

**FINAL REMEDIAL OBJECTIVES REPORT
KLONDYKE TAILINGS
WQARF REGISTRY SITE
KLONDYKE, ARIZONA**



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LIST OF ABBREVIATIONS & ACRONYMS

AAC	Arizona Administrative Code
ADEQ	Arizona Department of Environmental Quality
ADWR	Arizona Department of Water Resources
ARS	Arizona Revised Statutes
ASWQS	Arizona Surface Water Quality Standard
AWQS	Aquifer Water Quality Standard
BLM	Bureau of Land Management
COC	Chemicals of Concern
ERA	Early Response Action
FS	Feasibility Study
GPM	Gallons per Minute
mg/kg	milligrams per Kilogram
mg/L	Milligrams per Liter
RO	Remedial Objective
RI	Remedial Investigation
SVOC	Semi Volatile Organic Compounds
SRL	Soil Remediation Level
R-SRL	Residential Soil Remediation Level
VOC	Volatile Organic Compound
WQARF	Water Quality Assurance Revolving Fund

1.0 INTRODUCTION

The Arizona Department of Environmental Quality (ADEQ) has prepared this Final Remedial Objectives (ROs) report for the Klondyke Tailings Water Quality Assurance Revolving Fund (WQARF) Registry Site (the site) to meet requirements established under Arizona Administrative Code (A.A.C.) R18-16-406. This RO report relies upon the land and water use study questionnaires collected in 2008 and the solicitation of proposed Remedial Objectives during the comment period on the Draft Remedial Investigation report (RI) in 2014. The land and water use questionnaires are included in Appendix F of the Klondyke Tailings RI Report prepared by URS Corporation for ADEQ.

ROs are established for the current and reasonably foreseeable uses of land and waters of the state that have been or are threatened to be affected by a release of a hazardous substance. Pursuant to A.A.C. R18-16-406(D), it is specified that reasonably foreseeable uses of land are those likely to occur at the site and the reasonably foreseeable uses of water are those likely to occur within one hundred years unless site-specific information suggests a longer time period is more appropriate.

Reasonably foreseeable uses are those likely to occur, based on information provided by water providers, well owners, land owners, government agencies, and others. Not every use identified in the RI Report will have a corresponding RO. Uses identified in the RI Report may or may not be addressed based on information gathered during the public involvement process, limitations of WQARF, and whether the use is reasonably foreseeable.

The ROs must be stated in the following terms: (1) protecting against the loss or impairment of each use; (2) restoring, replacing, or otherwise providing for each use; (3) when action is needed to protect or provide for the use; and (4) how long action is needed to protect or provide for the use.

The ROs chosen for the site will be evaluated in the feasibility study (FS) phase of the WQARF process. The FS will evaluate specific remedial measures and strategies required to meet ROs. A remedial strategy is one or a combination of six general strategies identified in Arizona Revised Statutes (A.R.S.) §49-282-06(B)(4). These strategies include: plume remediation, physical containment, controlled migration, source control, monitoring, and no action. A.R.S. §49-282-06(B)(4)(a) indicates that for remediation of soil, the selected remedial action shall be consistent with the soil remediation standards adopted pursuant to A.R.S. §49-152. A remedial measure is a specific action taken in conjunction with remedial strategies to achieve one or more ROs (for example, well replacement, well modification, water treatment, water supply replacement, and engineering controls.)

The FS will propose at least three remedies (a reference remedy and generally two alternative remedies) capable of meeting ROs. A reference remedy is a combination of remedial strategies and measures capable of achieving ROs, and is compared with alternative remedies for purposes of selecting a proposed remedy. An alternative remedy is a combination of remedial strategies and measures different from the reference remedy; alternative remedies are compared with the reference remedy for purposes of selecting a proposed remedy. Proposed remedies will also be generally compatible with future land use specified by land owners.

Written comments on this proposed RO report will be accepted for a period of 30 days following the release. The comment period may be extended if significant public interest exists or if significant issues or information is brought to the attention of ADEQ. The final report will include a responsiveness summary to written comments received from the public during the comment period. The final RO Report will be an appendix to the final RI Report.

