev(Mean, Sd) UCL	6.938
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	9.452
95% Approximate Gamma UCL (Use when n >= 40)	4.104		
95% Adjusted Gamma UCL (Use when n < 40)	4.233		

Potential UCL to Use		Use 95% Chebyshev (Mean, Sd) UCL	5.658

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Vanadium - DWRPs

General Statistics

Number of Valid Observations	23	Number of Distinct Observations	21

Raw Statistics		Log-transformed Statistics	
Minimum	16.1	Minimum of Log Data	2.779
Maximum	31.5	Maximum of Log Data	3.45
Mean	23.18	Mean of log Data	3.121
Geometric Mean	22.66	SD of log Data	0.218
Median	22.5		
SD	5.067		
Std. Error of Mean	1.057		
Coefficient of Variation	0.219		
Skewness	0.288		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.919	Shapiro Wilk Test Statistic	0.93
Shapiro Wilk Critical Value	0.914	Shapiro Wilk Critical Value	0.914
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	25	95% H-UCL	25.2
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	27.82
95% Adjusted-CLT UCL (Chen-1995)	24.99	97.5% Chebyshev (MVUE) UCL	29.83
95% Modified-t UCL (Johnson-1978)	25.01	99% Chebyshev (MVUE) UCL	33.77
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	19.23	Data appear Normal at 5% Significance Level	
Theta Star	1.206		
MLE of Mean	23.18		
MLE of Standard Deviation	5.287		
nu star	884.5		
Approximate Chi Square Value (.05)	816.4	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0389	95% CLT UCL	24.92
Adjusted Chi Square Value	811.7	95% Jackknife UCL	25
		95% Standard Bootstrap UCL	24.87
Anderson-Darling Test Statistic	0.61	95% Bootstrap-t UCL	25.03
Anderson-Darling 5% Critical Value	0.742	95% Hall's Bootstrap UCL	24.9
Kolmogorov-Smirnov Test Statistic	0.142	95% Percentile Bootstrap UCL	24.89
Kolmogorov-Smirnov 5% Critical Value	0.181	95% BCA Bootstrap UCL	24.97
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	27.79
		97.5% Chebyshev(Mean, Sd) UCL	29.78
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	33.7
95% Approximate Gamma UCL (Use when n >= 40)	25.11		
95% Adjusted Gamma UCL (Use when n < 40)	25.26		
Potential UCL to Use		Use 95% Student's-t UCL	25

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

General UCL Statistics for Data Sets with Non-Detects

User Selected Options

From File	C:\Users\admin\Desktop\site bkgd comparisons\soil bkdg dataset.wst
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Aluminum - Background

General Statistics

Number of Valid Observations	22	Number of Distinct Observations	21

Raw Statistics		**Log-transformed Statistics**	
Minimum	7250	Minimum of Log Data	8.889
Maximum	24600	Maximum of Log Data	10.11
Mean	16889	Mean of log Data	9.696
Geometric Mean	16250	SD of log Data	0.299
Median	18000		
SD	4397		
Std. Error of Mean	937.5		
Coefficient of Variation	0.26		
Skewness	-0.484		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.954	Shapiro Wilk Test Statistic	0.898
Shapiro Wilk Critical Value	0.911	Shapiro Wilk Critical Value	0.911
Data appear Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	18502	95% H-UCL	19156
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	21734
95% Adjusted-CLT UCL (Chen-1995)	18327	97.5% Chebyshev (MVUE) UCL	23802
95% Modified-t UCL (Johnson-1978)	18486	99% Chebyshev (MVUE) UCL	27863
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	11.37	Data appear Normal at 5% Significance Level	
Theta Star	1485		
MLE of Mean	16889		
MLE of Standard Deviation	5008		
nu star	500.4		
Approximate Chi Square Value (.05)	449.5	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0386	95% CLT UCL	18431
Adjusted Chi Square Value	445.9	95% Jackknife UCL	18502
		95% Standard Bootstrap UCL	18414
Anderson-Darling Test Statistic	0.806	95% Bootstrap-t UCL	18423
Anderson-Darling 5% Critical Value	0.743	95% Hall's Bootstrap UCL	18327
Kolmogorov-Smirnov Test Statistic	0.216	95% Percentile Bootstrap UCL	18377
Kolmogorov-Smirnov 5% Critical Value	0.185	95% BCA Bootstrap UCL	18309
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	20975
		97.5% Chebyshev(Mean, Sd) UCL	22744
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	26217
95% Approximate Gamma UCL (Use when n >= 40)	18800		
95% Adjusted Gamma UCL (Use when n < 40)	18951		
Potential UCL to Use		Use 95% Student's-t UCL	18502

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Note: For highly negative-skewed data, confidence limits
(e.g., Chen, Johnson, Lognormal, and Gamma) may not be
reliable. Chen's and Johnson's methods provide
adjustments for positvely skewed data sets.

