United States Department of the Interior

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TAKE PRIDE IN AMERICA

In Reply Refer To:
3809 (NV063)
NVN-067881

Dear Reader:

The Bureau of Land Management (BLM) Mount Lewis Field Office (MLFO) has received a Plan of Operations amendment from Tonkin Springs LLC (TSL) for the Tonkin Springs Mine. The proposed project is located in the northern Simpson Park Mountains in Eureka County, Nevada, approximately 40 miles northwest of the town of Eureka.

The Mine Project Area encompasses approximately 25,600 acres of lands administered by the BLM MLFO. The Mine Plan Area, for which the proposed amendment to the Plan (NVN-067881) pertains, is a subset of the Project Area, and covers approximately 3,000 acres. TSL's Plan amendment proposes to reroute the discharge flows from TSP-1 via the construction of a diversion pipeline off of the existing TSP-1 Pit water pipeline to the event pond for in-pond enhanced evaporation. Disturbance associated with this amendment is approximately 0.2 acres.

The BLM has prepared an Environmental Assessment (EA) for this proposed action. This EA will be available for public comment and review for 15 days. Written comments on the EA will be accepted at the above listed address, until 4:30 p.m. (COB), December 17, 2008.

If you have any questions or comments regarding this proposal, please contact Casey Strickland at the above address or at (775) 635-4017.

Sincerely,

Douglas W. Furtado
Field Manager
Mount Lewis Field Office

BLM

U.S. Department of the Interior
Bureau of Land Management

Environmental Assessment NV062-EA08-150

November 2008

Tonkin Springs Mine
Amendment to Plan of Operations
NVN-067881

Location:	**Eureka County, Nevada**
Applicant/Address:	**Tonkin Springs LLC** **1595 Meadow Wood Ln., Suite 3** **Reno, NV 89502** **165 S Union Blvd, Ste. 565** **Lakewood, CO 80228-2224**

United States Department of the Interior

Bureau of Land Management

Battle Mountain District

Mount Lewis Field Office

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MISSION STATEMENT

The Bureau of Land Management is responsible for the stewardship of our public lands. It is committed to manage, protect, and improve these lands in a manner to serve the needs of the American people for all times. Management is based upon the principles of multiple use and sustained yield of our nation's resources within a framework of environmental responsibility and scientific technology. These resources include recreation, rangelands, timber, minerals, watershed, fish and wildlife, air and scenic, scientific and cultural values.

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1.0 INTRODUCTION

This Environmental Assessment (EA) analyzes and discloses the potential environmental impacts associated with the proposed *Tonkin Springs Mine Amendment to Plan of Operations #NVN-067881*, dated May 12, 2008, for modifications to the site water management system, in accordance with the Decision issued by the United States Department of the Interior, Bureau of Land Management, Mount Lewis Field Office (BLM) on February 14, 2008. The Project proponent is Tonkin Springs LLC (TSL), a wholly owned subsidiary of U.S. Gold Corporation (US·Gold). The Decision addressed the requirement to amend the existing Plan of Operations to address the "short-term management, immediate reclamation, and water management issues" associated with the TSP-1 Pit water. The Decision stated that "Specific operations" be addressed including:

- The pH adjustment system;
- The tailings seepage collection system;
- Re-routing of the fluids from the tailings impoundment to the Event Pond;
- Monitoring the crack in the southeast corner of the heap leach pad;
- Installation of an above-ground pipeline from the upper vault to the lower vault;
- Installation of stainless steel tanks to be used for backup for the pH adjustment system; and,
- All other immediate water issues within the project area that could cause undue and unnecessary degradation.

TSL is proposing to construct a diversion pipeline from the existing TSP-1 Pit water conveyance pipeline over to the Event Pond. This system would replace the existing system that allows the pH-adjusted water to gravity flow to the tailings impoundment. The existing heap leach draindown conveyance pipelines, which connect to the existing TSP-1 Pit water conveyance pipeline and discharges heap draindown into the tailings impoundment, would be closed at the existing valves between the reclaimed heap leach pad and the Event Pond in order to redirect all future heap drainage into the Event Pond for management. The Event Pond inflows would be actively evaporated.

The Proposed Action under consideration in this EA is an interim fluid management plan for a period of two to three years and would be replaced by final permanent closure plans in the 4th Quarter of 2009. As such, potential impacts associated with the Proposed Action were considered in the context of the short duration of operation.

The Tonkin Springs Mine is located in the northern Simpson Park Mountains in Eureka County, Nevada, approximately 40 miles northeast of the town of Eureka (**Figure 1**). The Mine Project Area encompasses approximately 25,600 acres of lands administered by the BLM (**Figure 2)**. The Mine Plan Area, for which the proposed amendment to Plan of Operations (PoO) #NVN-067881 pertains, is a subset of the Project Area, and covers approximately 3,000 acres (**Figure 3**). The facility layout including TSP-1, tailings storage facility (TSF), heap leach pad, Event Pond and associated pipelines are depicted in **Figure 4**.

1.1 Purpose and Need for Action and Decision to Be Made

The proponent's need for the proposed modification to the site water management system is to fully dewater and close the existing TSF. By diverting the pH-adjusted TSP-1 Pit water and heap leach pad draindown to the Event Pond, TSL would be able to dewater the existing TSF to where final permanent closure of the facility can be performed.

In order to construct and operate the proposed pipeline diversion on public lands, TSL submitted the PoO amendment in May 2008 to the BLM in accordance with BLM Surface Management Regulations, 43 Code of Federal Regulations (CFR) 3809 (as amended). The BLM is required to comply with the National Environmental Policy Act (NEPA) to analyze the impacts the Proposed Action and alternatives would have on the human environment.

An Environmental Assessment (EA) is a NEPA document that provides sufficient information on the potential impacts to the quality of the human environment to determine whether to prepare an Environmental Impact Statement (EIS) or a *Finding of No Significant Impact*. The EA allows for specialist review of affected resources even if impacts are not significant, and also provides a mechanism for developing and identifying appropriate mitigation measures (BLM, 1993).

1.2 Scoping and Issues

The internal BLM specialist scoping meeting was held on July 15, 2008. The only substantive issue identified during that meeting was the potential spread of noxious weeds, invasive and non-native Species. As the new pipeline and monitoring point would be constructed in an area of existing disturbed within the Mine Plan Area, no further issues are anticipated.

1.3 Conformance Statement

This EA is prepared in conformance with the NEPA, associated Council of Environmental Quality (CEQ) regulations (40 CFR 1500-1508), and BLM NEPA Handbook H-1790-1 (BLM, 2008). The BLM Handbook provides instructions for compliance with the CEQ regulations for implementing the procedural provisions of NEPA and the Department of the Interior's (DOI's) manual on NEPA (516 DM 1-7).

The Proposed Action and the No Action Alternative described in this EA are in conformance with the BLM's Shoshone-Eureka Resource Management Plan (RMP) Record of Decision (ROD) (BLM 1986) and are consistent with federal, state, and local laws.

2.0 Proposed Action and Alternatives

2.1 Proposed Action

The amendment to PoO #NVN-067881 (Proposed Action) is an interim fluid management plan for an anticipated period of two to three years, while TSL prepares final permanent closure plans for the facilities. These plans are expected to be submitted in the 4^{th} Quarter of 2009. In the interim, the Proposed Action includes the following activities:

1. The continued use of the existing sodium hydroxide (caustic) pH adjustment system to neutralize TSP-1 pit water. This system consists of a buried pipe-in-pipe that gravity flows from the TSP-1 Pit sump outlet to an automated pH adjustment system in a buried vault, which subsequently gravity flows to the discharge location via a buried pipe-in-pipe. The Proposed Action would redirect the discharge flows via the **construction of a diversion pipeline** off of the existing TSP-1 Pit water conveyance pipeline to the Event Pond for in-pond enhanced evaporation. TSP-1 Pit water is currently pH-adjusted and routed via gravity flow directly to the TSF;
2. The continued maintenance and possible use of the original lime pH neutralization system utilized by previous and current operators since 1998, including the submerged pump and sump evacuation pipeline to the stainless steel tanks near the mill, lime slaking and mixing in a smaller processing tank, and discharge of the pH-adjusted water to the TSF. This activity is included as an emergency backup procedure should the operation of the current pH adjustment system fail and remain inoperable for an extended period. TSP-1 Pit water would be stored in the pit sump during shorter inoperable periods; and
3. The continued monitoring of the surface crack in the southeast corner of the heap leach pad through weekly inspections and the current survey lath method.

TSL proposes to continue to monitor the heap leach pad through weekly visual inspections and use of the survey lath method currently employed. As part of this Proposed Action, TSL would continue to backfill or regrade portions of the heap leach pad, as necessary to manage stormwater runoff.

2.1.1 Design Approach and Details

The proposed location of the diversion pipeline is illustrated on **Figure 4**. The proposed pipeline diversion would be constructed in the same manner as the existing TSP-1 Pit water conveyance pipeline, using 4-inch diameter HDPE pipeline inside 8-inch diameter pressure-rated corrugated polyethylene. Installation of the existing pipeline included excavation of a 24-inch trench; though the overall surface disturbance width was approximately 20 feet to include vehicle traffic areas and trench soil stockpiling. The pipeline would generally be buried a minimum of 3 feet below existing ground surface. The pipeline and connections would be constructed and tested in accordance with manufacturer's specifications.

The diversion would be connected to the existing TSP-1 Pit water conveyance pipeline south of the heap leach pad in the form of a 4-inch by 8-inch dual containment "wye" fitting. A butterfly valve would be installed immediately downstream of the wye in each of the two pipeline segments to facilitate flow control to either the TSF or the Event Pond. The valves would be installed inside a tee in the outer 8-inch leak detection pipeline. The tee and a valve control extension would be extended to the ground surface at the valve location and capped above grade.

2.1.2 Spill Contingency Plan

The current contingency for the existing pH system would remain the same; if the caustic pH system was not operable. The TSP-1 Pit water would be pumped to the stainless steel tanks near the mill for pH adjustment with lime prior to being pumped to the TSF. There is an additional contingency; if either the Event Pond or new constructed pipeline to the Event pond is unusable, the TSP-1 Pit water and heap leach pad draindown would be routed via the existing pipelines to the TSF, as is the current operating procedure.

2.1.3 Estimated Construction and Operation Schedule

Construction would begin within six to eight weeks of plan approval, depending on contractor availability and/or seasonal accessibility, and is anticipated to require three to four weeks to complete. It is currently anticipated that the proposed diversion pipeline would be used through the closure and post-closure period to manage TSP-1 Pit water and heap draindown flows in the short term (two to three years) to facilitate TSF closure and as part of the conceptual evaporation pond operation during the post-closure period. Active evaporation within the Event Pond can only occur during months where the average daily temperature is above freezing, estimated to be March or April through October or November of each year.

2.1.4 Monitoring Plan Modifications

Site-wide monitoring is currently performed in accordance with Water Pollution Control Permit (WPCP) NEV0085021. Existing fluid management system monitoring related to TSP-1 Pit and heap leach pad water includes leak detection monitoring at all downstream open ends of the 8-inch leak detection pipe. The Proposed Action would require a new leak detection monitoring point at the discharge location of the new pipeline segment into the Event Pond. In addition, the sampling and measurement location for heap leach pad draindown and TSP-1 Pit water would move to their respective discharge locations into the Event Pond. Finally, the combined TSP-1 and heap leach flows typically measured and sampled at the discharge location to the TSF would not be sampled during fluid management in the Event Pond.

2.1.5 Interim Management Plan (Seasonal Closure Plan)

Pursuant to NAC 445A.399, a seasonal closure plan is required for facilities located where the mean diurnal temperature does not exceed freezing (32° F) for 30 days or more each year. During periods of non-operation or seasonal closure, TSL would monitor the water level within the Event Pond and evaluate the necessity to divert flows to the TSF.

Because the proposed pipeline would be buried to protect it from freezing and the water would continue to be pH adjusted, there would be no other specific requirements for seasonal closure.

2.2 Existing Mine Facilities

Current operations at the Tonkin Springs Mine primarily consist of ongoing exploration activities and closure of historic mine process facilities that are not needed for future development activities. **Figure 3** shows the location of the existing mine facilities. The major components of the existing operations include roads, open pits, a process pond (Event Pond), a covered and revegetated heap leach pad, waste rock dumps, TSF, buildings and structure areas, storage and equipment areas, and a fluid management system that handles flows from the heap leach pad and TSP-1 in the tailings facility. **Table 1** outlines the existing surface disturbance by type of disturbance. Mining-related surface disturbance within the mine area occurs on public lands administered by the BLM.

The proposed new pipeline segment would be constructed within existing disturbance south and southeast of the heap leach pad (an area accounted for in the current reclamation plan as Area 41 - Yard 22). Refer to **Figure 4** for the location of the existing pH adjustment system and pipeline, and the proposed location of the diversion pipeline to the Event Pond.

Table 1: Existing Mining Related Surface Disturbance

Component	**Existing Surface Disturbance** (acres)
Open Pits	67.6
Waste Rock Dumps	22.0
Haul Roads	64.7
Tailings Storage Facility	16.6
Mill and Heap Facility	19.2
Access Road	18.8
Temporary Housing Area	6.3
Topsoil Stockpiles	11.8
Ancillary Facilities	221.5
Exploration	33.6
Totals	**482.1**

2.2.1 Roads

There are approximately 83.5 acres of road related disturbance in the mine site. The existing road system includes access and secondary roads, haul roads, drainage crossings, exploration roads, and a public access trail. The existing roads are currently used for exploration activities, or for access to the existing mine facilities. Haul roads comprise 64.7 acres of the total road related disturbance. The remaining 18.8 acres is an access road with an average disturbance width of 60 feet. Roads were generally constructed with standard cut and fill techniques. There are approximately 1,280 linear feet of culverts throughout the mine site. Culverts range in diameter from 24 to 36 inches and in length from 60 linear feet to 160 linear feet.

2.2.2 Open Pits

There are nine open pits within the mine site known as TSP-1, TSP-2, TSP-3, TSP-4, TSP-5 TSP-6, TSP-6E, TSP-7 and Rooster. The open pits very in size from 27.0 acres (TSP-5) to 0.8 acre (TSP-6E) and encompass a total surface area of 67.6 acres. With the exception of TSP-1, the material mined in the open pits was of oxide composition. These pits are described in more detail in the *Tonkin Springs LLC Exploration Project* (BLM, 2001).

Sulfide mineralization has been exposed in TSP-1 as a result of the mining of the shallow oxide ore cap. The existing disturbance is approximately 14.7 acres. The open pit does not extend significantly below the ground surface and would more accurately be described as a side cut quarry with two benches cut into the surrounding hill. A shallow sump was created along the east side (down-gradient side) of the open pit, west of the north/south trending fault. Diversion ditches have been constructed around the upgradient area of the TSP-1 open pit. In addition, a safety berm has been constructed above the high wall. Water accumulating in the open pit, including meteoric water, reports to the sump. Water contact with sulfide material in TSP-1 results in formation of acid which lowers the pH of the sump water.

Currently, TSP-1 pit water flows from the sump via gravity in a four-inch HDPE conveyance pipeline, through a pH adjustment system for caustic dosing, and then to the TSF. The system was constructed in accordance with an Administrative Order of Consent (AOC) established in January 2006 with the Nevada Division of Environmental Protection, Bureau of Mining Regulation and Reclamation (NDEP-BMRR).

TSP-1 has historically had an ephemeral open pit lake. SRK conducted a groundwater study in 1999, which concluded that the majority of the flow into the sump is derived from the shallow groundwater system. During the implementation of hydrogeological studies conducted in 1999, SRK found that deep groundwater was entering the TSP-1 open pit through unplugged exploration boreholes. In 2001, a number of unplugged holes were closed in accordance with Nevada Division of Water Resources (NDWR) standards (SRK, 2001). TSL completed an extensive borehole closure program in the summer and fall of 2007, during which TSL located and closed 27 open drill holes. TSL is currently planning to continue the drill hole closure program during the summer of 2008. Although data is still being collected and processed, the combined success of the borehole closure programs has significantly reduced the quantity of water entering the sump. To further reduce the quantity of water reporting to the sump, and in compliance with the renewed Water Pollution Control Permit NEV0085021, TSL constructed stormwater channels up-gradient of the TSP-1 open pit to prevent stormwater from entering the open pit

Approximately 10,000 linear feet of surface water diversion channels have been constructed on the perimeters of the TSP-1 and TSP-5 open pits and southwest of the tailings facility.