2.0 REMEDIAL OBJECTIVES FOR LAND USE

The Klondyke Tailings WQARF site is located on the north bank of Aravaipa Creek, approximately two miles north of the town of Klondyke, Arizona and approximately five miles upstream of the perennial flow of Aravaipa Creek. The site is located in Section 6, Township 7 South, Range 20 East. The boundaries of this Site are irregular and the site boundaries are defined by the extent of the soil contamination above the residential soil remediation level (R-SRL) for lead of 400 milligrams per kilogram (mg/kg). The site is comprised of two piles of mine tailings, the soil is between and adjacent to these piles and several surrounding properties.

Contaminants of concern (COCs) for the site are antimony, arsenic, cadmium, copper, lead, manganese, mercury, and zinc. Lead is the most prevalent contaminant in the samples analyzed.

2.1 Summary of Impacts to Current and Reasonably Foreseeable Land Use

The site is located in a rural residential area. Based on land and water use study questionnaires provided by property owners at the site, land use in the area is characterized as mixed use residential and agricultural. Agricultural uses are predominately cattle ranching and hay farming. According to the questionnaires, there are no immediate plans to change the land use or zoning for properties in the site. Some residents indicate the desire to build several residences on their properties.

Early Response Actions (ERAs) performed to date at the site included consolidation and capping of the most upstream tailings pile and the removal, and replacement with clean fill, of one foot of contaminated soils in the immediate area of the primary residential living area on three properties. These ERAs reduced the exposure to COCs detected in the surface soils at the site.

The immediate area is defined as an area approximately 200 feet by 200 feet around the primary residential living area. The primary residential living area also includes garages and other structures in the area around the primary residence. In addition, soil was removed and replaced with clean fill material to a depth of two feet in areas on the properties used for sustenance gardening.

The removal actions described above are based on the assumption that removal of surficial contaminated soils and placement of a cover of clean soil will be protective of human health and the environment. Furthermore, the removal actions are based on the assumption that a minimum of 12 inch soil cover is adequate. (*U.S. EPA, 2003. Superfund Lead-Contaminated Residential Sites Handbook. OSWER 9285.7-5*).

Typically, ROs for land use are established for those properties known to be contaminated with hazardous substances above a SRL or a risk-based level. Outside of the source area property, parcel 110-47-003G, containing the tailings piles, approximately 65 acres covering 11 parcels are impacted by lead concentrations in surficial soils exceeding the R-SRL. The 11 additional parcels impacted include 110-47-001B, 110-47-001G, 110-47-001H, 110-47-001I, 110-47-001K, 110-47-001M, 110-47-003B, 110-47-003D, 110-47-003F, 110-47-003H and 110-47-006. Figure 1.

Parcels with full time residences receive the priority for consideration of removal actions in the immediate area of the primary residential living area. These are parcels 110-47-003B, 110-47-003D, 110-47-001M and 110-47-06. Residences occupied on a part-time basis receive second priority. These parcels include 110-47-001G and 110-47-003D. Currently unoccupied parcels, outside the source area property, receive the lowest priority for removal actions.

2.2 Soil Remedial Objective

Because the properties in the site are currently, and will for the foreseeable future, be zoned for residential use, residential SRLs apply. Therefore, the ROs for land use at the site are:

To restore soil conditions to the remediation standards for residential use specified in A.A.C. R18-7-203 (specifically background remediation standards prescribed in R18-7-204, predetermined remediation standards prescribed in R18-7-205, or site specific remediation standards prescribed in R18-7-206) that are applicable to the hazardous substances identified. This action is needed for the present time and for as long as the level of contamination in the soil on the property threatens the use as a residential property.

3.0 REMEDIAL OBJECTIVES FOR GROUNDWATER USE

The groundwater use portion of the RI is an inclusive summary of information gathered from the reports describing groundwater use in the area, the Arizona Department of Water Resources (ADWR), and land owners. According to the responses to the ADEQ questionnaire, the current property owners at Klondyke use their wells water for water supply, domestic purposes, irrigation, and livestock watering. Projected water use according to the questionnaires will be water supply for new or additional residences. The reasonably foreseeable uses of groundwater at the site are not expected to change.