Antimony - Background

General Statistics

Number of Valid Data	22	Number of Detected Data	0
Number of Distinct Detected Data	0	Number of Non-Detect Data	22
		Percent Non-Detects	100.00%

Warning: All observations are Non-Detects (NDs), therefore all statistics and estimates should also be NDs!
Specifically, sample mean, UCLs, UPLs, and other statistics are also NDs lying below the largest detection limit!
The Project Team may decide to use alternative site specific values to estimate environmental parameters (e.g., EPC, BTV).

The data set for variable Sbb was not processed!

Arsenic - Background

General Statistics

Number of Valid Observations	22	Number of Distinct Observations	19

Raw Statistics		**Log-transformed Statistics**	
Minimum	2.8	Minimum of Log Data	1.03
Maximum	181	Maximum of Log Data	5.198
Mean	16.42	Mean of log Data	1.995
Geometric Mean	7.352	SD of log Data	0.96
Median	5.9		
SD	38.34		
Std. Error of Mean	8.175		
Coefficient of Variation	2.335		
Skewness	4.175		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.358	Shapiro Wilk Test Statistic	0.744
Shapiro Wilk Critical Value	0.911	Shapiro Wilk Critical Value	0.911
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	30.48	95% H-UCL	19.81
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	22.64
95% Adjusted-CLT UCL (Chen-1995)	37.64	97.5% Chebyshev (MVUE) UCL	27.54
95% Modified-t UCL (Johnson-1978)	31.7	99% Chebyshev (MVUE) UCL	37.16
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	0.674	Data do not follow a Discernable Distribution (0.05)	
Theta Star	24.35		
MLE of Mean	16.42		
MLE of Standard Deviation	19.99		
nu star	29.67		
Approximate Chi Square Value (.05)	18.23	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0386	95% CLT UCL	29.86
Adjusted Chi Square Value	17.56	95% Jackknife UCL	30.48
		95% Standard Bootstrap UCL	29.09
Anderson-Darling Test Statistic	3.746	95% Bootstrap-t UCL	165.6
Anderson-Darling 5% Critical Value	0.783	95% Hall's Bootstrap UCL	90.85
Kolmogorov-Smirnov Test Statistic	0.352	95% Percentile Bootstrap UCL	31.94
Kolmogorov-Smirnov 5% Critical Value	0.193	95% BCA Bootstrap UCL	40.6
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	52.05
		97.5% Chebyshev(Mean, Sd) UCL	67.47
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	97.75
95% Approximate Gamma UCL (Use when n >= 40)	26.72		
95% Adjusted Gamma UCL (Use when n < 40)	27.73		
Potential UCL to Use		Use 95% Chebyshev (Mean, Sd) UCL	52.05

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Barium - Background

General Statistics

Number of Valid Observations	22	Number of Distinct Observations	21

Raw Statistics		Log-transformed Statistics	
Minimum	69.5	Minimum of Log Data	4.241
Maximum	175	Maximum of Log Data	5.165
Mean	122	Mean of log Data	4.775
Geometric Mean	118.5	SD of log Data	0.254
Median	125		
SD	29.3		
Std. Error of Mean	6.248		
Coefficient of Variation	0.24		
Skewness	-0.0628		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.967	Shapiro Wilk Test Statistic	0.949
Shapiro Wilk Critical Value	0.911	Shapiro Wilk Critical Value	0.911
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	132.8	95% H-UCL	135.2
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	151.3
95% Adjusted-CLT UCL (Chen-1995)	132.2	97.5% Chebyshev (MVUE) UCL	163.8
95% Modified-t UCL (Johnson-1978)	132.8	99% Chebyshev (MVUE) UCL	188.6

Gamma Distribution Test		Data Distribution	
k star (bias corrected)	14.81	Data appear Normal at 5% Significance Level	
Theta Star	8.238		
MLE of Mean	122		
MLE of Standard Deviation	31.7		
nu star	651.7		
Approximate Chi Square Value (.05)	593.4	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0386	95% CLT UCL	132.3
Adjusted Chi Square Value	589.3	95% Jackknife UCL	132.8
		95% Standard Bootstrap UCL	131.9
Anderson-Darling Test Statistic	0.423	95% Bootstrap-t UCL	132.9
Anderson-Darling 5% Critical Value	0.741	95% Hall's Bootstrap UCL	132.7
Kolmogorov-Smirnov Test Statistic	0.143	95% Percentile Bootstrap UCL	132.3
Kolmogorov-Smirnov 5% Critical Value	0.185	95% BCA Bootstrap UCL	131.8
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	149.2
		97.5% Chebyshev(Mean, Sd) UCL	161
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	184.2
95% Approximate Gamma UCL (Use when n >= 40)	134		
95% Adjusted Gamma UCL (Use when n < 40)	134.9		

Potential UCL to Use		Use 95% Student's-t UCL	132.8

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Note: For highly negative-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.