2.2.3 Process Ponds

There is one lined process pond at the mine site, which is the double-lined Event Pond east of the reclaimed heap leach pad. This pond is currently used as backup storage for heap leach pad draindown should the current use of the conveyance pipeline for heap discharge to the TSF be interrupted.

2.2.4 Heap Leach Pad

The existing heap leach pad was recontoured and covered with a minimum of 18 inches of growth medium in the summer of 2006. In addition, revegetation activities were completed in the late fall of 2006. Any residual flows from the heap leach pad are collected and routed through the heap water conveyance pipeline, which is further discussed in the Fluid Management System section, below (Section 2.3).

A small, reoccurring crack in the southeast corner of the heap leach pad is currently being monitored by weekly visual inspection and the use of a system of survey lath. The crack is located in the same area that failed several years ago, but has since been regraded to a much shallower slope. The crack, currently about 12 inches wide at the widest point, tends to reoccur following major precipitation events. During a recent inspection by the NDEP, it was noted that the crack has partially filled through natural sloughing. TSL confirmed that no movement in the toe of the heap below the crack has occurred in at least two years, and, while TSL believes it is unlikely that another significant failure is imminent, TSL would continue to monitor the crack and backfill or regrade when and if the crack exceeds 12 inches in width, or as necessary, to minimize infiltration of meteoric water into the crack.

2.2.5 Tailings Storage Facility

The Tailings Storage Facility (TSF) was constructed as a zero-discharge facility in December 1988. The TSF currently contains an estimated 40,000 tons of tailings and encompasses 16.6 acres. During the original design of the TSF, the geotechnical site investigation (Welsh, 1988) revealed that, below the upper alluvial soils in the area of the TSF (±20 feet thick), are Tuffaceous Tertiary clayey sands or sandy clays which are of stiff to very stiff consistency and have very low in-situ permeability (less than 1×10^{-6} to 1×10^{-7} cm/sec. The underlying geology of the TSF is described in more detail in the *Tonkin Springs LLC Exploration Project* (BLM, 2001).

The TSF is currently an integral part of the mine's fluid management system and is used to store and evaporate excess water. The majority of the fluid within the impoundment is meteoric water. The TSF also currently receives pH-adjusted TSP-1 Pit water and draindown from the heap leach pad. The TSF pond is undergoing active evaporation with one snowmaker/evaporator and two large sprinklers.

Seepage collected in the impoundment's under-drain and toe drain systems flows by gravity through a buried pipe to the tailings seepage collection tank located approximately 900 feet east of the embankment.

2.2.6 Waste Rock Dumps and Solid Waste Landfill

The mine site contains several existing waste rock storage facilities for the TSP-1, TSP-2, TSP-3, TSP-4, TSP-5, TSP-6, TSP-6E, and TSP-7 pits. With the exception of TSP-1, these facilities have been revegetated; however, each waste rock storage facility has yet to be evaluated for revegetation release.

The existing Class III landfill located at the mine was reopened for use in ongoing reclamation and closure activities.

2.2.7 Structures and Building Areas

This category includes areas that are occupied by buildings and structures, such as the administration area, laboratory, processing area, warehouse area, and the truck shop area along with other miscellaneous areas. The administration area, laboratory, warehouse area, and the truck shop area are currently being used to support both exploration activities and the closure and monitoring activities. The stainless steel tanks in the processing area are currently used as the back-up system for TSP-1 Pit water management.

2.3 Existing Fluid Management System

The existing fluid management system at the Tonkin Springs Mine provides for active management of the seepage and surface water collecting in the TSP-1 Pit and sump, draindown from the heap leach pad, and seepage from the impoundment underdrain and toe drain systems at the TSF. The current fluid management system was constructed in 2006 and early 2007 in accordance with the aforementioned AOC agreement with NDEP-BMRR. Both NDEP and BLM conducted field inspections and provided comments, technical input, and compliance oversight during construction and activation of the system (BLM, 2006; NDEP-BMRR, 2006).

Detailed design and as-built documents were submitted to the BLM and the NDEP-BMRR during the design and construction phases of the AOC implementation project (SRK, 2006a, 2006b, 2006c, 2006d, 2007).

2.3.1 TSP-1 Pit Water Management

Prior to the installation in 2006 of the current in-line pH adjustment system, TSP-1 Pit water management, included: periodic pumping of accumulated sump water to the stainless steel mill tanks; pH adjustment in an interim mixing tank using slaked lime; and, discharge of the pH-adjusted water via above-ground piping into the TSF. This system was difficult to maintain and susceptible to freezing conditions. In response to the requirements of the aforementioned AOC agreement, TSL designed and constructed a more efficient and reliable interim water management system.

During late 2006 and early 2007, TSL constructed a four-inch diameter HDPE pit water conveyance pipeline from the TSP-1 sump through a new pH adjustment system and then to the TSF. New surface disturbance associated with the construction of this pipeline was limited to 1.56 acres on previously undisturbed ground. The remaining construction (approximately 1,815 linear feet) was on existing disturbance.

The water conveyance pipeline is buried at a minimum depth of three feet below existing ground surface for protection against freezing. In accordance with leak detection requirements of NAC 445A.436, and following discussions with the BLM and the NDEP-BMRR, the pipeline was installed within a second 8-inch diameter, pipeline over its entire length. The pipeline exits the sump area at an elevation below the base of the sump trench and drains via gravity to the TSF to ensure that the pit is maintained in a constant state of draw down.

Prior to mixing with the heap flows and then discharging into the TSF, TSP-1 Pit water is routed via the conveyance pipeline through an in-line pH-adjustment system located within a buried precast concrete vault. The pH adjustment system is a skid-mounted unit that incorporates a caustic supply pump, controlled by a flow meter and pH meter. Caustic and TSP-1 water flow through an in-line static mixer and then past the flow and pH meters.

The existing system provides a quasi-passive version of the previous management system (i.e. gravity flow instead of pumping and caustic injection instead of lime slaking and mixing), provides for year-round operation in the buried conveyance pipeline and pH adjustment system, and ensures the sump is maintained in a constant state of drawdown to facilitate borehole and pit closure. The previously employed pumping and piping infrastructure through the stainless steel mill tanks remains in place as a backup system in the event of failure of the existing system.

2.3.2 Heap Draindown Management

Heap draindown management, prior to the installation of the existing system in 2006, included collection of draindown within the Event Pond and periodic pumping as necessary to maintain a manageable pond inventory via above-ground piping to the TSF. In response to the requirements of the aforementioned AOC agreement, TSL constructed a perimeter drain in the draindown collection channel along the eastern edge of the heap leach pad, regraded the leach pad to promote run-off, and covered the entire leach pad with a minimum of 18 inches of growth media. The final covered surface was then revegetated with an approved seed mix. Heap draindown flows were subsequently incorporated into the interim fluid management system by the construction of a draindown collection system and conveyance pipeline to the TSF. The new system is more efficient and reliable than the previous system.

The heap water conveyance and transfer pipeline was constructed within an eight-inch diameter pipeline for leak detection. The previously employed pumping and piping infrastructure from the Event Pond to the TSF remains in place as a backup system in the event of a problem with the existing system.

2.3.3 Tailings Seepage Management

Management of tailings seepage collection, prior to the installation of the existing system in the summer of 2006, included collection of seepage flows from the TSF sub-drain system in a tank-within-a-tank, set inside the tailings seepage collection pond.

The existing tailings seepage collection tank was installed in accordance with the aforementioned AOC agreement and is effectively an engineered version of the previous system without the pond. Seepage collected in the tank is automatically pumped back to the TSF through a three inch HDPE pipe. The pump is operated by a level-actuated switch within the inner tank.

2.3.4 Fluid Evaporation in TSF

TSP-1 Pit water, heap leach pad draindown, and seepage returned to the TSF via the TSCT are actively evaporated in the tailings impoundment during the warmer spring and summer months using one SMI Super PoleCat snowmaker/evaporator and two sprinklers. Enhanced evaporation (using only the snowmaker/evaporator) was estimated at a maximum of 75 percent of 100 gpm (or 75 gpm) for the snowmaker during summer months. The large sprinklers used to evaporate water were not considered in the water balance. During the 2007 evaporation season, the free water pool within the tailings impoundment was substantially reduced.

2.4 Reclamation

Reclamation of the proposed construction disturbance (~0.2 acres) would be completed in accordance with the Tonkin Springs Mine Plan of Operations #NVN-067881 and Reclamation Permit (No. 0166), and to the standards described in 43 CFR 3809.420.

The installation in 2006 of the existing (current) pH neutralization system disturbed approximately 1.56 acres of previously undisturbed ground west of the heap leach pad and around the new dosing vault. These areas were included under previous cultural resource investigations, and, therefore, new investigations were not required. The remaining construction for the existing pipeline system (approximately 1,815 linear feet or about 0.83 acres) was on existing disturbance. These areas have not yet been reclaimed.

The proposed new pipeline bypass segment would be constructed within existing disturbance south and southeast of the heap leach pad (an area accounted for in the current reclamation plan as Area 41 - Yard 22). No new disturbance would be associated with the Proposed Action.

2.5 Environmental Protection Measures

As part of the Proposed Action, TSL commits to the following Environmental Protection Measures and Best Management Practices (BMPs) to prevent unnecessary and undue degradation during construction, operation, and reclamation of the proposed diversion pipeline. The measures are derived from the general requirements established in the BLM's Surface Management Regulations at 43 CFR 3809 and NDEP-BMRR mining reclamation regulations, as well as other water regulations and BLM protocols.

Air Quality

- The dust from the use of roads and excavation activities would be minimized to the extent reasonable and practicable by using BMPs such as minimizing vehicular traffic, using prudent vehicle speeds (i.e., 15 to 25 miles per hour), and watering to minimize fugitive dust.

Hazardous or Solid Wastes

- Pursuant to 43 CFR 8365.1-1(b)(3), no sewage, petroleum products, or refuse would be dumped from any trailer or vehicle.
- Regulated wastes would be removed from the Project Area and disposed of in a state, federally, or locally designated area.
- All refuse generated during the Project would be removed and disposed of in an authorized landfill facility off site, consistent with applicable regulations. No refuse would be disposed of or left on site.

Water Quality

- Sediment control structures could include, but not be limited to, fabric and/or hay bale (certified weed-free) filter fences, or filter berms, mud pits, and downgradient drainage channels in order to prevent unnecessary or undue degradation to the environment.

Public Safety

- Public safety would be maintained throughout the life of the Project. All equipment and other facilities would be maintained in a safe and orderly manner.
- All Project-related traffic would observe prudent speed limits to enhance public safety, protect wildlife and livestock, and minimize dust emissions. All activities would be conducted in conformance with applicable federal and state health and safety requirements.

Fire Management

The following precautionary measures would be taken to prevent wildland fires.

- All equipment would be properly muffled and equipped with suitable and necessary fire suppression equipment, such as fire extinguishers and hand tools.
- Adequate fire fighting equipment (i.e. shovel, pulaski, extinguishers), and/or an ample water supply would be kept at the drill site(s).
- Vehicle catalytic converters would be inspected often and cleaned of all brush and grass debris.

- When conducting welding operations, the operations would be conducted in an area free from, or mostly free from, vegetation. An ample water supply and shovel would be on hand to extinguish any fires created from the sparks. Extra personnel would also be at the welding site to watch out for fires created by welding sparks.
- Wildland fires would be reported immediately to the BLM Central Nevada Interagency Dispatch Center at (775) 623-3444.
- When conducting operations during the months of May through September, TSL would contact the Battle Mountain District (BMD), Division of Fire and Aviation to determine if any fire restrictions are in place for the area of operation and to advise the BLM of approximate beginning and ending dates for the activities.

Wildlife

- In order to avoid potential impacts to migratory birds, a nest survey would be conducted within potential breeding habitat prior to any surface disturbance during the avian breeding season (May 15 through early July). If nests are located, or if other evidence of nesting (i.e., mated pairs, territorial defense, carrying nest material, transporting food) is observed, a protective buffer (the size depending on the habitat requirements of the species) should be delineated and the buffer area avoided to prevent destruction or disturbance to nests until they are no longer active. No new construction would be scheduled during the migratory bird breeding season prior to conducting a nest survey.

Noxious Weeds, Invasive & Non-native Species

- Noxious weeds would be controlled by washing vehicles and equipment with high pressure sprayers prior to mobilizing to the Project Area.
- Provide on-site personnel with BLM weed identification information.
- Reseeding roads within the Project Area with a BLM approved certified weed free seed mix. Reseeding would be consistent with all BLM recommendations for mix constituents, application rates, seeding methods, and seeding periods.
- If noxious weeds were introduced as a result of the Proposed Action, eradication measures would avoid impacts to wildlife species.

Wild Horses and Burros

- No activities would block access to water, and presence near water sources would be minimized to the extent possible.
- Any conflicts or concerns about wild horses in the Project Area would be forwarded to the Field Office Wild Horse and Burro Specialist immediately.

2.6 Alternatives to the Proposed Action

No alternatives other than the “No Action” alternative are analyzed in this EA as there are no unresolved conflicts.

2.6.1 No Action Alternative

Under the No Action Alternative, the Proposed Action would not be approved by the BLM. The bypass pipeline connecting the TSP-1 pipeline to the Event Pond would not be constructed. Instead, TSL would continue to route TSP-1 Pit water though the existing caustic pH-adjustment system and continue to discharge that water into the TSF via gravity flow. The system, described in detail in Section 2.3, was constructed in accordance with an Administrative Order of Consent (AOC) established on January 12, 2006 with the NDEP-BMRR. Construction of the system was completed in December 2006, and commenced operation in April, 2007.

Further, the existing heap leach draindown conveyance pipeline would remain connected to the TSP-1 pipeline and would also continue to discharge drainage water to the TSF. The evaporator and sprinklers would continue to be operated during the warmer spring and summer months. The TSL activities would be conducted according to the same environmental protection measures and/or BMPs as specified in the Proposed Action.

3.0 AFFECTED ENVIRONMENT

3.1 Critical Elements of the Human Environment

This section describes the current status of critical elements and resources that may be affected by either the Proposed Action or No Action Alternative. The topography in the area of the Tonkin Springs Mine is typical of that found in the Basin and Range Physiographic Province of the western U.S. Data concerning existing (i.e., baseline) conditions and resource trends were obtained from: previous studies; published sources; unpublished materials; interviews with representatives of local, state, and federal agencies; and/or field observations of the Mine Plan Area.

To comply with NEPA, the BLM mandates that all environmental assessments address specific critical elements of the environment that are subject to requirements specified in statute, regulation, or by Executive Order (EO) (BLM, 1988; BLM, 1997; EO13186; EO12898). **Table 2** outlines the critical elements that must be addressed in all environmental assessments and whether or not the Proposed Action potentially impacts those elements.

Table 2: Environmental Resources Addressed for the Proposed Project

Critical Element	Not Present	Present, But Not Affected	Present and Potentially Affected	Rationale for Inclusion or Exclusion
Air Quality			●	Project-related activities could generate fugitive dust during construction
Areas of Critical Environmental Concern (ACEC)	●			No ACECs occur in or near the Mine Plan Area
Cultural Resources	●			The Proposed Action would be on existing disturbance and would not affect cultural resources.
Environmental Justice	●			No minority or low-income groups would be affected by disproportionately high and adverse health or environmental effects.
Farm Lands (prime or unique)	●			No prime or unique farmlands occur in or near the Mine Plan Area.
Floodplains	●			No Floodplains occur in or near the Mine Plan Area.
Noxious Weeds, Invasive & Non-native Species			●	Disturbance of soil during construction could allow establishment of invasive, non-native species and/or noxious weeds
Migratory Birds			●	Migratory birds utilize the Project Area as well as the Mine Plan Area.
Native American Religious Concerns		●		Small activity on previously disturbed ground. Lack of response from local tribes on past projects within Project Area.