3.1 Summary of Impacts To Current and Reasonably Foreseeable Groundwater Use

Water wells located in the vicinity of the site are typically completed in the shallow alluvium of the Aravaipa Valley groundwater basin. Well depths vary from 10 to 100 feet and may yield up to 1,200 gallons per minute (gpm). However, some wells in the vicinity of the site produce less than 10 gpm. The subsurface alluvial sediments in Aravaipa Valley vary with depth and lateral distance from the valley slopes. Wells near the center of the valley and in the Aravaipa Creek floodplain generally are completed in coarse grained sand and gravel and produce larger amounts of water. Wells installed at upslope locations are completed in finer grained or thinner alluvial units and include more clay layers, which results in lower well productivity.

In July 2001, ADEQ conducted a regional groundwater sampling event of domestic wells upgradient and downgradient of the site. Wells in the vicinity of the site that were sampled include domestic wells on parcels 110-47-001I, 110-47-006, and 110-47-003D. Domestic wells upgradient of the site include Garwood, and Sollers. Wells downgradient of the site include three wells on Cobra Ranch (CR-01 through CR-03), Sollers, Stampfer, Luepke, Franzone, and three Nature Conservancy wells. Samples were analyzed by EPA method 200 series for metals. No analytes were detected above Arizona Aquifer water Quality Standards (AWQS) and generally indicated water of excellent quality. Figure 2.

Since 2006, four domestic water wells located at the site have been sampled to assess water quality and to assist in characterizing the groundwater quality in the area. Groundwater samples for metals were unfiltered. Groundwater samples are analyzed for 15 total metals by EPA Method 200 series. Lead was detected at a concentration of 0.145 milligram per liter (mg/L) in the sample collected from the 110-47-001M well on August 29, 2007 and exceeded the AWQS for lead of 0.05 mg/L resulting with a re-sampling event on October 17, 2007. The analytical results for the October 17, 2007 did not detect lead above the laboratory detection limit of 0.005 mg/L. Therefore, the detection of lead above the AWQS could not be confirmed. No other metals have been detected above an AWQS.

Four monitor wells on the source area property have been sampled 11 times since their installation in December 2005. Groundwater samples are analyzed for 15 total metals by EPA Method 200 series. No metals have been detected above an AWQS.

In 2006 and 2007, samples from these wells were analyzed for cyanide by EPA method 4500-CN. Cyanide was not detected above the laboratory reporting limit. In 2007 samples from all four wells were analyzed for volatile organic compounds (VOCs) by EPA Method 8260B and semi-volatile organic compounds (SVOCs) by EPA Method 8270C. No VOCs or SVOCs were detected above laboratory reporting limits.

3.2 Groundwater Remedial Objective

Current groundwater use in the site is for domestic use, irrigation, and livestock watering. Only one sample has exceeded a water quality standard since sampling began in 2001. Based on this information, a remedial objective for the groundwater is not needed. ADEQ will continue to monitor water quality in the area of the site.

4.0

REMEDIAL OBJECTIVES FOR SURFACE WATER USE

Aravaipa Creek and Laurel Creek are ephemeral and typically dry at the site. Surface water generally only flows during winter storms, in early spring, and in July and August as a result of summer thunderstorms. According to the responses to the ADEQ land and water use questionnaire, the current property owners at Klondyke do not use surface water. Surface water uses in the area of the site are not expected to change in the future.

Located approximately five miles downstream from the site, Aravaipa Creek's 17 mile long perennial flow stretch is considered by the Arizona Game and Fish Department to have the best remaining assemblage of desert fishes in Arizona. The stretch is home to seven native species including three federally-listed endangered species; the Spikedace, Loach Minnow, and the Gila Topminnow. Aravaipa Creek, from its confluence with Stowe Gulch to the downstream boundary of the Aravaipa Canyon Wilderness Area, is designated an outstanding Arizona water under Arizona Administrative Code, R18-11-112. The site lies approximately four miles upstream of the Nature Conservancy's Aravaipa Canyon Preserve and approximately six miles upstream of the upper boundary of the Bureau of Land Management's (BLM) Aravaipa Canyon Wilderness Area.

4.1 Summary of Impacts to Current and Reasonably Foreseeable Surface Water Use

Arizona Administrative Code, R18-11-123, Appendix B, list the designated uses for this section of Aravaipa Creek as; full body contact, fish consumption, agricultural livestock watering, and aquatic and wildlife, warm water.