Chromium - Background

General Statistics

Number of Valid Observations	22	Number of Distinct Observations	20

Raw Statistics		Log-transformed Statistics	
Minimum	5.3	Minimum of Log Data	1.668
Maximum	18	Maximum of Log Data	2.89
Mean	12.42	Mean of log Data	2.466
Geometric Mean	11.78	SD of log Data	0.35
Median	12.8		
SD	3.814		
Std. Error of Mean	0.813		
Coefficient of Variation	0.307		
Skewness	-0.336		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.945	Shapiro Wilk Test Statistic	0.912
Shapiro Wilk Critical Value	0.911	Shapiro Wilk Critical Value	0.911
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	13.82	95% H-UCL	14.45
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	16.63
95% Adjusted-CLT UCL (Chen-1995)	13.7	97.5% Chebyshev (MVUE) UCL	18.42
95% Modified-t UCL (Johnson-1978)	13.81	99% Chebyshev (MVUE) UCL	21.94

Gamma Distribution Test		Data Distribution	
k star (bias corrected)	8.284	Data appear Normal at 5% Significance Level	
Theta Star	1.5		
MLE of Mean	12.42		
MLE of Standard Deviation	4.316		
nu star	364.5		
Approximate Chi Square Value (.05)	321.3	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0386	95% CLT UCL	13.76
Adjusted Chi Square Value	318.2	95% Jackknife UCL	13.82
		95% Standard Bootstrap UCL	13.77
Anderson-Darling Test Statistic	0.611	95% Bootstrap-t UCL	13.82
Anderson-Darling 5% Critical Value	0.744	95% Hall's Bootstrap UCL	13.71
Kolmogorov-Smirnov Test Statistic	0.17	95% Percentile Bootstrap UCL	13.66
Kolmogorov-Smirnov 5% Critical Value	0.185	95% BCA Bootstrap UCL	13.61
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	15.97
		97.5% Chebyshev(Mean, Sd) UCL	17.5
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	20.51
95% Approximate Gamma UCL (Use when n >= 40)	14.09		
95% Adjusted Gamma UCL (Use when n < 40)	14.23		

Potential UCL to Use		Use 95% Student's-t UCL	13.82

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Note: For highly negative-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.

Iron - Background

General Statistics

Number of Valid Observations	22	Number of Distinct Observations	22

Raw Statistics		Log-transformed Statistics	
Minimum	16000	Minimum of Log Data	9.68
Maximum	34000	Maximum of Log Data	10.43
Mean	23082	Mean of log Data	10.03
Geometric Mean	22625	SD of log Data	0.202
Median	22100		
SD	4866		
Std. Error of Mean	1038		
Coefficient of Variation	0.211		
Skewness	0.868		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.933	Shapiro Wilk Test Statistic	0.971
Shapiro Wilk Critical Value	0.911	Shapiro Wilk Critical Value	0.911
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	24867	95% H-UCL	24977
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	27439
95% Adjusted-CLT UCL (Chen-1995)	24994	97.5% Chebyshev (MVUE) UCL	29330
95% Modified-t UCL (Johnson-1978)	24899	99% Chebyshev (MVUE) UCL	33043
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	21.75	Data appear Normal at 5% Significance Level	
Theta Star	1061		
MLE of Mean	23082		
MLE of Standard Deviation	4949		
nu star	957.1		
Approximate Chi Square Value (.05)	886.3	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0386	95% CLT UCL	24788
Adjusted Chi Square Value	881.2	95% Jackknife UCL	24867
		95% Standard Bootstrap UCL	24796
Anderson-Darling Test Statistic	0.266	95% Bootstrap-t UCL	25046
Anderson-Darling 5% Critical Value	0.741	95% Hall's Bootstrap UCL	25306
Kolmogorov-Smirnov Test Statistic	0.121	95% Percentile Bootstrap UCL	24936
Kolmogorov-Smirnov 5% Critical Value	0.185	95% BCA Bootstrap UCL	24927
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	27604
		97.5% Chebyshev(Mean, Sd) UCL	29561
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	33405
95% Approximate Gamma UCL (Use when n >= 40)	24926		
95% Adjusted Gamma UCL (Use when n < 40)	25069		
Potential UCL to Use		Use 95% Student's-t UCL	24867

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Lead - Background

General Statistics

Number of Valid Observations	22	Number of Distinct Observations	19

Raw Statistics		Log-transformed Statistics	
Minimum	4	Minimum of Log Data	1.386
Maximum	31.1	Maximum of Log Data	3.437
Mean	11.29	Mean of log Data	2.341
Geometric Mean	10.39	SD of log Data	0.401
Median	9.95		
SD	5.431		
Std. Error of Mean	1.158		
Coefficient of Variation	0.481		
Skewness	2.494		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.752	Shapiro Wilk Test Statistic	0.93
Shapiro Wilk Critical Value	0.911	Shapiro Wilk Critical Value	0.911
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	13.28	95% H-UCL	13.31
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	15.51
95% Adjusted-CLT UCL (Chen-1995)	13.85	97.5% Chebyshev (MVUE) UCL	17.36
95% Modified-t UCL (Johnson-1978)	13.38	99% Chebyshev (MVUE) UCL	21.01