Critical Element	Not Present	Present, But Not Affected	Present and Potentially Affected	Rationale for Inclusion or Exclusion
Threatened or Endangered Species	•			No federally threatened or endangered species are known to exist in the Mine Plan Area
Waste, Hazardous or Solid			•	.
Water Quality Drinking/Ground			•	
Wetlands / Riparian Zones	•			No Wetlands/Riparian Zones occur in or near the Mine Plan Area
Wild and Scenic Rivers	•			No wild and scenic rivers occur in or near the Mine Plan Area
Wilderness	•			No wilderness occurs in or near the Mine Plan Area

In addition to the resource elements outlined in **Table 2**, the BLM considers other resources that occur on public lands, or issues that may result from the implementation of the Proposed Action. The potential resources and uses that are present and potentially affected by the Proposed Action or No Action Alternative include:

- Fire Management,
- Special Status Species, and
- Wildlife.

These resources are described in the Affected Environment (Section 3) and are analyzed in the Environmental Consequences (Section 4).

Several resources that are present, but are not affected by the Proposed Action or No Action Alternative, but are included in the Affected Environment (Section 3) for informational purposes only, and are not carried forward for further analysis include:

- Native American Religious Concerns,
- Range Resources,
- Soils,
- Vegetation,
- Visual Resources, and
- Wild Horses and Burros.

Finally, resources that are not present and/or are not affected by the Proposed Action or No Action Alternative, include:

- Geology and Minerals,
- Land Access
- Recreation, and

- Socioeconomics.

These resources are not discussed in the Affected Environment (Section 3), and are not carried forward for further analysis.

The following describes the resources of the human environment that are present and may or may not be potentially affected. For consistency, the resources are listed in the same order as in **Table 2** followed by the additional resources presented above.

3.2 Air Quality

The Mine Plan Area lies between the Simpson Park Mountains and the Roberts Mountains. Elevations in the Project Area average approximately 6,600 feet above mean sea level (amsl). The climate is characterized by warm, dry summers and cool moist winters. The average annual precipitation recorded at the weather station located at the Beowawe University of Nevada Ranch, located approximately 15 miles to the southwest of the Project Area, is 10.47 inches. The average annual low temperature is 30.7 degrees Fahrenheit (°F) and the average annual high is 63°F. The average annual snowfall between 1972 and 2007 was 28.4 inches (**Table 3**).

Table 3: Monthly Climate Summary (Beowawe Station #260800)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Average Max. Temperature (°F)	40.4	45.5	51.8	58.9	68.6	78.8	88	86	77.7	66.3	51.5	42.1	63.0
Average Min. Temperature (°F)	13.1	19	25.4	29.8	36.6	43.5	50	47.5	38.8	28.9	21	14.5	30.7
Average Total Precipitation (in.)	0.97	0.71	1.19	1.17	1.26	0.74	0.54	0.54	0.73	0.9	0.9	0.8	10.47
Average Total SnowFall (in.)	7	4.2	5.1	3.3	1.4	0	0	0	0	0.5	2.3	4.7	28.4

Period of Record : 9/ 1/1972 to 12/31/2007; Western Regional Climate Center, wrcc@dri.edu

Ambient air quality and the emission of air pollutants are regulated under both federal and state laws and regulations. Regulations potentially applicable to the Proposed Action and the No Action Alternative include the Nevada State Ambient Air Quality Standards and state of Nevada air quality regulations (NAC 445B).

The Mine Plan Area is located within three hydrographic basins: the Grass Valley Basin (No. 138), the Kobeh Valley Basin (No. 139), and the Pine Valley Basin (No. 53). However, the bulk of the Mine Plan Area, including the area of the Proposed Action, lies within the Pine Valley Basin (**Figure 5**). A Basin is defined as a geographic area drained by a single major stream or an area consisting of a drainage system comprised of streams and often natural or man-made lakes. Also referred to as Drainage Basin, Watershed, or Hydrographic Region. The U.S. Geological Survey and the Nevada Division of Water Resources, Department of Conservation and Natural Resources, have divided the state into discrete hydrologic units for water planning and management purposes. In addition, these basins are used in characterizing and quantifying air quality resources and management planning.

The Pine Valley hydrographic basin No. 53 is generally considered 'unclassifiable' or "better than national standards" for all major air pollutants (40CFR§ 81.329 Nevada). An unclassified area is one for which insufficient ambient air quality data are available, and the area may be above or below ambient standards. Unclassified areas are managed as attainment areas. An attainment area is one that does not exceed any national standard of ambient air quality for the pollutant.

3.3 Cultural Resources

Ten Class III cultural resource surveys were conducted within the Project Area prior to 2006 and are discussed in further detail in EA #NV063-EA00-43 (TSL, 2001). The Mine Plan Area has been disturbed, so any cultural resources that may have been located within the area have already been mitigated.

The Archaeological Resources Protection Act (ARPA) codified at 43 CFR 7, as well as the Native American Graves Protection and Repatriation Act (NAGPRA), codified at 43 CFR 10, both provide protection for historic properties, cultural resources, and Native American funerary items and/or physical remains located on federal land. In addition, ARPA provides for the assessment of criminal and/or civil penalties for damaging cultural resources. Any unplanned discovery of cultural resources, human remains, items of cultural patrimony, sacred objects, or funerary items, requires that all activity in the vicinity of the find ceases, and notification be made to Mr. Doug Furtado, Field Manager, Mount Lewis Field Office, 50 Bastian Way, Battle Mountain, NV, 89820 (775 – 635 – 4000), by telephone, with written confirmation to follow, immediately upon such discovery. The location of the find would not be publically disclosed and any human remains would be secured and preserved in place until a Notice to Proceed is issued by Mr. Furtado.

3.4 Noxious Weeds, Invasive and Non-native Species

Noxious weeds are designated so by Federal and State laws and have been defined by the State of Nevada as, "detrimental or destructive and difficult to control or eradicate." BLM further defines a noxious weed as, "a plant that interferes with management objectives for a given area of land at a given point in time." The BMD recognizes the current noxious weed list developed by the State of Nevada Department of Agriculture, which can be found on the internet at:

http://agri.nv.gov/nwac/PLANT_NoxWeedList.htm.

Invasive/non-native species are also troublesome plants (including annual grasses) or animals that have entered into an ecosystem from another area. Executive Order 13112 states that, "Invasive species are likely to cause economic harm or harm to human health." Noxious weeds, invasive and non-native species are highly adaptable, competitive, aggressive and easily spread. Weeds that become established in a particular area tends to lead to a decline in natural resource values including; the lack of native plant diversity, a decline in wildlife habitat and the reduction of forage for livestock, native ungulates and wild horses and burros. Weed infestations can negatively impact property and aesthetic values and reduce recreation enjoyment. Weed species are not generally eaten by wildlife, livestock or wild horses as their thorns, spines, and/or chemical content render them unpalatable.

The strategy for noxious weed management is to, "prevent and control the spread of noxious weeds through local and regional cooperative efforts…to ensure maintenance and restoration of healthy ecosystems on BMD-managed lands." In addition, noxious weed control would be based on a program of "prevention, education, early detection and rapid response (control) of small infestations."

In response of the noxious weed problem, there have been enacted Federal and State laws, executive orders, regulations, policies, and agreements that pertain to invasive nonnative species, including:

- The Federal Insecticide, Fungicide and Rodenticide Act (1972);
- The Federal Noxious Weed Act (1974);
- FLPMA (1976);
- The Public Rangelands Improvement Act (1978);
- Chapter 555 of the Nevada Revised Statues and Nevada Administrative Code;
- Executive Order 11312 (Prevention and Control of Invasive Species);
- BLM manuals and Partners Against Weeds Action Plan; and
- BLM cooperative agreements.

In addition, the BLM has developed an Integrated Weed Management (IWM) Program for the BMD.

The Mine Plan Area is effectively fenced against livestock intrusion. Noxious weeds, invasive and non-native species known to occur in the Project Area (but not necessarily the Mine Plan Area) include hoary cress or whitetop (*Cardaria draba*), Russian knapweed (*Acroptilon repens*), Scotch thistle (*Onopordum acanthium*), bull thistle (*Cirsium vugare*), musk thistle (*Carduus nutans*) and minor occurrences of salt cedar (*Tamarix spp.)*. Some thistle infestations have been identified in the northern part of the Mine Plan Area, and to the west of the Proposed Action (**Figure 6**).

3.5 Wildlife (Including Threatened and Endangered Species, Special Status Species, and Migratory Birds)

The wildlife species observed in the Mine Plan Area are typical of the arid/semi-arid environment in the central Great Basin. The BLM identified mule deer (*Odocoileus hemionus*), pronghorn antelope (*Antilocapra americana*), mountain lion (*Puma concolor*), coyote (*Canis latrans*), bobcat (*Lynx rufus*), badger (*Taxidea taxus*), long-tailed weasel (*Mustela frenata*), gray and kit foxes (*Urocyon cinereoargenteus* and *Vulpes macrotis*), and numerous small mammals, birds, and reptiles, as wildlife species with potential habitat in the Mine Plan Area (BLM, 2007).

Mule deer use a variety of vegetation types and habitats seasonally within the local livestock grazing allotment for forage, thermal cover, and escape cover for seasonal needs. The Project is located within Nevada Department of Wildlife (NDOW) Hunt Unit 155 (**Figure 7**). Mule deer occupy almost all types of habitat within their range, yet they seem to prefer arid, open areas and rocky hillsides (NDOW, 2005). The vegetation types preferred are primarily mountain brush and aspen habitats. Deer population numbers are dependent upon quality and quantity of browse forage including forbs and woody species such as sagebrush and bitterbrush. The Mine Plan Area contains potential mule deer habitat (BLM, 2007).

The western half of the Mine Plan Area lies within bighorn sheep range (**Figure 8**). The desert subspecies of bighorn sheep (*Ovis canadensis nelsoni*) ranges from Nevada and California to west Texas and south into Mexico. Bighorn inhabit alpine meadows, grassy mountain slopes and foothill country near rugged, rocky cliffs and bluffs, allowing for quick escape.

Pronghorn antelope occupy the flats and foothills of the Mine Plan Area. The eastern portion of the Mine Plan Area contains pronghorn antelope habitat (BLM, 2007) as shown on **Figure 9**.

3.5.1 Threatened and Endangered Species

The U.S. Department of the Interior, Fish and Wildlife Service (FWS) (2008) identified the Lahontan cutthroat trout (LCT), *Oncorhynchus clarkii henshawi*, as the only federally-listed species that may occur in the region. However, the Nevada Natural Heritage Program (NNHP) (2008) database did not indicate that no at-risk taxa were present in the Mine Plan Area. Given that no suitable surface water that could support LCT habitat is located within the Mine Plan Area, this specie is not present. Therefore, no threatened and endangered species are present in the Mine Plan Area.

3.5.2 Special Status Species

In addition to federally listed species, the BLM also identifies and protects special status species (SSS) by policy (BLM, 1988). The list includes certain species designated by the State of Nevada, as well as species designated as “sensitive” by the Nevada BLM State Director. Special status species known or believed to occur either in the Mine Plan Area include a number of bat, raptor and migratory bird species.

Bats

The NDOW has identified the following four BLM sensitive bat species as having the potential to occur in the Mine Plan Area and vicinity: small-footed myotis (*Myotis ciliolabrum*), long-eared myotis (*Myotis evotis*), long-legged myotis (*Myotis volans*), and Townsend’s big-eared bat (*Corynorhinus townsendii*). The following 12 BLM sensitive bat species were also identified by the NDOW as potentially occurring in the Project Area (but may or may not occur in the Mine Plan Area): pallid bat (*Antrozous pallidus*), big brown bat (*Eptesicus fuscus*), spotted bat (*Euderma maculatum*), silver-haired bat (*Lasionycteris noctivagans*), western red bat (*Lasiurus blossevillii*), hoary bat (*Lasiurus cinereus*), California myotis (*Myotis californicus*), little brown bat (*Myotis lucifugus*), fringed myotis (*Myotis thysanodes*), Yuma myotis (*Myotis yumanensis*), western pipistrelle (*Pipistrellus hesperus*), and Brazilian free-tailed bat (*Tadarida brasiliensis*) (BLM, 2007). Water sources in Nevada's desert are critical for bats and at least partially determine the distribution and abundance of some of Nevada's bat species. Water sources in Nevada available to bats are either natural (e.g., springs, streams, rivers, wetlands, ponds, and lakes) or artificial (e.g., troughs, spring boxes, reservoirs, some lakes, pools, and industrial process ponds) (Bradley *et al.*, 2006).

Pygmy Rabbit

Pygmy rabbit, *Brachylagus idahoensis*, is a Nevada BLM sensitive species for which habitat may be available within the Mine Plan Area (NNHP, 2008) (**Figure 10**). Pygmy rabbit habitat typically consists of dense stands of big sagebrush growing in deep loose soils. No pygmy rabbits have been observed in the Mine Plan Area.

Lahontan Cutthroat Trout

Currently, no habitat exists in the Mine Area for the LCT. The streams nearest to the Project Area occupied by LCT include Pete Hanson and Birch Creeks, located in the Roberts Mountains to the east (BLM, 2007).

Greater Sage-grouse

Greater sage-grouse inhabit most of the JD Grazing Allotment and several known leks are located within that allotment. Within the Mine Plan Area, no greater sage-grouse have been observed.

3.5.3 Migratory Birds

"Migratory bird" is defined as any bird listed in 50 CFR 10.13. Migratory birds may be found in the Mine Plan Area as either seasonal residents or as migrants. Provisions of the Migratory Bird Treaty Act (MBTA) (16 USC 701-718h) prohibits the taking of migratory birds, their parts, nests, eggs, and nestlings. Executive Order 13186, *Responsibilities of Federal Agencies to Protect Migratory Birds*, was signed on January 10, 2001 to further enhance and ensure the protection of migratory birds, and directs federal agencies to protect migratory birds by integrating bird conservation principles, measures, and practices. **Table 4** lists the migratory birds known to have distributions that overlap with the Mine Plan Area (Great Basin Bird Observatory, 2006).

Table 4: Migratory Birds with Distributions that Overlap the Mine Plan Area

Common Name	Scientific Name	PIF[1] "Immediate Action" Species	PIF[1] "Long-term Planning and Responsibility" Species	PIF[1] "Management" Species	NVPIF[2] Priority Species
Black rosyfinch[3,4]	*Leucosticte atrata*	No	**Yes**	No	**Yes**
Ferruginous hawk[3]	*Buteo regalis*	No	No	No	**Yes**
Piñon jay[3,4]	*Gymnorhinus cyanocephalus*	No	No	**Yes**	**Yes**
Prairie falcon[3,4]	*Falco mexicanus*	No	No	No	**Yes**
Short-eared owl[3,4]	*Asio flammeus*	No	No	No	**Yes**
Vesper sparrow[3,4]	*Pooecetes gramineus*	No	No	No	**Yes**
Lewis'woodpecker[3,4]	*Melanerpes lewis*	No	No	**Yes**	**Yes**
Northern goshawk[3]	*Accipiter gentilis*	No	No	No	**Yes**
Olive-sided flycatcher[4]	*Contopus cooperi*	No	No	**Yes**	**Yes**
Red-naped sapsucker[3,4]	*Sphyrapicus nuchalis*	No	**Yes**	No	**Yes**
Swainson's hawk[3,4]	*Buteo swainsoni*	No	No	**Yes**	**Yes**
Yellow-breasted chat[3,4]	*Icteria virens*	No	No	No	**Yes**
Loggerhead shrike[3,4]	*Lanius ludovicianus*	No	No	No	**Yes**

[1] PIF = Partners in Flight
[2] Nevada Partners in Flight
[3] BLM Sensitive Species
[4] NNHP Watch Species

3.6 Native American Religious Concerns

Located within the traditional territory of the Western Shoshone, the BMD administrative boundary contains spiritual, traditional, and cultural resources, sites, and social practices that aid in maintaining and strengthening social, cultural, and spiritual integrity. Recognized tribes with interests within the BLM BMD administrative boundary are: the Te-Moak Tribe of Western Shoshone (Elko, South Fork, Wells, and Battle Mountain Bands), Duck Valley Sho-Pai Tribes of Idaho and Nevada, Duckwater Shoshone Tribe, Ely Shoshone Tribe, Yomba Shoshone, Timbisha Shoshone, and various other community members and individuals.