In 1977, the Department of Botany and Microbiology at Arizona State University conducted a microchemical analysis of Aravaipa Creek and adjacent aquatic habitats relative to land and water use management. Fifteen water quality sampling stations were established along the Aravaipa Creek and its tributaries from downstream of the site to the confluence of the San Pedro River. Sampling was conducted in August 1976, October 1976, November 1976 and January 1977. The samples were analyzed by EPA 200 series for dissolved and total metals.

Except for one mercury sample, the study concluded that metals were within water quality standards in effect at the time. However, the total metals concentrations of lead exceeded current water use standards which are applicable to Aravaipa Creek. The maximum concentration of lead was found to be 0.146 mg/L, which is higher than the current Arizona Surface Water Quality Standard (ASWQS) for full body contact of 0.015 mg/L and the agricultural livestock watering standard of 0.100 mg/L.

Reported concentrations of copper, lead, selenium, and zinc in the perennial reach of Aravaipa Creek and lead in the vicinity of Klondyke tailings were greater than the hardness-adjusted National Ambient Water Quality Criteria (NAWQC). In the long term, this may increase risk to fish, invertebrates, or insectivorous and piscivorous birds or mammals.

Furthermore, metals concentrations in surface water can rise dramatically during storm events when bottom sediments are re-suspended and surface runoff leaches water-soluble metals and salts into the creek. Since many fish and amphibian species hatch during the spring when rain events are common, they may be exposed to higher than normal concentrations of dissolved metals and lower than normal pH. Although fish and amphibian eggs are relatively tolerant to metal and low pH exposure, egg-sac fry, alevins, and tadpoles are much more sensitive than adults. Therefore, water quality conditions that are non-threatening to adults could cause adverse effects on juvenile life history stages.

The BLM and ADEQ monitored water quality by collecting water samples from six locations in the perennial reach of Aravaipa Creek between 1986 and 1992. Samples were analyzed for general chemistry and metals. The results indicated that, except for iron, the detected concentrations of metals did not exceed recommended water quality standards.

Whole body fish were taken from Aravaipa Creek on October 28, 1997, by Kirke King and Mike Martinez of the U.S. Fish and Wildlife Service. Samples were analyzed for arsenic, cadmium, lead, and mercury. Concentration of an element were considered elevated when they exceeded the 85 percentile of the 1990 National Contaminant Biomonitoring Program. Analytical results for arsenic, cadmium, and lead indicated that fish from Aravaipa Creek were above this 85 percentile. Mercury was not detected. King and Martinez concluded the effect of this contamination is difficult to quantify. Seven species of native fish thrived in the creek, which suggested that these 1997 levels of contaminants were below adverse effect thresholds. King and Martinez recommended that proactive efforts should be made to prevent further contamination of the creek.

Three surface water samples were collected by ADEQ in August 2006 following a large storm event. One surface water samples collected approximately four miles upstream from the site did not contain metals at concentrations exceeding the corresponding ASWQS for full body contact and fish consumption. Arsenic, copper, iron, lead, manganese, nickel, and zinc were detected above the corresponding laboratory reporting limits.