Gamma Distribution Test		Data Distribution	
k star (bias corrected)	5.375	Data Follow Appr. Gamma Distribution at 5% Significance Level	
Theta Star	2.1		
MLE of Mean	11.29		
MLE of Standard Deviation	4.868		
nu star	236.5		
Approximate Chi Square Value (.05)	201.9	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0386	95% CLT UCL	13.19
Adjusted Chi Square Value	199.5	95% Jackknife UCL	13.28
		95% Standard Bootstrap UCL	13.13
Anderson-Darling Test Statistic	0.78	95% Bootstrap-t UCL	14.5
Anderson-Darling 5% Critical Value	0.746	95% Hall's Bootstrap UCL	23.41
Kolmogorov-Smirnov Test Statistic	0.173	95% Percentile Bootstrap UCL	13.28
Kolmogorov-Smirnov 5% Critical Value	0.186	95% BCA Bootstrap UCL	13.97
Data follow Appr. Gamma Distribution at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	16.33
		97.5% Chebyshev(Mean, Sd) UCL	18.52
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	22.81
95% Approximate Gamma UCL (Use when n >= 40)	13.22		
95% Adjusted Gamma UCL (Use when n < 40)	13.38		

Potential UCL to Use		Use 95% Approximate Gamma UCL	13.22

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Manganese - Background

General Statistics

Number of Valid Observations	22	Number of Distinct Observations	22

Raw Statistics		Log-transformed Statistics	
Minimum	305	Minimum of Log Data	5.72
Maximum	781	Maximum of Log Data	6.661
Mean	534.8	Mean of log Data	6.24
Geometric Mean	512.7	SD of log Data	0.3
Median	497		
SD	157.4		
Std. Error of Mean	33.56		
Coefficient of Variation	0.294		
Skewness	0.26		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.924	Shapiro Wilk Test Statistic	0.939
Shapiro Wilk Critical Value	0.911	Shapiro Wilk Critical Value	0.911
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	592.6	95% H-UCL	604.8
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	686.5
95% Adjusted-CLT UCL (Chen-1995)	592	97.5% Chebyshev (MVUE) UCL	752
95% Modified-t UCL (Johnson-1978)	592.9	99% Chebyshev (MVUE) UCL	880.6

Gamma Distribution Test		Data Distribution	
k star (bias corrected)	10.38	Data appear Normal at 5% Significance Level	
Theta Star	51.55		
MLE of Mean	534.8		
MLE of Standard Deviation	166		
nu star	456.5		
Approximate Chi Square Value (.05)	408	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0386	95% CLT UCL	590
Adjusted Chi Square Value	404.6	95% Jackknife UCL	592.6
		95% Standard Bootstrap UCL	589.4
Anderson-Darling Test Statistic	0.494	95% Bootstrap-t UCL	595.5
Anderson-Darling 5% Critical Value	0.743	95% Hall's Bootstrap UCL	590.9
Kolmogorov-Smirnov Test Statistic	0.131	95% Percentile Bootstrap UCL	589.1
Kolmogorov-Smirnov 5% Critical Value	0.185	95% BCA Bootstrap UCL	590.5
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	681.1
		97.5% Chebyshev(Mean, Sd) UCL	744.4
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	868.7
95% Approximate Gamma UCL (Use when n >= 40)	598.4		
95% Adjusted Gamma UCL (Use when n < 40)	603.5		

Potential UCL to Use		Use 95% Student's-t UCL	592.6

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Mercury - Background

General Statistics

Number of Valid Data	22	Number of Detected Data	19
Number of Distinct Detected Data	10	Number of Non-Detect Data	3
		Percent Non-Detects	13.64%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.01	Minimum Detected	-4.605
Maximum Detected	0.07	Maximum Detected	-2.659
Mean of Detected	0.0272	Mean of Detected	-3.764
SD of Detected	0.0169	SD of Detected	0.565
Minimum Non-Detect	0.01	Minimum Non-Detect	-4.605
Maximum Non-Detect	0.01	Maximum Non-Detect	-4.605

UCL Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	0.816	Shapiro Wilk Test Statistic	0.922
5% Shapiro Wilk Critical Value	0.901	5% Shapiro Wilk Critical Value	0.901
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	0.0241	Mean	-3.973
SD	0.0175	SD	0.751
95% DL/2 (t) UCL	0.0306	95% H-Stat (DL/2) UCL	0.0361
Maximum Likelihood Estimate(MLE) Method		Log ROS Method	
Mean	0.0234	Mean in Log Scale	-3.941
SD	0.0183	SD in Log Scale	0.697
95% MLE (t) UCL	0.0301	Mean in Original Scale	0.0243
95% MLE (Tiku) UCL	0.03	SD in Original Scale	0.0173
		95% t UCL	0.0307
		95% Percentile Bootstrap UCL	0.0304
		95% BCA Bootstrap UCL	0.0315
		95% H UCL	0.0346