Though archaeological data and theory states that the Western Shoshone (Newe) began to inhabit the Great Basin area around 600 years ago, contemporary Western Shoshone contend they were here since time immemorial. Social activities that define the culture took place across the Great Basin. Pine nut gathering, edible and medical plant gathering, hunting and fishing, spiritual/ceremonial practices, and trade occurred as the natives practiced a hunting and gathering lifestyle. As with the delicate and sensitive nature of the fragile resources of the Great Basin, the native cultures appeared to be heavily impacted by social, cultural, and environmental change, which rapidly accompanied the nonnative migration from east to west. Confined to reservations and encouraged to participate in a more sedentary lifestyle (farming and cattle ranching), the Western Shoshone and other Great Basin tribes continued to practice certain cultural, spiritual, and traditional activities, visited their sacred sites, hunted game, and gathered the available medicinal and edible plants. Through oral history and the practice of handing down knowledge from the elders to the younger generations, some Western Shoshone continue to maintain a world view similar to that of their ancestors.

Cultural, traditional, and spiritual sites and activities of importance to tribes include, but are not limited to: existing antelope traps; certain mountain tops used for vision questing and prayer; medicinal and edible plant gathering locations; prehistoric and historic village sites and gravesites; sites associated with creation stories; hot and cold springs; collection of materials used for basketry and cradle board making; locations of stone tools such as points and grinding stones (mono and matate); chert and obsidian quarries; hunting sites; sweat lodge locations; locations of pine nut ceremonies, traditional gathering, and camping; rocks used for offerings and medicine gathering; tribally identified Traditional Cultural Properties (TCP’s); TCP’s found eligible to the National Register of Historic Places; rock shelters; rock art locations; lands or resources that are near, within, or bordering current reservation boundaries, and actions that conflict with tribal land acquisition efforts that involve the Nevada Congressional Delegation. Through discussions between BLM and Tribal members, the Roberts Mountains and the Tonkin Springs areas were once the locations of prehistoric and historic village and camp sites and contained significant pine nut harvesting and hunting areas. Specifically, Roberts Creek and the Tonkin Springs area were known to produce consistent pine nut crops. Cultural resources inventory and survey (archaeological sites and artifacts) appear to support the traditional/cultural use information given by tribal members.

In accordance with the National Historic Preservation Act (P.L. 89-665), the NEPA, the Federal Land Policy and Management Act (P.L. 94-579), the American Indian Religious Freedom Act (P.L. 95-341), the Native American Graves Protection and Repatriation Act (P.L. 101-601) and Executive Order 13007, the BLM must make efforts to identify locations having traditional cultural or religious values to Native Americans and insure that land management actions do not unduly or unnecessarily burden the pursuit of traditional religion or life ways by inadvertently damaging important locations or hinder access. There are no identified traditional cultural properties documented in the Project Area or Mine Plan Area. There has been no apparent interest by local Native Americans in this Proposed Action.

3.7 Waste, Hazardous and Solid

Solid waste from the Tonkin Springs Mine is currently collected and transported offsite to the Eureka County Landfill for proper disposal. No hazardous wastes, as defined by the Resource Conservation and Recovery Act (RCRA), 42 USC Section 1004(5), are stored at the site.

3.8 Water Quality, Drinking/Ground

3.8.1 Drinking Water

Drinking water at the Tonkin Springs Mine man camp is obtained from a domestic groundwater well located at the man camp site. The mine processing/production supply well, which is located about 0.5 miles from the man camp, is of domestic supply beneficial use quality, but, since the well was not constructed as a domestic well, it has been designated non-potable. Drinking water at the mine site is brought in as bottled water.

Surface waters within the Project Area consist of several springs and intermittent or ephemeral drainages, most of which run dry during the summer months. Springs or seeps within the Project Area include Indian Springs, Black Springs (a.k.a., Coils Creek East). With the exception of Indian Springs, the remaining springs only have flow in response to precipitation events. There are no known springs within the Mine Plan Area. Surface water bodies within the Project Area, the Mine Plan Area, and downgradient of existing and proposed disturbances are shown in **Figure 11**. It should be noted that Sage Hen Spring is located just outside the southwest project area boundary and the McClusky Creek crosses through the same edge of the Project Area.

The nearest year-round water source is about two miles southeast of the Mine Plan Area. Denay Creek, the major stream in the area, is located approximately 1.5 miles east of the Mine Plan Area and is fed by Tonkin Spring. Tonkin Reservoir, an approximately four-acre man-made body of water, and potential drinking water source, is located less than one mile east of the Project Area.

3.8.2 Groundwater

Several hydrogeological studies (HCI, 1995, 1996; Simon Hydro-Search, 1994) have been conducted in the Project Area, the most recent of which was performed for the TSP-1 pit area (SRK, 2000). The following summary is based on the data gathered during these investigations.

Regionally, groundwater from the Denay Valley drains in a north-northeasterly direction toward the Humboldt River, which flows westerly, eventually reaching the Carson Sink. The Mine Plan Area is located near the head of the Denay Valley Drainage where the Simpson Park and Roberts Mountains converge. Groundwater occurs in variable amounts in each geological unit, with flows generally following the topography. Geological structures (faults, dikes, etc.) play a significant role in controlling the groundwater flow system.

3.9 Fire Management

The Red Hills Hazardous Fuels Reduction Project (NV-064-2823-JM-JF28) is an ongoing hazardous fuels reduction projects in the vicinity of the Mine Plan Area. This action is being conducted under the Healthy Forest Initiative Categorical Exclusion authority for hazardous reduction projects (516 DM 2, Appendix 1, 1.12. and is in conformance with the RMP, amended for Fire Management in 2002, as well as the Fire Land Use Plan Amendment and Decision Record (NV61-EA97-071) which was approved on September 17, 2002. This Project is also in compliance with the BMD Fire Management Plan approved September 30, 2004.

The Red Hills Unit encompasses 3,671 acres. Broadcast prescribed fire would be conducted on 1,700 to 2,537 acres (46 to 70 percent of the Red Hills Unit). Up to 100 acres would be treated by pile and/or slash burning and up to 400 acres would be treated utilizing mechanical methods. The purpose of this action is to reduce hazardous fuel accumulations in the Red Hills/Tonkin Springs area of Eureka County, Nevada. In addition to hazardous fuels reduction, secondary benefits of the project would be to protect and improve wildlife habitat in the long term, particularly sage-grouse habitat, and to reintroduce fire under prescribed conditions into this fire-dependent ecosystem. Approximately 1,135 acres of the Red Hills Maximum Manageable Area (MMA) and 449 acres of the Red Hills Unit overlap with the Project Area.

The Mine Plan Area lies within the Three Bars Fire Management Unit, which has a relatively high fire occurrence and a history of large fires. Since 1994, seven recorded wildland fires have been recorded in the Project Area. The Trail Canyon fire of 1999 burned approximately 106,500 acres, of which approximately 3,000 to 4,000 acres were within the western portion of the Project Area. Other fires burned a total of approximately 2,084 acres within the Project Area. Following the Trail Canyon fire, soil stabilization and revegetation treatments were implemented.

3.10 Range Resources

The Mine Plan Area is located on the JD Grazing Allotment administered by the BMD. The JD Grazing Allotment consists of 145,934 acres of land and is presently managed for approximately 8,200 cattle animal unit months (AUMs) annually from May 1 through January 31. An AUM represents the amount of forage required to support one cow and calf pair for one month.

The Mine Plan Area is enclosed by four-strand barbed wire livestock fencing which precludes livestock access.

3.11 Soils

The pre-mining Soils within the Mine Plan Area are typical of valley fans and steep mountain slopes of the north-central Great Basin. Slopes vary from inset fans with slow runoff to the crest and shoulders of ballenas with medium runoff to slopes of mountains with very rapid runoff. Soils in the Mine Plan Area were mapped prior to disturbance by the U.S. Soil Conservation Service (now known as the Natural Resource Conservation

Service [NRCS]), the BLM, and the University of Nevada Agricultural Experiment Station, as part of a Soil Survey of Eureka County (NRCS 1989). Characteristics of the soil associations in the Mine Plan Area prior to mine disturbance are defined in **Figure 12**. The soils in the Mine Plan Area ranged in texture from sandy loam to very gravelly loam to extremely stony loam. According to the NRCS, the erosion potential by water for the various soils found in the Mine Plan Area varies from slight to severe and the erosion potential by wind for all soils in the Mine Plan Area also ranges from slight to severe (**Figure 13**).

3.12 Vegetation

The Mine Plan Area is located in the Intermountain Region in the Central Great Basin Section of the Great Basin Division. The Mine Plan Area is located on the northern edge of the Simpson Park Range and west of the Roberts Mountains. Prior to mining, vegetation in the vicinity of the Mine Plan Area was consistent with Great Basin cold desert steppe, dominated by sagebrush/bunchgrass and piñon-juniper communities, with other shrubs, forbs, and grasses present (**Figure 14**).

The mining disturbance within the Mine Plan Area has altered the vegetative regime in and around the open pits, waste rock dumps, and process facilities. The dominant vegetation in areas previously disturbed is Green rabbitbrush (*Chrysothamnus viscidiflorus*). The vegetation in the surrounding undisturbed areas, around and between the TSP-1 Pit, waste rock dumps, heap leach pad, and process facilities are listed in **Table 5**.

Table 5: Dominant Vegetation in Undisturbed Portions of Mine Plan Area

Arrowleaf balsamroot (*Balsamorhize sagittata*)	Mulesear (*Wyethia amplexicaulis*)
Bluebell (*Mertensia longiflora*)	Onion (*Allium douglasii*)
Bluebunch wheatgrass (*Agropyron spicatum*)	Pinyon pine (*Pinus monophylla*)
Bottlebrush squirreltail (*Elymious elyoides*)	Prickly pear (*Opunita polycantha*)
Desert Buckwheat (*Erigonum spp.)*	Rocky Mountain aster (*Aster adscendens*)
Desert Paintbrush (red) (*Castilleja chromosa*)	Rubber rabbitbrush (*Chrysothamnus nauseosus*)
Great Basin Wildrye (*Elymus cineraus*)	Scarlet Globemallow (*Sphaeralcea coccinea*)
Green rabbitbrush (*Chrysothamnus viscidiflorus*)	Service berry (*Amelanchier alnifolia*)
Idaho fescue (*Festuca idahensis*)	Squaw Current (*Ribes cereum*)
Indian rice grass (*Oryzopsis hymenoides*)	Wild rose (*Rosa Woodsii*)
Juniper (*Juniperus occidentalis*)	Wyoming big sage (*Artemisia tridentata*)
Lupine (*Lupinus spp*.)	Yarrow (*Achillea millefolium*)

3.13 Visual Resources

The Mine Plan Area is located in a Class IV Visual Resource Management (VRM) area. The objective of this class is to provide for management activities that allow for major modification of the existing character of the landscape. The level of change to the characteristic landscape can be high. Management activities could dominate the view and be the major focus of viewer attention. However, every attempt should be made to minimize the impact of such activities through careful location, minimal disturbance and repeating the basic elements of line, form, color, and texture (BLM 1986a).

The natural landscape is gently sloping to the east and is vegetated with sagebrush and piñon-juniper communities. Land and vegetation colors in the foreground and mid-ground are shades of green and tan, while the background includes dark green from the piñon/juniper trees and patches of tan and brown. The skyline in the west is dominated by the Simpson Park Mountains. Existing manmade features that are prominent in the Mine Plan Area include roads, road cuts, pit highwalls, the heap leach pad, TSF, and mine buildings.

3.14 Wild Horses and Burros

The BLM is responsible for the protection, management and control of wild horses and burros on public lands in accordance with the Wild Free-Roaming Horse and Burro Act of 1971 as amended (Public Law 92-195 Act) which states that the BLM "shall manage wild free-roaming horses and burros in a manner that is designed to achieve and maintain a thriving natural ecological balance on the public lands."

The Mine Plan Area lies within the Rocky Hills Herd Management Area (HMA) (BLM, 1986b). During 1999, approximately 47 percent, or 39,759 acres, of the Rocky Hills HMA burned as a result of wildfires. Nearly all of the HMA which overlaps the Project Area (**Figure 15**) burned. In November 1999, the BLM initiated an emergency removal of 251 of the 257 horses in the HMA. Only six horses remained in the HMA following the removal action.

In October 2002, the range conditions on the Rocky Hills HMA had improved sufficiently to allow the return of the horses. Seventy-four of the displaced horses were returned to the area. Forty-four wild horses were released in the JD Allotment, and 30 horses were released into the Grass Valley Allotment. After the release, the estimated population was 94 to 98 wild horses within the Rocky Hills HMA.

There are fences in the southern portion of the HMA that restrict wild horse movement into the southern portion of the HMA south of Rooster Canyon, and in the vicinity of the Mine Plan Area. A four-strand, barbed wire fence surrounds the Mine Plan Area, effectively excluding wild horses.

4.0 Analysis of Environmental Effects

TSL has incorporated environmental protection measures and BMPs into the Proposed Action in order to reduce potential effects to the environment. This chapter describes the potential direct, indirect, and residual impacts that may result from the Proposed Action and No Action Alternative associated with TSL PoO amendment. Potential impacts are presented for those critical elements and resources elements present in the affected environment as described in Chapter 3. Cumulative effects are discussed in Chapter 5.

4.1 Air Quality

Proposed Action

During construction of the pipeline, direct, temporary impacts to air quality from fugitive dust, as well as gaseous pollutants such as nitrous oxides, carbon monoxide, and sulfur dioxide, would result from the Proposed Action. Sources of gaseous pollutants would include construction equipment exhaust emissions, including mobile equipment and light vehicles. Sources of fugitive dust would include clearing, earth moving and wind erosion. TSL utilizes operating controls such as watering main roads and construction areas to control fugitive dust, and preventive equipment maintenance to control vehicle emissions.

Impacts to air quality would be transitory and temporary, limited in duration, and would end at the completion of the construction phase of the project.

Neither the continued maintenance nor the contingency use of the original lime pH neutralization system, or the continued monitoring of the recurring surface crack in the southeast corner of the heap leach pad would have any impact on air quality.

No Action Alternative

The continued routing of TSP-1 Pit water though the existing caustic pH-adjustment system and continued evaporation and discharge of that water into the TSF via gravity flow would be the same as the Proposed Action during water management activities.

4.2 Noxious Weeds, Invasive and Non-native Species

Proposed Action

Surface disturbance resulting from implementation of the Proposed Action has the potential to create conditions favorable for the establishment of noxious, invasive, non-native species and other undesirable vegetation, specifically in the area of pipeline construction. Weed infestations could spread from existing populations or be introduced into previously weed free areas from sources outside the Mine Plan Area.

The use of approved and certified weed free seed mixes, combined with only certified noxious weed-free seed, combined with implementation of prompt and appropriate revegetation techniques, would reduce the potential for invasive, non-native weed invasion. TSL would follow the established BMPs in order to prevent the spread of noxious, invasive weeds in the Mine Plan Area.

The Proposed Action would have a minimal potential to spread invasive, nonnative species and noxious weeds from monitoring activities or other vectors such as recreational uses, other mining activities, or wildfires. The redirecting of the pH-adjusted water to a lined pond system, and subsequent drying and reclamation of the TSF would also reduce the likelihood of establishment of water attracted noxious and invasive species, such as salt cedar (*Tamarix sp.*), that establish most frequently in soils that are seasonally saturated at the surface.

No Action Alternative

The No Action Alternative does not involve additional earth-moving or ground-disturbing activities. As such, the probability of occurrence of weed infestations as a result of surface disturbance would be less than that for the Proposed Action. However, non-native, invasive and noxious weeds could continue to spread in the area through other vectors such as recreational uses, other mining activities, wildfires. In addition, the continued disposal of pH-adjusted water to the TSF provides potential irrigation water for weed establishment and infestation.

4.3 Waste, Hazardous and Solid

Proposed Action

During pipeline construction, minimal solid waste, requiring off-site disposal, is expected to be generated. No hazardous waste would be generated. Spills of petroleum products would be cleaned and reported according to state regulations.