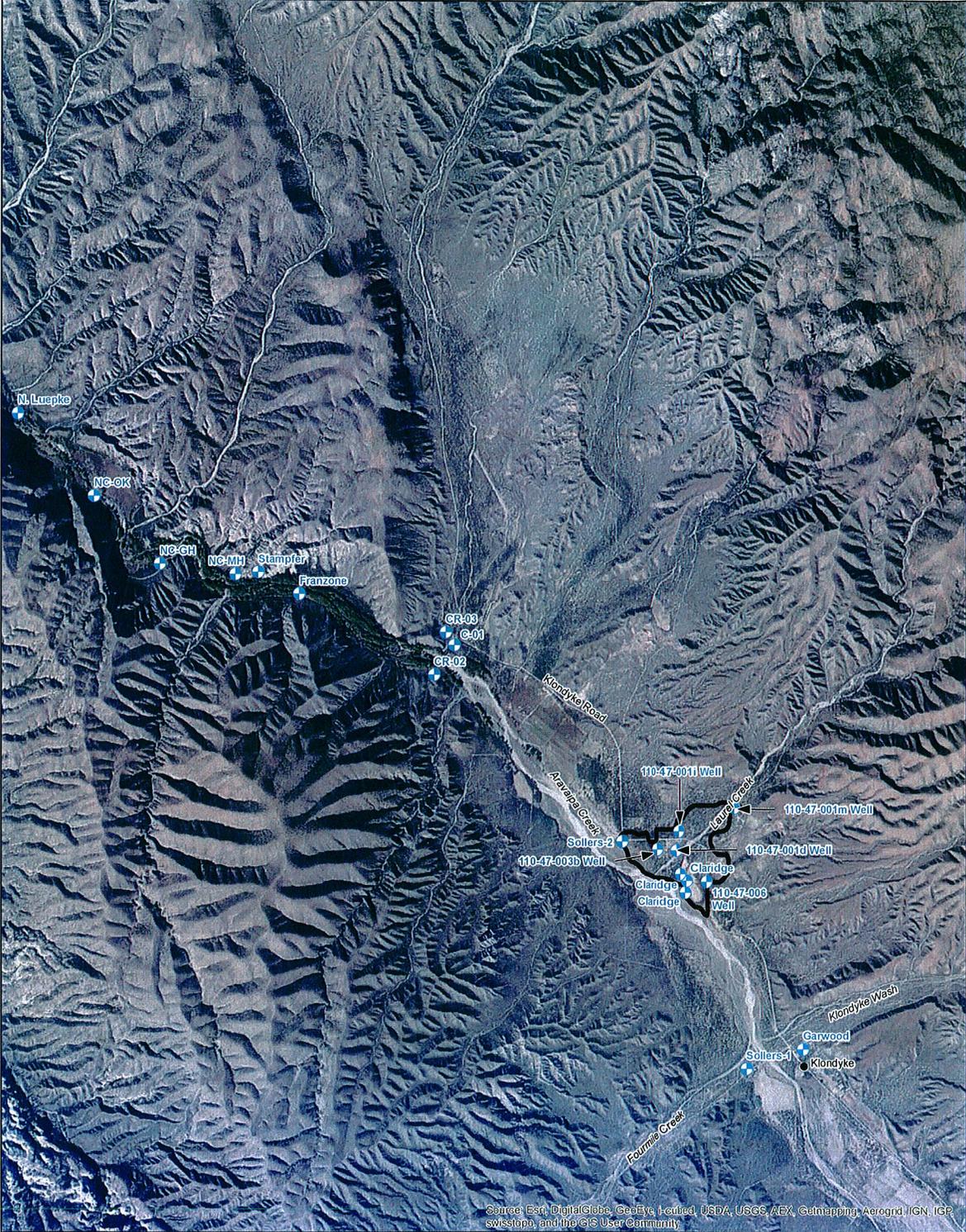
The surface water sample collected just downstream of the site and upstream of the Aravaipa Creek-Laurel Creek confluence and the surface water sample collected approximately two miles downstream from the site contained arsenic, beryllium, cadmium, chromium, copper, iron, lead, manganese, nickel, and zinc above the corresponding laboratory reporting limits. Lead was detected

above the ASWQS for full body contact of 0.015 mg/L in both samples at a concentration of 0.020 mg/L.

4.2 Surface Water Remedial Objective

Current surface water use in the area of the site are; full body contact, fish consumption, agricultural livestock watering, and aquatic and wildlife, warm water.

The remedial objective for surface water use at the site is to protect surface water for the designated uses from contamination at the site. This action is needed for the present time and for as long as the level of contamination in the tailings and soils at the source property threatens the use of surface water for its intended uses.



Source: Esri, DigitalGlobe, GeoEye, Earthstar (USA), USGS, AeroGRID, IGN, IGP, swisstopo, and the GIS User Community

Legend

- | | |
|------------------------------|---------------------------|
| Ground Water Features | Reference Features |
| Domestic Well | Klondike WQARF Site |
| | City/Town |

Figure 2
Offsite Domestic Wells

Klondike Tailings WQARF Site

Source: Topographical control provided by ATEAM Professional Assoc., Inc. Horizontal datum is NAD83 Arizona State Plane, Central Zone, Vertical datum is based on NAVD29.