Gamma Distribution Test with Detected Values Only		Data Distribution Test with Detected Values Only	
k star (bias corrected)	2.833	Data appear Lognormal at 5% Significance Level	
Theta Star	0.00959		
nu star	107.7		
A-D Test Statistic	0.872	Nonparametric Statistics	
5% A-D Critical Value	0.747	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.747	Mean	0.0248
5% K-S Critical Value	0.2	SD	0.0164
Data not Gamma Distributed at 5% Significance Level		SE of Mean	0.00359
		95% KM (t) UCL	0.031
Assuming Gamma Distribution		95% KM (z) UCL	0.0307
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	0.031
Minimum	0.000001	95% KM (bootstrap t) UCL	0.0326
Maximum	0.07	95% KM (BCA) UCL	0.0313
Mean	0.0235	95% KM (Percentile Bootstrap) UCL	0.0311
Median	0.02	95% KM (Chebyshev) UCL	0.0405
SD	0.0183	97.5% KM (Chebyshev) UCL	0.0473
k star	0.432	99% KM (Chebyshev) UCL	0.0606
Theta star	0.0543		
Nu star	19	Potential UCLs to Use	
AppChi2	10.12	95% KM (Chebyshev) UCL	0.0405
95% Gamma Approximate UCL (Use when n >= 40)	0.044		
95% Adjusted Gamma UCL (Use when n < 40)	0.0463		

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

Selenium - Background

General Statistics

Number of Valid Data	22	Number of Detected Data	0
Number of Distinct Detected Data	0	Number of Non-Detect Data	22
		Percent Non-Detects	100.00%

Warning: All observations are Non-Detects (NDs), therefore all statistics and estimates should also be NDs!

Specifically, sample mean, UCLs, UPLs, and other statistics are also NDs lying below the largest detection limit!

The Project Team may decide to use alternative site specific values to estimate environmental parameters (e.g., EPC, BTV).

The data set for variable Seb was not processed!

Silver - Background

General Statistics

Number of Valid Data	22	Number of Detected Data	4
Number of Distinct Detected Data	3	Number of Non-Detect Data	18
		Percent Non-Detects	81.82%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.2	Minimum Detected	-1.609
Maximum Detected	0.6	Maximum Detected	-0.511
Mean of Detected	0.375	Mean of Detected	-1.106
SD of Detected	0.206	SD of Detected	0.586
Minimum Non-Detect	0.2	Minimum Non-Detect	-1.609
Maximum Non-Detect	0.4	Maximum Non-Detect	-0.916

Note: Data have multiple DLs - Use of KM Method is recommended	Number treated as Non-Detect	20
For all methods (except KM, DL/2, and ROS Methods),	Number treated as Detected	2
Observations < Largest ND are treated as NDs	Single DL Non-Detect Percentage	90.91%

Warning: There are only 3 Distinct Detected Values in this data set
The number of detected data may not be adequate enough to perform GOF tests, bootstrap, and ROS methods.
Those methods will return a 'N/A' value on your output display!

It is necessary to have 4 or more Distinct Values for bootstrap methods.
However, results obtained using 4 to 9 distinct values may not be reliable.
It is recommended to have 10 to 15 or more observations for accurate and meaningful results and estimates.

UCL Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	0.829	Shapiro Wilk Test Statistic	0.8
5% Shapiro Wilk Critical Value	0.748	5% Shapiro Wilk Critical Value	0.748
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	0.159	Mean	-2.017
SD	0.132	SD	0.524
95% DL/2 (t) UCL	0.208	95% H-Stat (DL/2) UCL	0.192
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE method failed to converge properly		Mean in Log Scale	-3.027
		SD in Log Scale	1.249
		Mean in Original Scale	0.104
		SD in Original Scale	0.155
		95% t UCL	0.161
		95% Percentile Bootstrap UCL	0.156
		95% BCA Bootstrap UCL	0.183
		95% H-UCL	0.236

Gamma Distribution Test with Detected Values Only		Data Distribution Test with Detected Values Only	
k star (bias corrected)	1.207	Data appear Normal at 5% Significance Level	
Theta Star	0.311		
nu star	9.66		
A-D Test Statistic	0.556	**Nonparametric Statistics**	
5% A-D Critical Value	0.659	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.659	Mean	0.232
5% K-S Critical Value	0.396	SD	0.102
Data appear Gamma Distributed at 5% Significance Level		SE of Mean	0.025
		95% KM (t) UCL	0.275
Assuming Gamma Distribution		95% KM (z) UCL	0.273
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	0.27
Minimum	0.000001	95% KM (bootstrap t) UCL	0.263
Maximum	0.6	95% KM (BCA) UCL	0.509
Mean	0.0682	95% KM (Percentile Bootstrap) UCL	0.514
Median	0.000001	95% KM (Chebyshev) UCL	0.341