Sediments and chemical precipitates that accumulate in the Event Pond as a result of the pH adjustment process would be characterized and managed as part of the overall site reclamation and closure under the approved reclamation plan.

No Action Alternative

No solid waste or hazardous waste would be generated as a result of the No Action Alternative.

Sediments would continue to accumulate in the TSF as a result of the pH adjustment process.

4.4 Water Quality

Proposed Action

From the TSP-1 Pit to the Event Pond, the current pH adjustment system is a closed system. Double-containment structures and leak detection has been included to ensure that this water is not released to the environment.

The physical construction of the proposed pipeline could result in a limited, short-term increase of sediment in runoff water in the vicinity of the proposed two-acre disturbance. However, since the proposed pipeline is designed to avoid drainages, and with the adherence to the prescribed environmental protection measures and BMPs, the potential impacts to surface water would be negligible.

No construction related impacts to groundwater resources are projected.

No Action Alternative

Under the No Action Alternative, surface waters are captured and managed as part of the TSF system. Seepage is collected and pumped back to the impoundment.

The pH-adjusted effluent from the TSP-1 Pit would continue to be discharged to the TSF. The TSF is situated over more than 280 feet of clayey sands or sandy clays which have very low in-situ permeability (less than 1×10^{-6} to 1×10^{-7} cm/sec. (Welsh, 1988). Condemnation holes drilled in this material extended to a depth of 280 feet, and did not encounter permanent groundwater. The pH-adjusted-water discharged to the TSF would take upwards of 270 years to reach the depth of the condemnation holes, and even longer to reach groundwater should it lie even deeper (Welsh, 1988).

4.5 Fire Management

Implementation of the Proposed Action would be coordinated with the BMD fire staff in order to ensure the safety of TSL personnel during periods of prescribed fire activity pertaining to the Red Hills Hazardous Fuels Reduction Project. Prescribed fire activities may occur in the late spring or fall seasons through 2009, or until the Red Hills Hazardous Fuels Reduction Project is completed.

Based on fire avoidance measures to be implemented under the Proposed Action and the fact that the Mine Plan Area would continue to be accessible, no impacts to fire management are anticipated. In addition, reclamation measures include seeding with native vegetation that may be more favorable to fire avoidance and suppression in the long term.

No Action

Impacts from fire management would remain the same for the No Action alternative.

4.6 Wildlife (Including Threatened and Endangered Species, Special Status Species, and Migratory Birds)

Proposed Action

Pipeline construction would be located on existing disturbance, with limited habitat area or value. Approximately 0.2 acres of wildlife habitat in the Mine Plan Area would be lost.

Reclamation of the proposed construction disturbance would be completed in accordance with the Tonkin Springs Mine Plan of Operations #NVN-067881 and Reclamation Permit (No. 0166), and to the standards described in 43 CFR 3809.420. The resulting herbaceous-shrub community consisting of vegetation from the reclamation seed mix would provide diversified forage for local wildlife. Eventually the reclaimed area would be similar in vegetative composition to the surrounding area.

Mule deer migration is unlikely to be disrupted by the noise and activity associated with pipeline construction. Mule deer and antelope may tend to avoid construction activities, but avoidance should not affect the populations of these species.

Human activity is already limited within the Mine Plan Area for safety reasons. Therefore, there would be no change to the dispersed recreation (i.e., hunting of wildlife) due to the Proposed Action.

Effluent water from the TSP-1 pH adjustment system would be redirected and collected in the Event Pond. This water would be accessible to smaller terrestrial wildlife species as well as avian wildlife. Larger terrestrial wildlife (i.e., deer, antelope, coyotes, etc.) as well as livestock that may trespass and gain access to the Mine Plan Area would be excluded from the Event Pond by fencing.

In order to analyze the potential impacts to wildlife from exposure to the Event Pond water, effluent water qualities from the caustic-treated pit water and the heap leach pad were compared to ecological threshold criteria initially developed by the Environmental Sciences Division and Life Sciences Division of Oak Ridge National Laboratory for the U.S. Department of Energy (*Sample et al*., 1996) (**Appendix A**). In general, if the concentration of a chemical in the water is lower than the lowest calculated threshold criteria, then the chemical is unlikely to represent a toxicological threat under normal site conditions. However, if the chemical concentration (or the reported analytical detection limit) of a chemical exceeds a specific wildlife threshold criteria, then further analysis of that constituent may be warranted to determine what, if any, hazard is posed by that chemical to the particular ecological receptor(s) and the local environment as a whole. The more a chemical concentration exceeds a criteria value, the more likely it is that the specific contaminant may pose an ecological risk. These screening benchmarks, therefore, provide a quick way to identify and prioritize possible contaminants of concern (CoCs) at a particular site.

For the TSP-1 caustic-treated effluent, the CoCs identified were arsenic, thallium, and Total Dissolved Solids (TDS). The current arsenic concentrations in the treated effluent are approximately ten times higher than the criteria for the larger of the terrestrial, mammalian receptors (including the deer, coyote, and marmot); five times higher than the criteria for the white-footed mouse; and twice the criteria concentration for the little brown bat. Because the larger animals would be excluded from the pond by fencing, and the smaller mammals are not likely to venture across and down the exposed black liner to the water surface, bats would be the only likely mammalian receptor species to use the Event Pond water for drinking. At two times the criteria, arsenic in the Event Pond water would pose a low to moderate risk to bats.

Thallium in the Event Pond could also pose a low to moderate risk to terrestrial wildlife. However, given the reasons cited above, the risk is likely to be low as a result of institutional controls around the pond.

TDS information for the pH-adjusted water was used to assess the overall ionic effect in a water source on livestock and wildlife. Certain physiological effects on plants and animals are often affected by the number of available ions in the water. TDS concentrations of less than 3,000 mg/L are usually considered satisfactory for most livestock (Boyles, 1999). The TDS concentrations in the pH-adjusted water ranges from 3,500 to 4,500 mg/L, suggesting that a low to moderate risk to livestock and wildlife could exist. However, exclusion of larger terrestrial animals (including livestock) from the Event Pond would effectively eliminate this potential risk.

No avian species appear to be at risk from exposure to the TSP-1 caustic-treated effluent, or the heap leach pad effluent. No geochemical modeling of the combination of these waters with meteoric precipitation, or the use of enhanced evaporation to reduce the pond inventory, was conducted for this analysis.

The continued maintenance of the original lime pH neutralization system and the continued monitoring of the recurring surface crack in the southeast corner of the heap leach pad would have no impact on wildlife because the area is fenced to exclude large wildlife. The contingency use of the original lime pH neutralization system would have similar impacts as the use of the caustic treatment system. In addition, aluminum could pose an added risk to terrestrial wildlife. No institutional controls exist around the TSF to prevent wildlife (and livestock) from accessing the water discharged therein. As such, the potential risks posed to wildlife would be more moderate than for the caustic treatment system.

No Action Alternative

The potential impacts from implementation of the No Action Alternative would result in no further loss (~0.2 acres) of previously altered wildlife habitat by construction of the bypass pipeline.

Livestock and wildlife would continue to have access to the water discharges to the TSF. Based on the assessment of that water (above), the risks posed by arsenic, thallium and TDS to animals consuming the TSF water would be moderate to high for exposed terrestrial wildlife and livestock, and remain low to moderate for bats. However, the water in the TSF is not likely to be used by livestock and wildlife as a sole water source in the area, so this potential risk would be somewhat lower.

5.0 Cumulative Impacts

This chapter analyzes the potential cumulative impacts from past, present, and reasonably foreseeable future actions combined with the USG proposed exploration program within a defined Cumulative Effects Study Area (CESA). As defined by federal regulations (40 CFR §1508.7), cumulative impacts are: "…the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or non-federal) or person undertakes such other actions." Cumulative effects can result from individually minor, but collectively significant actions taking place over a period of time.

Therefore, as required under NEPA, this chapter addresses the cumulative effects on the identified environmental resources in the Cumulative Effects Study Areas (CESA) which could result from the implementation of the Proposed Action.

For the purposes of this analysis and under federal regulations, "impacts" and "effects" are assumed to have the same meaning and are interchangeable.

5.1 Cumulative Effects Study Areas

Watershed boundaries were used to create a CESA in order to evaluate the cumulative impacts associated with the majority of the resources.

The CESA for this EA was determined through an examination of the Hierarchical Unit Classification (HUC) system of the U.S. Geologic Survey. The U.S. is divided and sub-divided into successively smaller hydrologic units, which are classified into four levels: regions, sub-regions, accounting units, and cataloging units. The hydrologic units are arranged within each other, from the smallest (cataloging units) to the largest (regions). Each hydrologic unit is identified by a unique hydrologic unit code (HUC) consisting of two to eight digits based on the four levels of classification in the hydrologic unit system. HUC 5, HUC 6, and HUC 7 refer to different sizes of hydrologic units or watersheds. A HUC 5 watershed ranges from 40,000 to 250,000 acres in size. A HUC 6 watershed, or sub-watershed, ranges from 10,000 to 40,000 acres in size, and is the typical size of watershed at which a landscape analysis is conducted. A HUC 7 watershed, or sub-sub-watershed, is typically less than 10,000 acres in size, averaging approximately 2,500 acres.

For this EA, the HUC 5 hydrographic basins, the typical areas considered for a CESA by the MLFO, was considered too large of an area to evaluate the incremental impacts associated with the Proposed Action. Instead, and for consistency with the Tonkin Springs Exploration Project EA (BLM, 2007), the immediate watersheds around the Project Area and Mine Plan Area, were combined from sub-basins of the three HUC 5 basins into a single unit encompassing 75,990 acres (Figure 16). Both the Project Area and Mine Area lie within this CESA, and was used for the cumulative impact assessment for the following resources:

- Air Quality,
- Noxious Weeds, Invasive & Non-Native Species,
- Waste, Hazardous And Solid,
- Water Quality,
- Fire Management, and
- Wildlife (Including Threatened and Endangered Species, Special Status Species, and Migratory Birds).

The following sections offer past actions, present actions, and reasonably foreseeable future actions for the area of the proposed TSL interim water management program. Mining, as well as livestock and wild horse grazing, are the primary past and present activities in this region. It is reasonable to expect that exploration and mining activities would continue to increase in this region based on the fact that this area is mineral rich, and the price of precious metals continues to remain above historic prices. All of the actions and uses have the potential to affect the environmental resources of concern within the identified CESA. The past, present, and reasonably foreseeable mining activities are outlined in **Table 6**.

Table 6: Past, Present, and Reasonably Foreseeable Mining Disturbance

Actions	Past and Present Approved Disturbances		RFFA Projected Disturbance (acres)	Total Approved + Projected Disturbance (acres)
	Total Approved Disturbances (acres)	Remaining Disturbances (acres)		
Total of 5 Notices	10.7	5.6	10	20.7
Total of 4 Plans	648.7	153.2	10	658.7
Total of 0 Sand & Gravel	0	0	0	0
Notices				
NVN 080128	0.3	0	4.7	4.98
NVN 084080	4.9	0.2	0	4.86
NVN 085356	0.3	0	4.7	4.96
NVN 085485	2.5	2.5	0.3	2.76
NVN 085486	2.9	2.9	0.3	3.19
Plans				
NVN 066464	21.2	0	0	21.2
NVN 067881	448.3	0	0	448
NVN 067934	29.2	3.2	10	39.2
NVN 077213	150.0	150.0	0	150
				0
Total	**659**	**159**	**20**	**679**

5.2 Past Actions

Past actions have been associated primarily with mining and exploration, livestock grazing, dispersed recreation, wildland fire, fire fuels treatments, fire rehabilitation, and wild horse herd gathers. Multiple wildland fires have been recorded in the CESA and Project Area since 1994. The Trail Canyon Fire of 1999 burned over 106,500 acres of sagebrush and piñon-juniper vegetation types. Approximately 3,000 to 4,000 acres of this fire burned within the Project Area. No wildlife has encroached in to the Mine Plan Area. Rehabilitation work was conducted following the Trail Canyon fire, including soil stabilization and revegetation treatments. The Trail Canyon fire was considered a high-severity wildfire and uncharacteristic of typical wildfires in these fuel types. An additional 2,084 acres burned in the Project Area since 1994 as a result of the other wildland fires. The average acres burned per fire was 347.

5.3 Present Actions

Present actions include livestock grazing, range improvement projects, dispersed recreation, fire fuels treatments rehabilitation, and mining activities that include exploration and closure/reclamation of the Tonkin Springs Mine. Current range improvement projects are construction of two fences and improvements to nine springs. Fire fuels treatments include the Red Hills and the Tonkin projects, which are included in Chapter 3. The Red Hills Unit includes 3,671 acres, 2,200 to 3,037 acres of which will be treated. The Tonkin Unit encompasses 2,400 acres, of which up to 1,000 acres will be treated.

5.4 Reasonably Foreseeable Future Actions

The RFFAs within the CESAs include the following: continued livestock grazing; dispersed recreation; fire fuels treatments; fire rehabilitation; and mining activities. In addition, the BLM proposes to thin piñion-juniper woodlands on approximately 3,000 acres of the Willow Creek drainage of the northern Roberts Mountains to enhance wildlife habitat. This project is within the JD Allotment, approximately 30 miles northwest of Eureka, Nevada. The trees would be thinned by crews using chainsaws and would be conducted over a period of several years as time and resources allow.

Wildland fires are also likely to occur within the CESA in the next ten years, though the probability of them occurring in the next two to three years is lower. Mineral exploration activities are expected to continue based on current supply and demand of minerals and commodities. Livestock grazing and recreational activities are expected to continue consistent with the present actions discussion.

5.5 Cumulative Impacts

In accordance with the guidance document, "Considering Cumulative Effects Under the National Environmental Policy Act" (CEQ, 1997), the potential cumulative impacts to the CESA for all of the resources presented and evaluated in Chapter 4, are discussed below.

5.5.1 Air Quality

Past actions that have had direct and temporary impacts to air quality, specifically particulate levels from fugitive dust, include mining operations, mineral exploration, grazing, wild horses, wildfires, and recreation (especially off-road vehicle use). The sources of fugitive dust are typically from any surface disturbance by either animal or man. Wind then erodes the disturbed soils and disperses the dust and debris. In the case of mineral exploration and development, the sources of fugitive dust included clearing, earth moving, drilling, and wind erosion from waste rock dumps and growth media stockpiles.

Direct and temporary impacts to past air quality relating to gaseous pollutants included mineral exploration and recreation from equipment exhaust emissions, including mobile equipment and light vehicles. In addition, the Tonkin Springs Mine may have temporarily contributed chemical vapor emissions during the beneficiation of ores. These sources would have impacted air quality within the CESA.

Present actions affecting air quality through either fugitive dust and gaseous emissions include the activities identified above, including exploration activities occurring within the Project Area.

Fugitive dust and vehicular combustion engine emissions associated with mineral exploration and development, dispersed recreation (e.g., OHV), and fire fuels treatments/fire rehabilitation is likely within the next two to three years. These types of operations would have direct and temporary, effects on air quality that would be limited in duration to the life of the operations. Expectations are that the present activities described above would also continue into the future.

Cumulative impacts to air resources within the CESA would result from the present actions, and RFFAs when combined with the Proposed Action. However, air pollutant emissions created by most of these actions would be regulated by the BAPC, and air resource impacts would be reduced to levels that are consistent with the ambient air quality standards.

5.5.2 Noxious Weeds, Invasive and Non-Native Species

Past actions that have had effects on the occurrence and spread of noxious weeds, invasive and non-native species include mining, mineral exploration, livestock and wild horse grazing, and any other activities that involved the disturbance of surface soils and vegetation enough to allow for the establishment of invasive, non-native species. This would also include the use of recreational, off-road vehicles that can not only create surface disturbance, but can transport noxious weeds, invasive and non-native species into the area. Historically, these 'spreading' activities have been completely unregulated activities. Spread of cheatgrass, an invasive species is associated with wildland fires.

The present actions that are affecting the establishment of noxious weeds, invasive and non-native species are the same as the past actions, including the current exploration activities being conducted by USG under the approved notices. In addition, the gathering and removal of livestock and wild horses from the CESA would likely have had the beneficial result of reducing the establishment of invasive, non-native species by reducing seed transport and localized disturbance. Approximately 4,442 acres of disturbance have been approved for mineral activities in the CESA. Reclamation has been performed on a majority of the exploration projects. Surveys of the Project Area have confirmed the presence of white top, Russian and spotted knapweeds, thistle, salt cedar, and perennial pepperweed (though not in the Mine Plan Area). Expectations are that the present activities described above would also continue into the future.

Potential impacts from noxious weeds, invasive and nonnative species as a result of mining, mineral exploration, grazing, dispersed recreation, or loss of native vegetation associated with potential wildland fires could occur in the future. The Proposed Action would affect less than 0.003 percent of the CESA. These impacts would be localized and minimized due to implementation of Environmental Protection Measures and the BMPs. Therefore, impacts from invasive, nonnative species as a result of the Proposed Action in combination with the past and present actions and RFFAs would be minimal.

5.5.3 Wastes, Hazardous and Solid

Past actions that have had impacts to hazardous and solid materials include mining operations, mineral exploration, wildland fire suppression, and dispersed recreation (especially off-road vehicle use).

The Tonkin Springs Mine previously used hazardous materials and generated solid wastes. These sources have since been removed from site, remediated or disposed of at approved facilities.

Present actions that are affecting hazardous materials and solid waste include the actions identified above, including the mineral exploration activities being conducted by TSL. Currently, USG handles solid waste and hazardous materials, like fuel, according to state and federal regulations and BMPs. Any spills of petroleum products would be cleaned up and reported according to state regulations. Solid waste would be disposed at an off site approved facility.

Mining activities, dispersed recreation, and wildland fire suppression efforts would have the potential to create the presence of wastes within the CESA.

There is potential for the creation of wastes within the CESA as a result of the past, present, and RFFAs when combined with the Proposed Action. However, cumulative impacts from hazardous and solid wastes would be limited due to implementation of the Environmental Protection Measures and BMPs throughout the short life of the Project.

5.5.4 Water Quality – Drinking, Surface and Groundwaters

5.5.4.1 Drinking Water

There are no designated drinking water resources identified within the Project Area or Mine Plan Area. No cumulative impacts to drinking water would occur.

Past actions that could impact water resources (surface water and groundwater) would have included mining activities, grazing, dispersed recreation, fire fuels treatments, and wildland fire suppression efforts that introduced sediment to ephemeral streams or springs or that consumed water within the immediate watershed. There are no specific data that quantify the amount of sedimentation.

A total of 4,442 acres of disturbance are approved for mineral activities. Some of this disturbance has been reclaimed or has naturally stabilized and revegetated over the years, thereby limiting the amount of sedimentation generated by this disturbance.

Potential impacts to water quality could result from mining activities, grazing, or dispersed recreation in the future. There are no specific data on the amount of sedimentation that could result from these activities. However, mining operations would be required to have spill prevention plans, stormwater pollution prevention plans, handle hazardous substances in accordance with NDOT and MSHA, adhere to NAC 534.4369 and 534.4371, and utilize BMPs, thus minimizing potential impacts to water quality. Based on the above analysis and findings from Chapter 4, impacts to water quality from the Proposed Action in combination with the past and present actions and RFFAs would be negligible.

5.5.5 Wildlife (Including Threatened And Endangered Species, Special Status Species, And Migratory Birds).

Past actions that have had effects on wildlife include livestock grazing, mineral exploration and mining, water developments/range improvements, dispersed recreation, and wildfires. While most result in the degradation of suitable habitat for wildlife, TES species, and migratory birds, wildfires have an added long-term benefit of creating new forage and habitat for some animals following reseeding and reclamation activities although with a concomitant temporary short-term decrease in habitat and forage. Fire treatments would have reduced the impacts to wildlife compared to a wildland fire.

The present actions that may be affecting wildlife and TES species are the same as the past actions, including the current mineral exploration activities being conducted by TSL. Approximately 4,442 acres were disturbed by mineral exploration in the CESA. Reclamation has been performed on a majority of the exploration projects, which has resulted in early stages of vegetation reestablishment and habitat restoration. Greater sage-grouse, migratory birds, and other special status species could also occur in the CESA and may have been impacted by past and present actions and loss of habitat due to fire. Impacts of present actions on greater sage-grouse as well as migratory birds are monitored and evaluated in the form of surveys to detect their presence and allow for mitigation through avoidance.

Potential impacts to wildlife from grazing, piñon-juniper thinning, dispersed recreation, or loss of habitat associated with potential wildland fires could occur in the future. In addition, noise from these activities could affect wildlife. There are no specific data on the potential impacts to habitat from grazing, dispersed recreation, or wildland fires. Impacts to wildlife from the Proposed Action would be limited to the removal of vegetation or destruction of habitat, and noise associated with exploration. These impacts would be localized and minimized due to implementation of Environmental

Protection Measures and BMPs. In addition, the piñon-juniper thinning proposed by the BLM is intended to improve wildlife habitat.

The Proposed Action would affect less than 0.003 percent of the CESA. No cumulative impacts to listed threatened or endangered species would occur as these species do not occur within the Project Area. Impacts to special status species or their habitat from the Proposed Action in combination with the past and present actions and RFFAs would be minimal.

5.6 No Action Alternative

The No-Action Alternative would prevent the disturbance of an additional 0.2 acres on public land under the Proposed Action. This acreage constitutes less than 0.003 percent of the CESA. Therefore, combined impacts of the No-Action Alternative, past and present actions, and other RFFAs would not contribute to impacts to the aforementioned resources.

5.7 Irreversible and Irretrievable Commitment of Resources

No irreversible and irretrievable commitment of resources is expected.

6.0 Mitigation and Monitoring

6.1 Proposed Mitigation

No additional mitigation is proposed as a result of the impact analysis. Environmental Protection Measures and Best Management Practices, which are part of the Proposed Action, serve to mitigate anticipated impacts.

6.2 Proposed Monitoring

No additional monitoring is proposed as a result of the impact analysis.

7.0 CONSULTATION AND COORDINATION

The scope of this EA was developed through consultation with BLM resource specialists (meetings and subsequent conversations); consultation with other local, state, and federal agency resource personnel; review of project proponent and agency files; field reconnaissance; and review of supporting documentation.

7.1 List of Preparers

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The following persons, groups, and agencies were contacted during the preparation of this document.

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7.2.2 Nevada Natural Heritage Program

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7.2.3 Nevada Bureau of Mining Regulation and Reclamation

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SRK Consulting (U.S.), Inc. (SRK). 2006c. *Engineering Design Report for Interim Water Management*, unpublished report prepared for Tonkin Springs, LLC and submitted to the Nevada Division of Environmental Protection on September 8, 2006.

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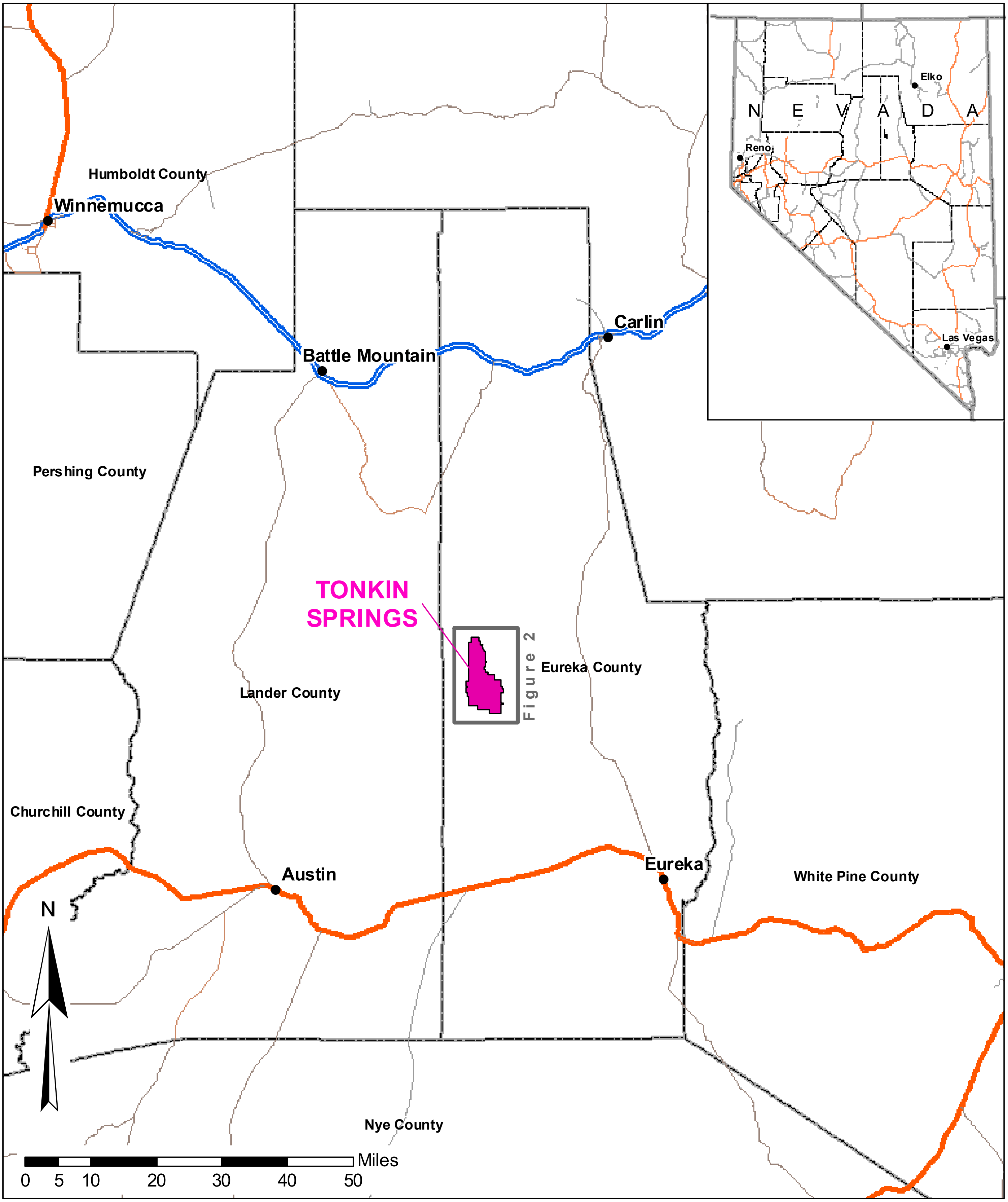
The following federal statutes were reviewed during the preparation of this environmental assessment:

- American Indian Religious Freedom Act 1978 (42 U.S.C. 1996)
- Clean Water Act of 1977 (33 U.S.C. 1251 *et seq*.)
- Clean Air Act as amended (42 U.S.C. 7401 *et seq*.)
- Comprehensive Environmental Response, Compensation, and Liability Act of 1980 as amended (42 U.S.C. 9615)
- Endangered Species Act of 1973 as amended (16 U.S.C. 1531)

- Executive Order 11988, as amended, Floodplain Management. May 24, 1977.
- Executive Order 11990, Protection of Wetlands. May 24, 1977.
- Executive Order 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations. February 11, 1994.
- Executive Order 13186, Responsibilities of Federal Agencies to Protect Migratory Birds. January 10, 2001.
- Federal Land Policy and Management Act of 1976. (43 U.S.C. 1701 *et seq*.)
- National Historic Preservation Act as amended (16 U.S.C. 470)
- Public Rangelands Improvement Act of 1978
- Resource Conservation and Recovery Act of 1976 (42 U.S.C. 6901 *et seq*.)
- Safe Drinking Water Act as amended (42 U.S.C. 300f et seq.)
- Surface Mining Control and Reclamation Act of 1977 (30 U.S.C. 1201 *et seq*.)
- Wild and Scenic Rivers Act as amended (16 U.S.C. 1271)
- Wilderness Act of 1964 (16 U.S.C. 1131 *et seq*.)

Figures



- City
- Freeway
- Highway
- Major Road

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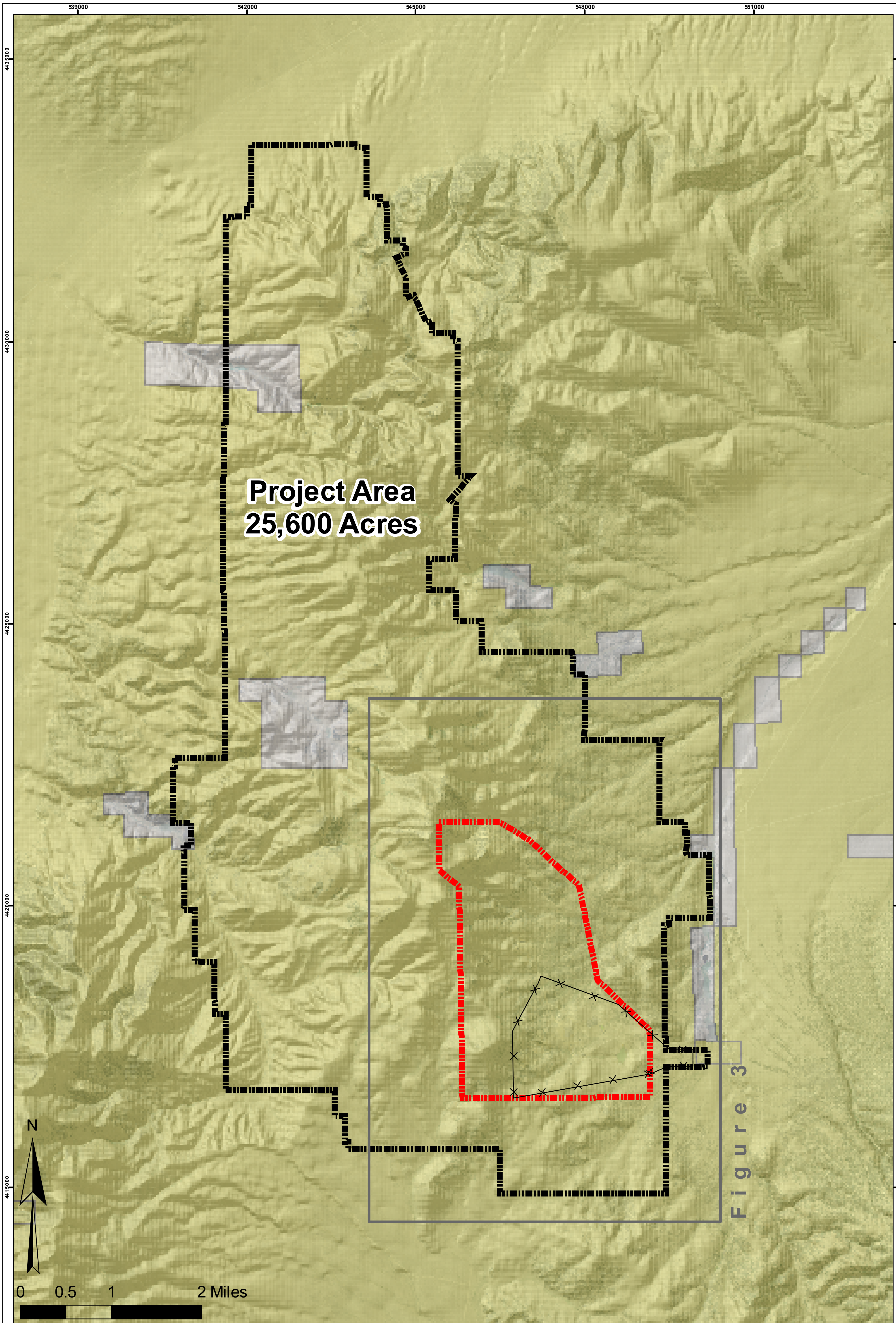
TONKIN SPRINGS
2008 PoO AMENDMENT
ENVIRONMENTAL ASSESSMENT