SD	0.167	97.5% KM (Chebyshev) UCL	0.388
k star	0.111	99% KM (Chebyshev) UCL	0.481
Theta star	0.617		
Nu star	4.865	**Potential UCLs to Use**	
AppChi2	1.09	95% KM (t) UCL	0.275
95% Gamma Approximate UCL (Use when n >= 40)	0.304	95% KM (Percentile Bootstrap) UCL	0.514
95% Adjusted Gamma UCL (Use when n < 40)	N/A		

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

Vanadium - Background

General Statistics

Number of Valid Observations	22	Number of Distinct Observations	20

Raw Statistics		Log-transformed Statistics	
Minimum	21.8	Minimum of Log Data	3.082
Maximum	57.1	Maximum of Log Data	4.045
Mean	32.57	Mean of log Data	3.45
Geometric Mean	31.49	SD of log Data	0.26
Median	30.35		
SD	9.169		
Std. Error of Mean	1.955		
Coefficient of Variation	0.282		
Skewness	1.167		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.888	Shapiro Wilk Test Statistic	0.938
Shapiro Wilk Critical Value	0.911	Shapiro Wilk Critical Value	0.911
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	35.94	95% H-UCL	36.1
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	40.46
95% Adjusted-CLT UCL (Chen-1995)	36.31	97.5% Chebyshev (MVUE) UCL	43.9
95% Modified-t UCL (Johnson-1978)	36.02	99% Chebyshev (MVUE) UCL	50.66
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	12.92	Data Follow Appr. Gamma Distribution at 5% Significance Level	
Theta Star	2.521		
MLE of Mean	32.57		
MLE of Standard Deviation	9.062		
nu star	568.5		
Approximate Chi Square Value (.05)	514.2	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0386	95% CLT UCL	35.79
Adjusted Chi Square Value	510.4	95% Jackknife UCL	35.94
		95% Standard Bootstrap UCL	35.64
Anderson-Darling Test Statistic	0.663	95% Bootstrap-t UCL	36.29
Anderson-Darling 5% Critical Value	0.742	95% Hall's Bootstrap UCL	36.72
Kolmogorov-Smirnov Test Statistic	0.19	95% Percentile Bootstrap UCL	35.81
Kolmogorov-Smirnov 5% Critical Value	0.185	95% BCA Bootstrap UCL	36.2
Data follow Appr. Gamma Distribution at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	41.09
		97.5% Chebyshev(Mean, Sd) UCL	44.78
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	52.02
95% Approximate Gamma UCL (Use when n >= 40)	36.01		
95% Adjusted Gamma UCL (Use when n < 40)	36.28		
Potential UCL to Use		Use 95% Approximate Gamma UCL	36.01

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Attachment A-4 Toxicity Data for Mammals and Birds

LOAEL Data for Reproduction, Growth, and Survival (mg/kg/d)					
Arsenic		Selenium		Silver	
Bird	Mammal	Bird	Mammal	Bird	Mammal
1.49	0.0065	0.0911	0.089	20.2	60.2
3.55	0.548	0.0912	0.0908	65.5	80.2
17.3	0.663	0.0988	0.0968	70.8	125
1.902	0.665	0.12	0.13	71.4	126
3	0.675	0.127	0.145	72.8	140
	0.844	0.127	0.156	72.8	140
	1.66	0.13	0.157	81.1	174
	3	0.18	0.163	81.1	188
	3	0.275	0.166	88.4	**74.2**
	4.5	0.306	0.168	98.6	**8**
	5	0.355	0.205	401	
	5	0.368	0.209	**65.5**	
	5	0.37	0.215	**11**	
	5	0.371	0.215		
	5	0.408	0.221		
	5.62	0.412	0.232		
	5.62	0.425	0.235		
	5.62	0.426	0.254		
	5.66	0.429	0.265		
	5.69	0.438	0.267		
	6.36	0.456	0.273		
	7.5	0.5	0.273		
	9.42	0.5	0.274		
	9.44	0.5	0.275		
	10.7	0.524	0.276		
	14.4	0.546	0.282		
	14.4	0.546	0.296		
	14.4	0.579	0.303		
	14.4	0.58	0.304		
	19.3	0.614	0.307		
	19.7	0.629	0.323		
	20	0.675	0.33		
	20.6	0.702	0.34		
	32.4	0.721	0.345		
	43.4	0.78	0.352		
	43.4	0.788	0.378		
	48	0.823	0.385		
	48	0.826	0.39		
	0.672	0.855	0.411		
	38	0.859	0.42		
		0.859	0.425		
		0.896	0.434		