Figure 1

PROJECT LOCATION



Project Area
Mine Plan Area
Fence
Public
Private
Figure 3

Datum: NAD 83 Zone 11, UTM, Meters

1:60,000

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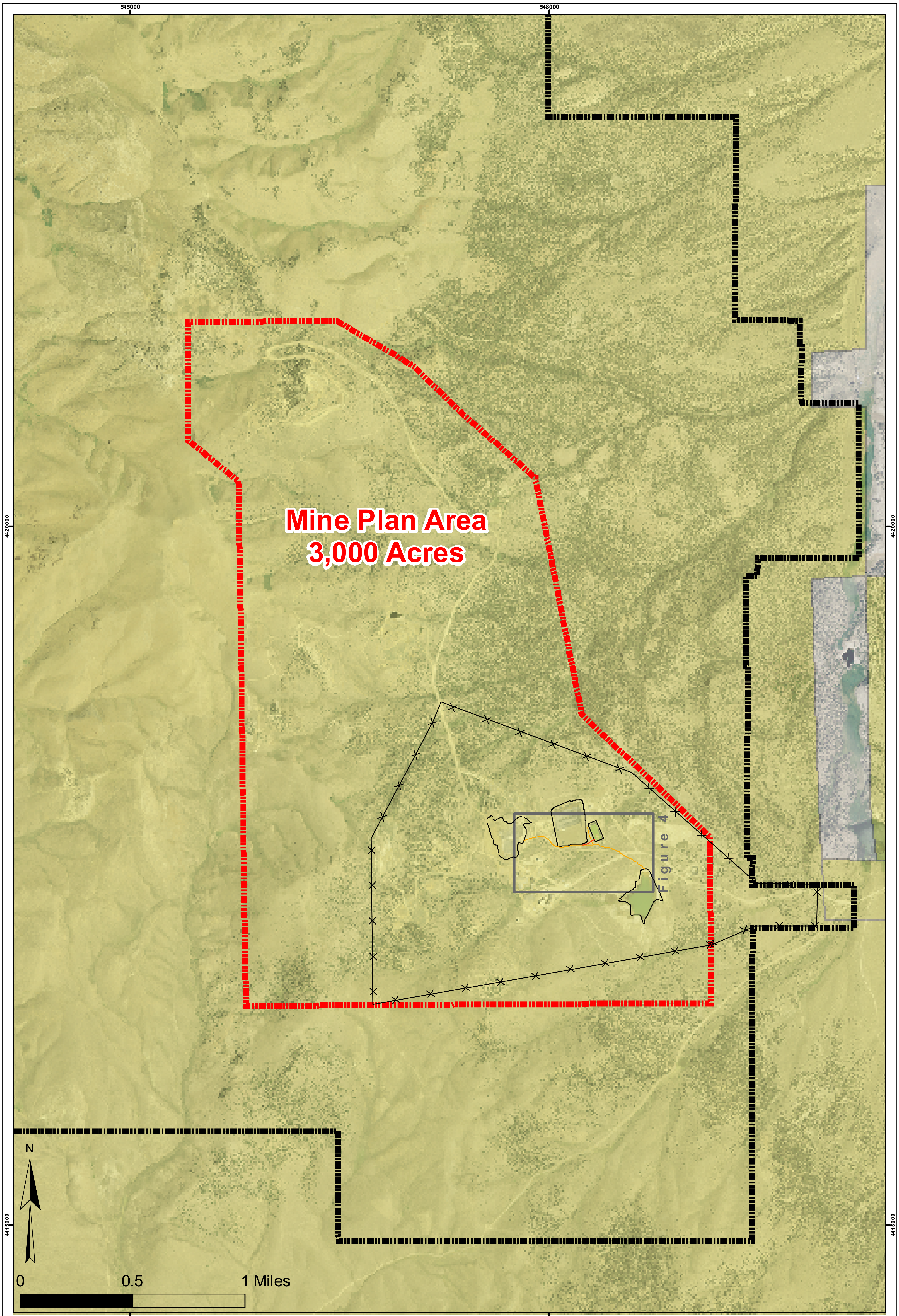
TONKIN SPRINGS
2008 PoO AMENDMENT
ENVIRONMENTAL ASSESSMENT

Figure 2

PROJECT BOUNDARY



Project Area
Mine Plan Area
Fence
Public
Private
Figure 4

Datum: NAD 83 Zone 11, UTM, Meters

1:24,000

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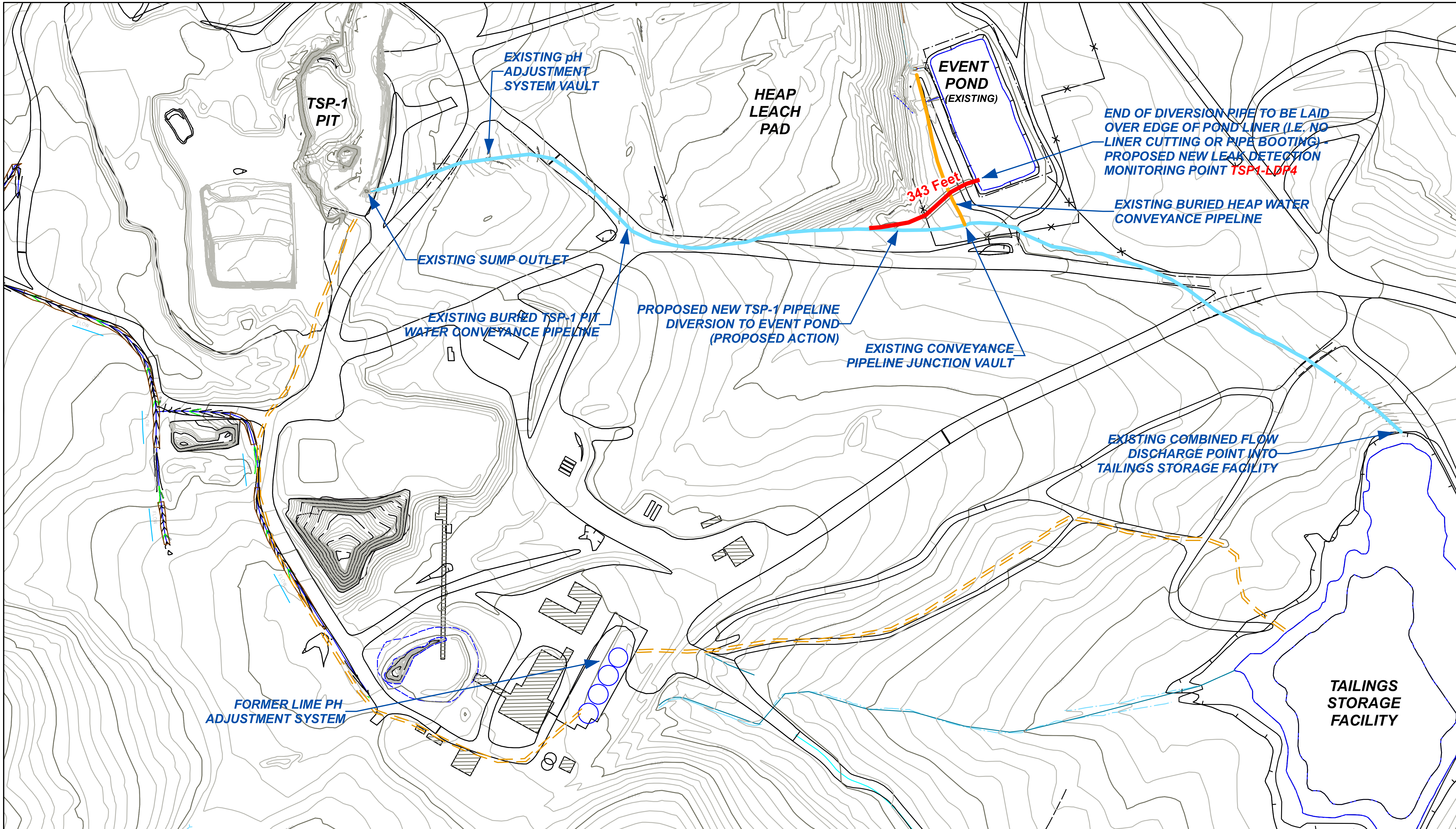
ENVIRONMENTAL ASSESSMENT

Figure 3

MINE PLAN AREA



Fence

Proposed Pipeline

Current pH Adjustment System Pipeline

Heap Effluent Collection Pipeline

Former pH Adjustment System Contingency Pipeline

Datum: NAD 83 Zone 11, UTM, Meters

0 100 200 400 Feet

1:3,000

N

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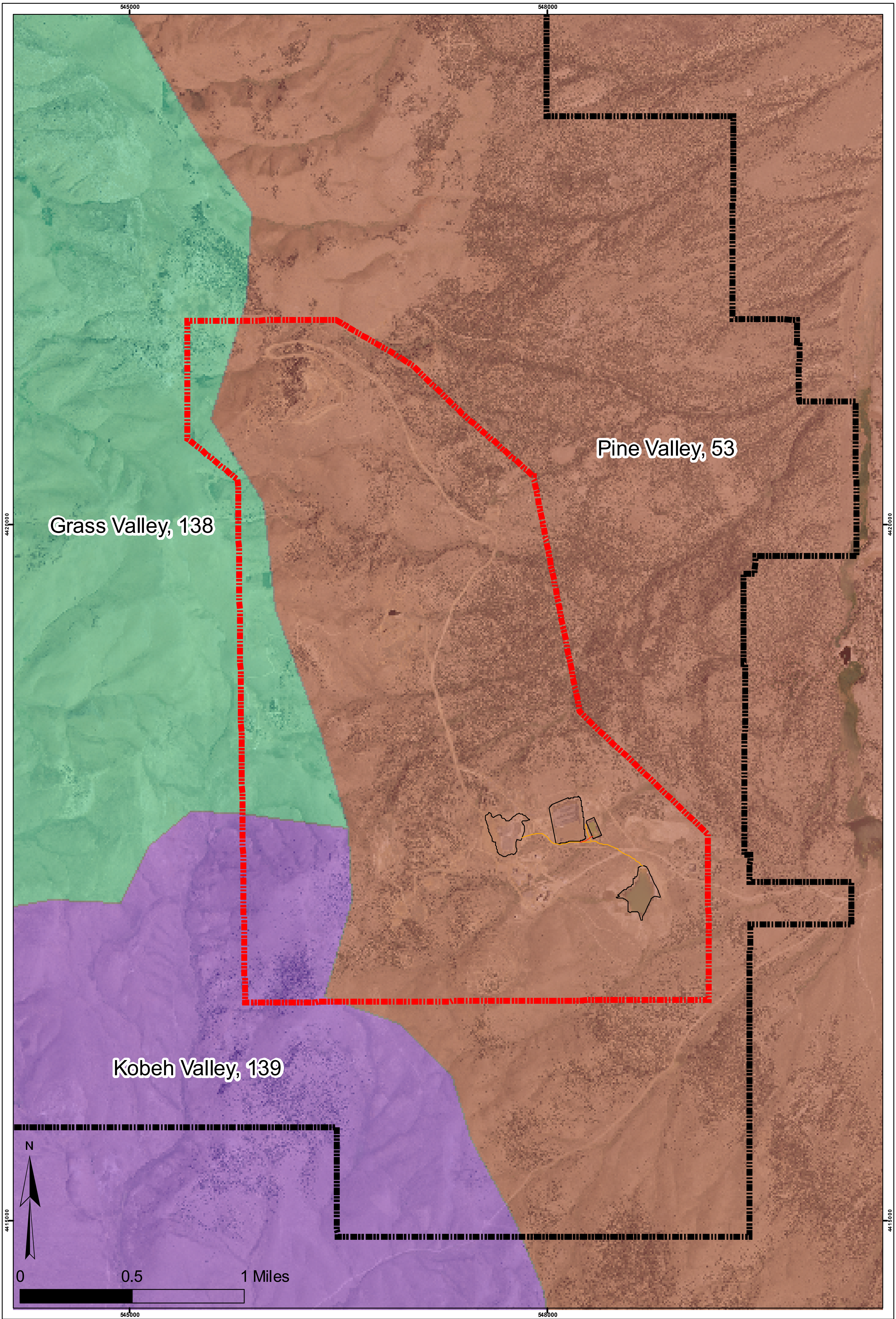
TONKIN SPRINGS
2008 PoO AMENDMENT
ENVIRONMENTAL ASSESSMENT

Figure 4

PROPOSED ACTION



Project Area
Mine Plan Area

Datum: NAD 83 Zone 11, UTM, Meters

1:24,000

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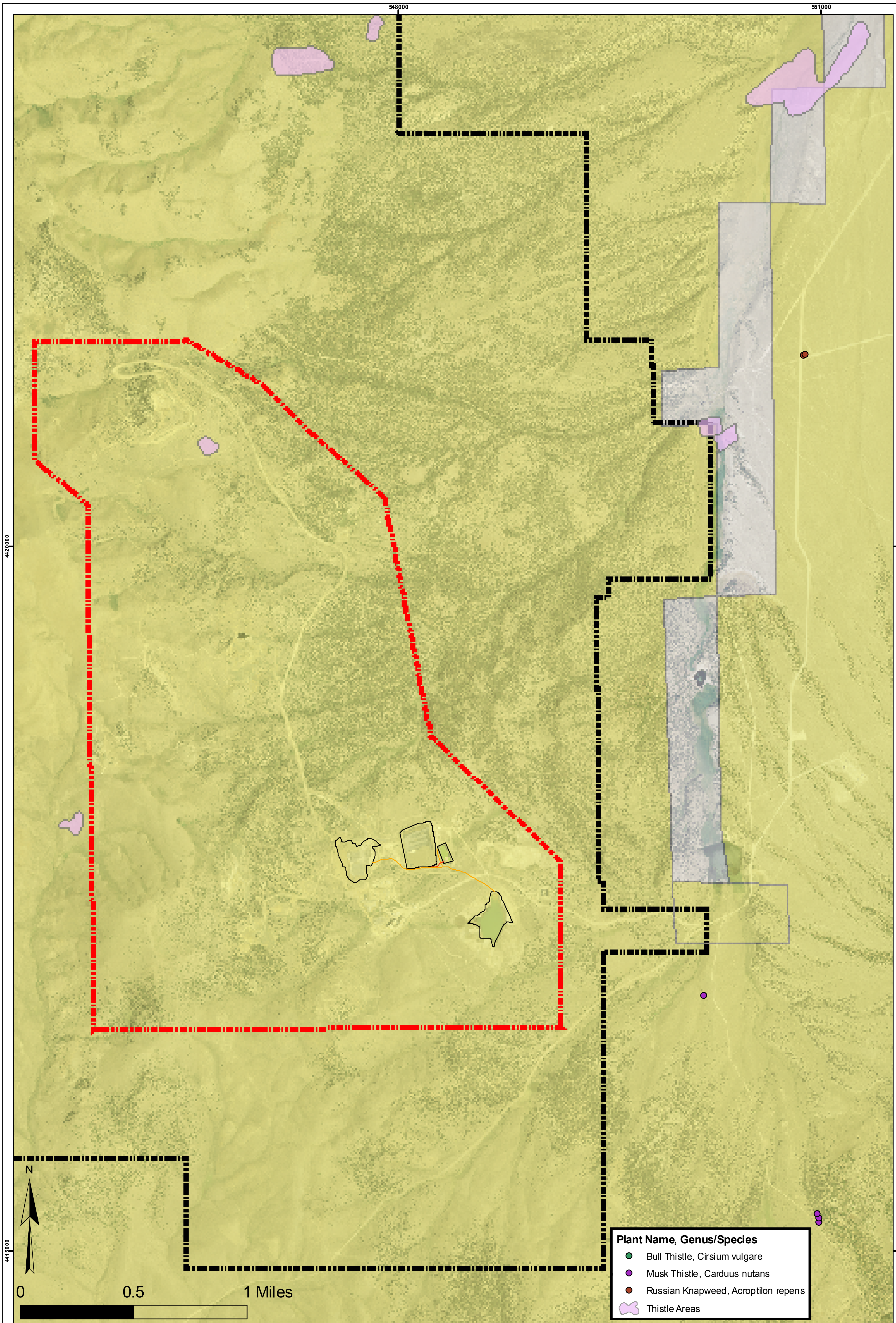
ENVIRONMENTAL ASSESSMENT