LOAEL Data for Reproduction, Growth, and Survival (mg/kg/d)					
Arsenic		Selenium		Silver	
Bird	Mammal	Bird	Mammal	Bird	Mammal
		0.898	0.435		
		1.08	0.435		
		1.13	0.435		
		1.14	0.44		
		1.19	0.441		
		1.2	0.454		
		1.23	0.47		
		1.29	0.489		
		1.38	0.49		
		1.4	0.493		
		1.44	0.498		
		1.55	0.504		
		1.72	0.51		
		1.73	0.521		
		1.78	0.521		
		1.78	0.523		
		2.27	0.54		
		2.44	0.54		
		2.58	0.543		
		2.76	0.548		
		2.9	0.55		
		3.44	0.55		
		3.48	0.564		
		3.64	0.567		
		4.19	0.57		
		4.26	0.577		
		4.49	0.58		
		4.53	0.589		
		4.53	0.632		
		4.75	0.653		
		4.8	0.667		
		4.94	0.704		
		4.94	0.712		
		5.75	0.72		
		6.08	0.733		
		6.14	0.747		
		6.99	0.749		
		7.98	0.754		
		8.32	0.763		
		11.5	0.763		
		11.7	0.763		
		11.9	0.763		
		12.3	0.767		
		29	0.768		

LOAEL Data for Reproduction, Growth, and Survival (mg/kg/d)					
Arsenic		Selenium		Silver	
Bird	Mammal	Bird	Mammal	Bird	Mammal
		0.2905	0.768		
		86	0.769		
			0.769		
			0.776		
			0.776		
			0.794		
			0.794		
			0.794		
			0.794		
			0.809		
			0.809		
			0.817		
			0.817		
			0.823		
			0.823		
			0.869		
			0.869		
			0.869		
			0.869		
			0.869		
			0.88		
			0.892		
			0.903		
			0.904		
			0.968		
			0.975		
			0.98		
			0.984		
			0.984		
			0.988		
			1.02		
			1.11		
			1.11		
			1.19		
			1.21		
			1.21		
			1.23		
			1.28		
			1.31		
			1.51		
			1.51		
			1.54		
			1.59		
			1.59		

LOAEL Data for Reproduction, Growth, and Survival (mg/kg/d)					
Arsenic		Selenium		Silver	
Bird	Mammal	Bird	Mammal	Bird	Mammal
			1.59		
			1.59		
			1.62		
			1.71		
			1.79		
			1.79		
			1.81		
			1.94		
			1.94		
			2.27		
			2.28		
			3.54		
			3.54		
			3.74		
			3.74		
			4.17		
			4.18		
			4.18		
			4.55		
			4.57		
			4.57		
			5.01		
			5.01		
			5.96		
			6		
			6.03		
			6.36		
			6.39		
			6.39		
			6.39		
			20		
			20		
			25.4		
			0.2388		
			163		

Highlighted and bolded cells are the 10th percentile value.
Bolded cells are the number of observtaions.
Sources:
Arsenic - EPA (2005)
Selenium - EPA (2007b)
Silver - EPA (2006)

Attachment A-5 Wildlife Exposure Models and Wildlife SSLs

Wildlife Exposure Model:
SSL = TRV/[(FIR*P*BAF)+(SIR*RGAF)]

Where:

SSL =	soil screening level (mg/kg)
TRV =	wildlife toxicity reference value (mg/kg/d)
FIR =	food ingestion rate (kg/kg/d)
P =	proportion of contaminated food in diet (unitless)
BAF =	bioaccumulation factor (unitless)
SIR =	soil ingestion rate (kg/kg/d)
RGAF =	gut absorption factor (unitless)

Arsenic - WRP exposure area

	Shrew	Robin	Vole	Source
SSL	60	47	110	Calculated
TRV	0.672	1.902	0.672	See Table A-4
FIR	0.209	0.214	0.0875	EPA (2007)
P	0.5	0.52	1	MTCA Table 749-4
SIR	0.00627	0.0351	0.0028	EPA (2007)
RGAF	1	1	1	MTCA Table 749-5
BAF_{worm}	0.047	0.047		EPA (2007)
BAF_{plant}			0.038	EPA (2007)

BAF_{worm} = Ce/Cs =	0.047	
Ce = Exp[ln(Ce)] =	12.311	
ln(Ce) = 0.706 * ln(Cs) - 1.421 =	2.511	
Cs =	262.1	(EPC WRPs exposure area)

Arsenic - DWRP exposure area

	Shrew	Robin	Vole	Source
SSL	56	46	110	Calculated
TRV	0.672	1.902	0.672	See Table A-4
FIR	0.209	0.214	0.0875	EPA (2007)
P	0.5	0.52	1	MTCA Table 749-4
SIR	0.00627	0.0351	0.0028	EPA (2007)
RGAF	1	1	1	MTCA Table 749-5
BAF_{worm}	0.056	0.056		EPA (2007)
BAF_{plant}			0.038	EPA (2007)

BAF_{worm} = Ce/Cs =	0.056	
Ce = Exp[ln(Ce)] =	8.161	
ln(Ce) = 0.706 * ln(Cs) - 1.421 =	2.099	
Cs =	146.4	(EPC DWRPs exposure area)

Arsenic - Site exposure area

	Shrew	Robin	Vole	Source
SSL	48	44	110	Calculated
TRV	0.672	1.902	0.672	See Table A-4
FIR	0.209	0.214	0.0875	EPA (2007)
P	0.5	0.52	1	MTCA Table 749-4
SIR	0.00627	0.0351	0.0028	EPA (2007)
RGAF	1	1	1	MTCA Table 749-5
BAF_{worm}	0.075	0.075		EPA (2007)
BAF_{plant}			0.038	EPA (2007)

BAF_{worm} = Ce/Cs =	0.075	
Ce = Exp[ln(Ce)] =	4.062	
ln(Ce) = 0.706 * ln(Cs) - 1.421 =	1.402	
Cs =	54.49	(EPC Site exposure area)

Selenium - WRP exposure area

	Shrew	Robin	Vole	Source
SSL	3	2	5	Calculated
TRV	0.239	0.291	0.239	See Table A-4
FIR	0.209	0.214	0.088	EPA (2007)
P	0.5	0.52	1	MTCA Table 749-4
SIR	0.0063	0.0351	0.0028	EPA (2007)
RGAF	1	1	1	MTCA Table 749-5
BAF_{worm}	0.821	0.821		EPA (2007)
BAF_{plant}			0.533	EPA (2007)

BAF_{worm} = Ce/Cs =	0.821	
Ce = Exp[ln(Ce)] =	1.299	
ln(Ce) = 0.733 * ln(Cs) - 0.075 =	0.261	
Cs =	1.582	(EPC WRP exposure area)

BAF_{plant} = Cp/Cs =	0.533	
Cp = Exp[ln(Cp)] =	0.843	
ln(Cp) = 1.104 * ln(Cs) - 0.677 =	-0.171	
Cs =	1.582	(EPC WRP exposure area)

Selenium - DWRP exposure area

	Shrew	Robin	Vole	Source
SSL	2	2	5	Calculated
TRV	0.239	0.291	0.239	See Table A-4
FIR	0.209	0.214	0.088	EPA (2007)
P	0.5	0.52	1	MTCA Table 749-4
SIR	0.0063	0.0351	0.0028	EPA (2007)
RGAF	1	1	1	MTCA Table 749-5
BAF_{worm}	0.975	0.975		EPA (2007)
BAF_{plant}			0.498	EPA (2007)

BAF_{worm} = Ce/Cs =	0.975	
Ce = Exp[ln(Ce)] =	0.809	
ln(Ce) = 0.733 * ln(Cs) - 0.075 =	-0.212	
Cs =	0.83	(EPC DWRP exposure area)

BAF_{plant} = Cp/Cs =	0.498	
Cp = Exp[ln(Cp)] =	0.414	
ln(Cp) = 1.104 * ln(Cs) - 0.677 =	-0.883	
Cs =	0.83	(EPC DWRP exposure area)

Selenium - Site exposure area

	Shrew	Robin	Vole	Source
SSL	2	2	5	Calculated
TRV	0.239	0.291	0.239	See Table A-4
FIR	0.209	0.214	0.088	EPA (2007)
P	0.5	0.52	1	MTCA Table 749-4
SIR	0.0063	0.0351	0.0028	EPA (2007)
RGAF	1	1	1	MTCA Table 749-5
BAF_{worm}	0.954	0.954		EPA (2007)
BAF_{plant}			0.503	EPA (2007)

BAF_{worm} = Ce/Cs =	0.954	
Ce = Exp[ln(Ce)] =	0.859	
ln(Ce) = 0.733 * ln(Cs) - 0.075 =	-0.152	
Cs =	0.9	(EPC SITE exposure area)

BAF_{plant} = Cp/Cs =	0.503	
Cp = Exp[ln(Cp)] =	0.452	
ln(Cp) = 1.104 * ln(Cs) - 0.677 =	-0.793	
Cs =	0.9	(EPC SITE exposure area)

Silver - All exposure areas

	Shrew	Robin	Vole	Source
SSL	337	249	18,435	Calculated
TRV	74.2	65.5	74.2	See Table A-4
FIR	0.209	0.214	0.0875	EPA (2007)
P	0.5	0.52	1	MTCA Table 749-4
SIR	0.00627	0.0351	0.0028	EPA (2007)
RGAF	1	1	1	MTCA Table 749-5
BAF_{worm}	2.045	2.045		EPA (2007)
BAF_{plant}			0.014	EPA (2007)

Mercury - All exposure areas

	Shrew	Robin	Vole	Source
SSL	19.8	4.9	212.2	Calculated
TRV	2.86	0.9	2.18	MTCA Table 749-5
FIR	0.209	0.214	0.0875	EPA (2007)
P	0.5	0.52	1	MTCA Table 749-4
SIR	0.00627	0.0351	0.0028	EPA (2007)
RGAF	1	1	1	MTCA Table 749-5
BAF_{worm}	1.32	1.32		MTCA Table 749-5
BAF_{plant}			0.0854	MTCA Table 749-5