Figure 5

HYDROGRAPHIC BASINS



Project Area
Mine Plan Area
Public
Private

Datum: NAD 83 Zone 11, UTM, Meters 1:24,000

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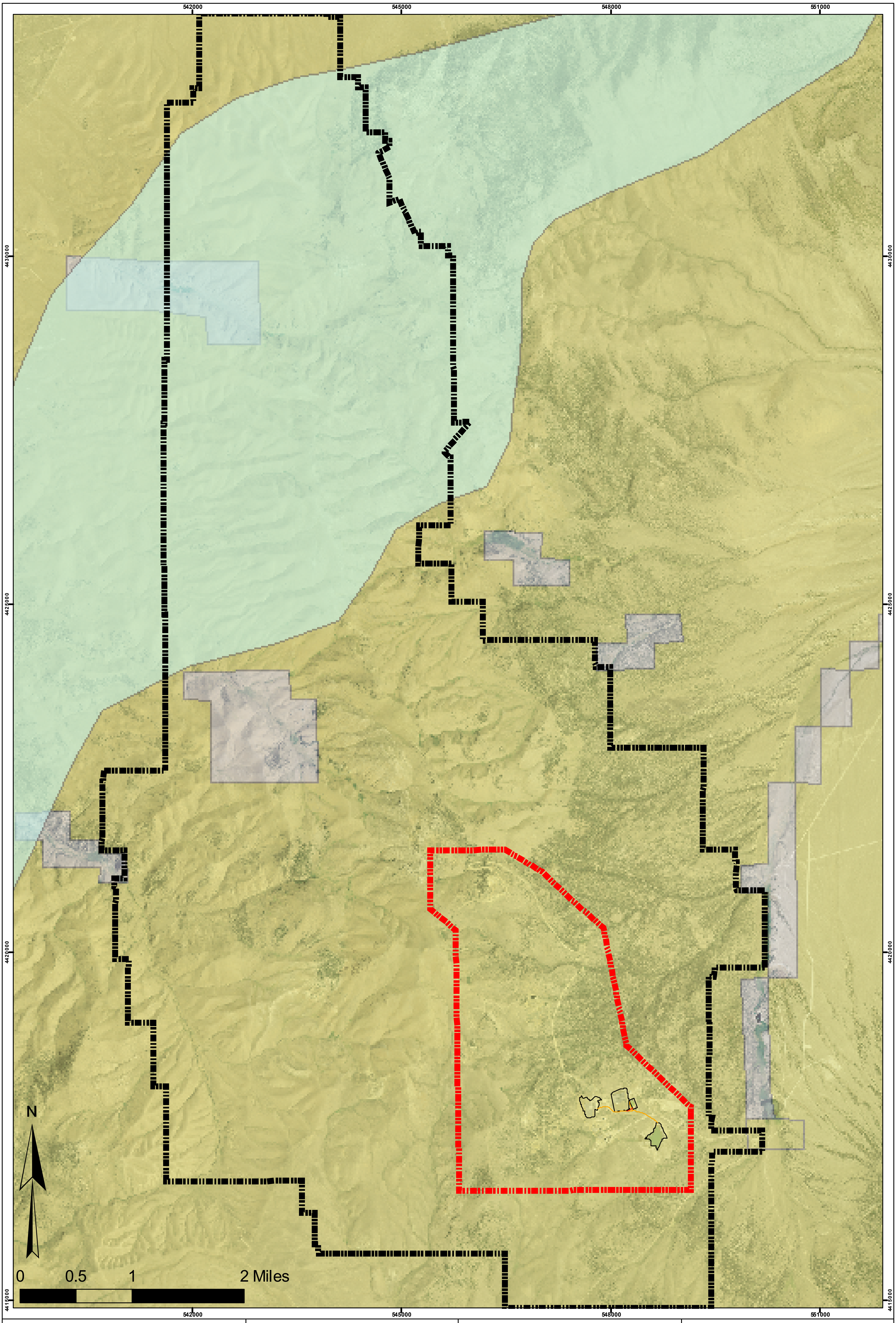
2008 PoO AMENDMENT
ENVIRONMENTAL ASSESSMENT

Figure 6

INVASIVE, NON-NATIVE SPECIES INVENTORY



Project Area
Mine Plan Area
Winter Range
Public
Private

Datum: NAD 83 Zone 11, UTM, Meters

1:48,000

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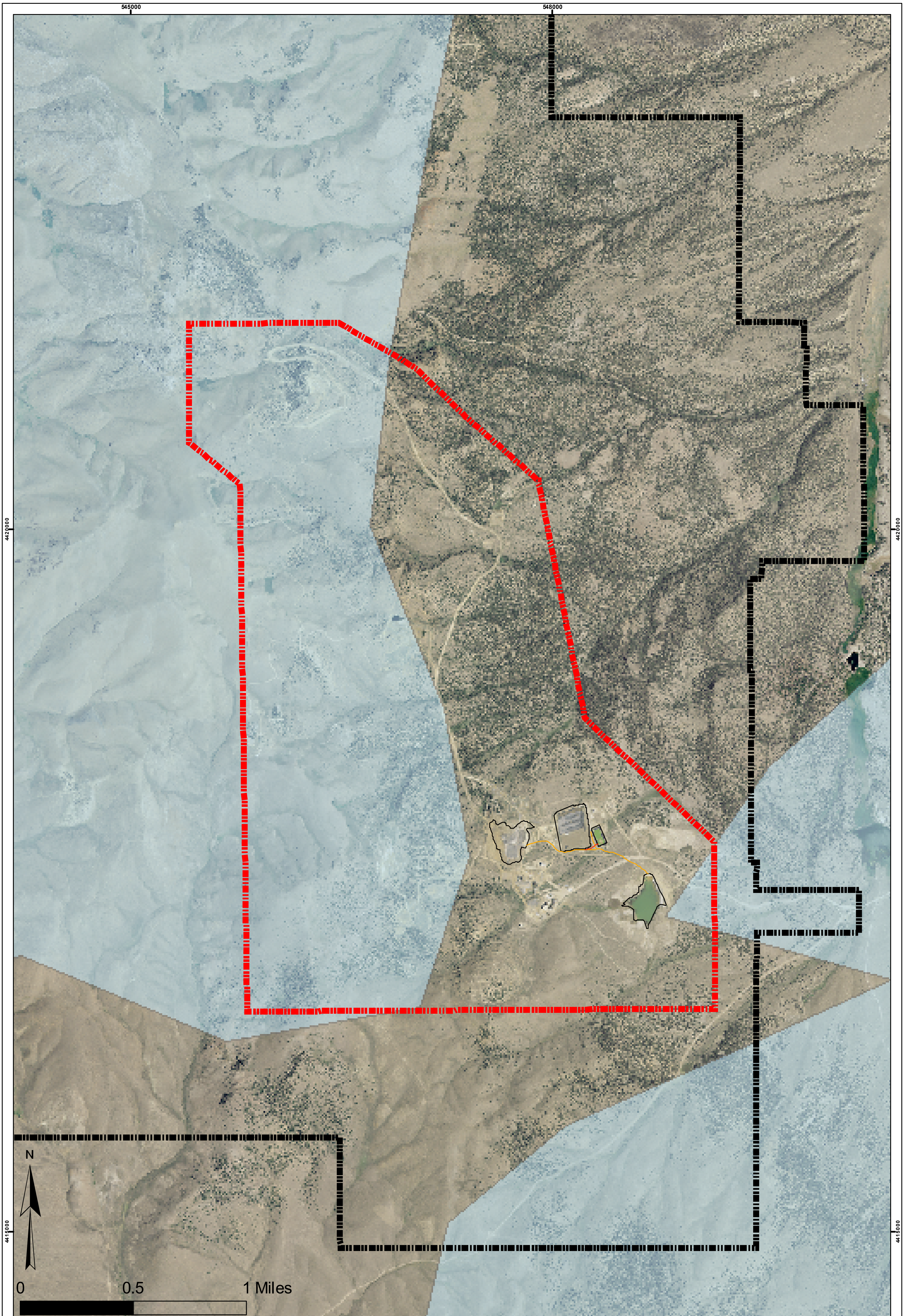
ENVIRONMENTAL ASSESSMENT

Figure 7

MULE DEER RANGE



Project Area
Mine Plan Area
Bighorn Sheep Range

Datum: NAD 83 Zone 11, UTM, Meters

1:24,000

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TONKIN SPRINGS
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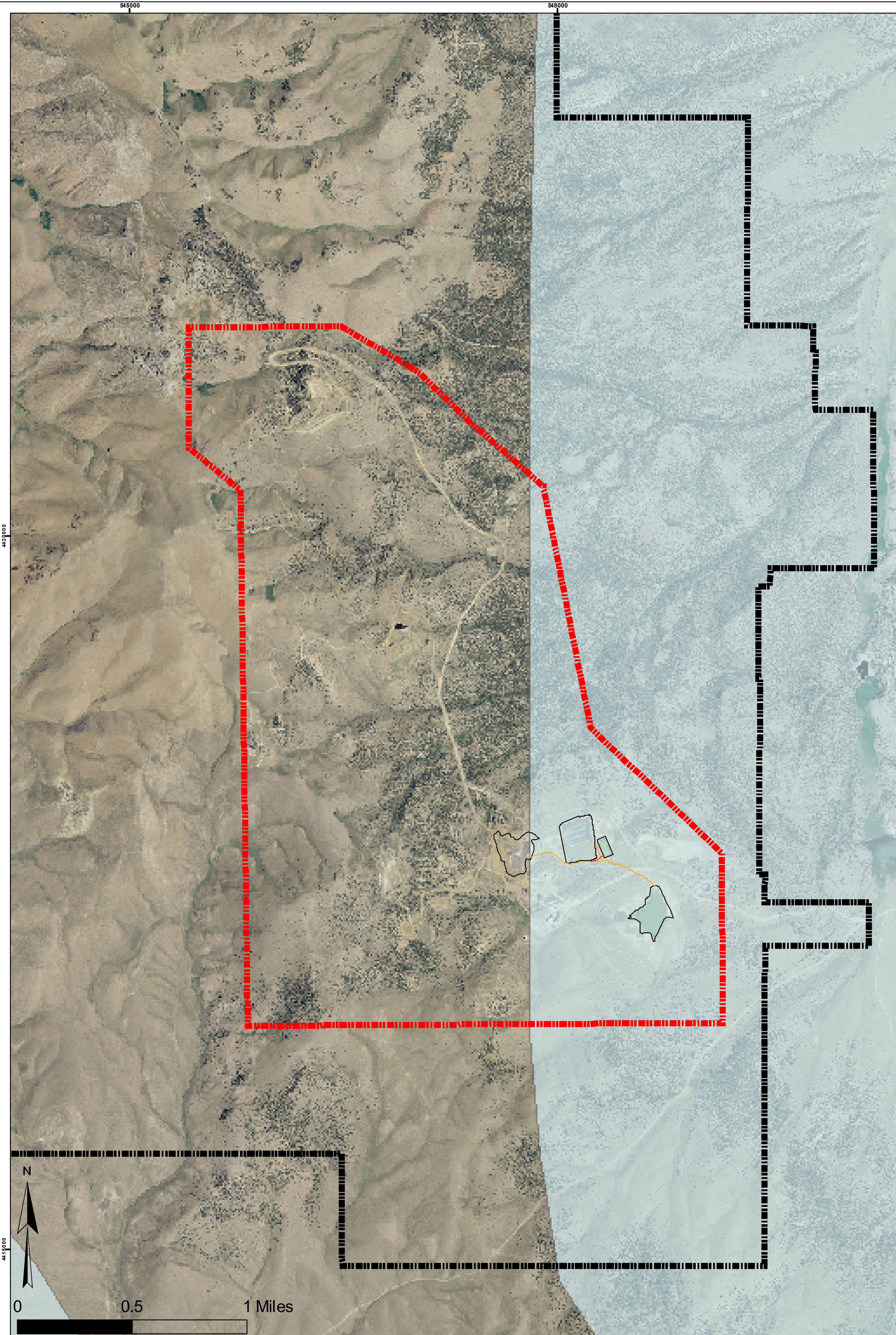
ENVIRONMENTAL ASSESSMENT

Figure 8

BIGHORN SHEEP RANGE



Project Area
Mine Plan Area
Pronghorn Antelope Range

Datum: NAD 83 Zone 11, UTM, Meters
1:24,000

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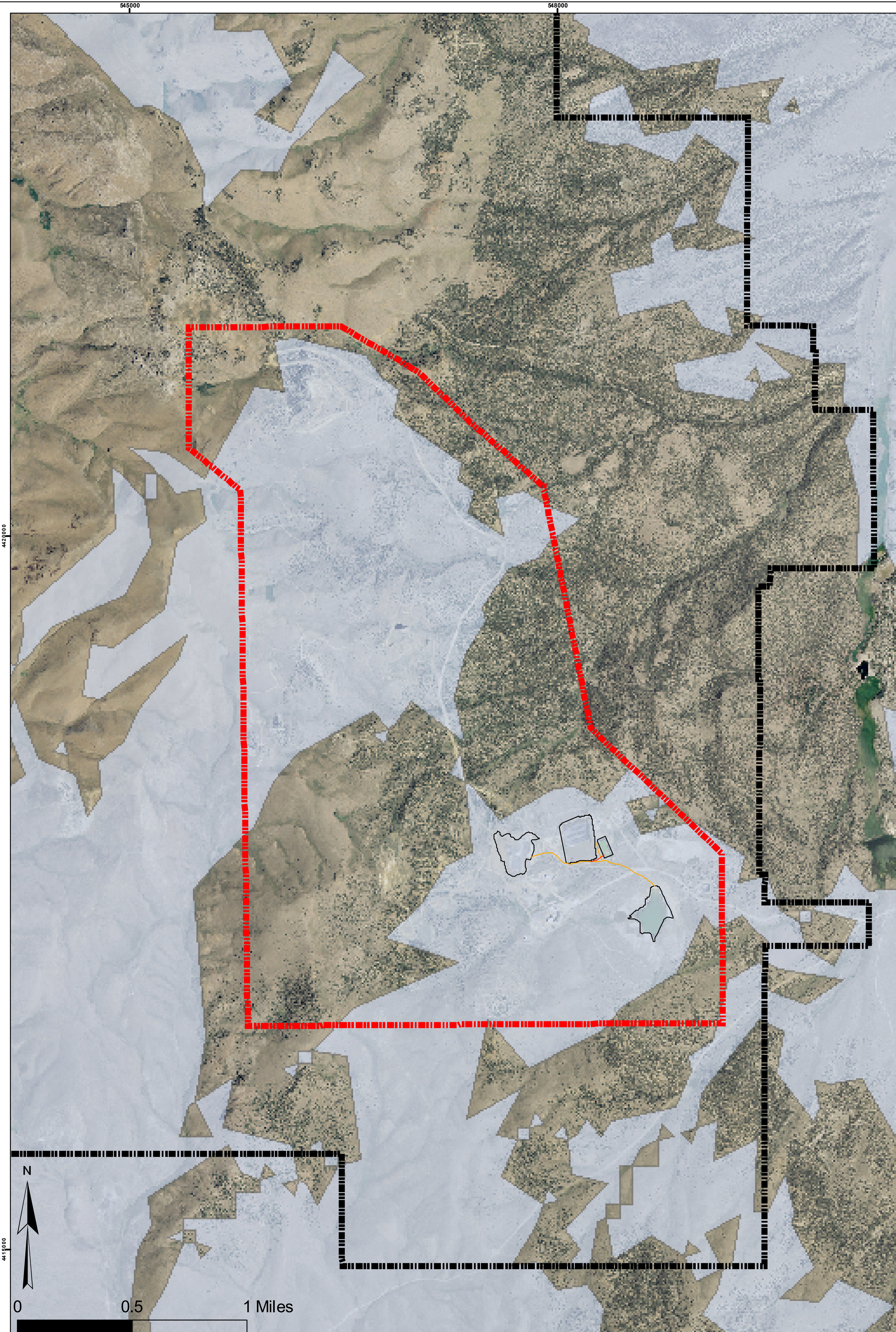
TONKIN SPRINGS
2008 PoO AMENDMENT
ENVIRONMENTAL ASSESSMENT

Figure 9

PRONGHORN ANTELOPE RANGE



Project Area
Mine Plan Area
Rabbit Range

Datum: NAD 83 Zone 11, UTM, Meters 1:24,000

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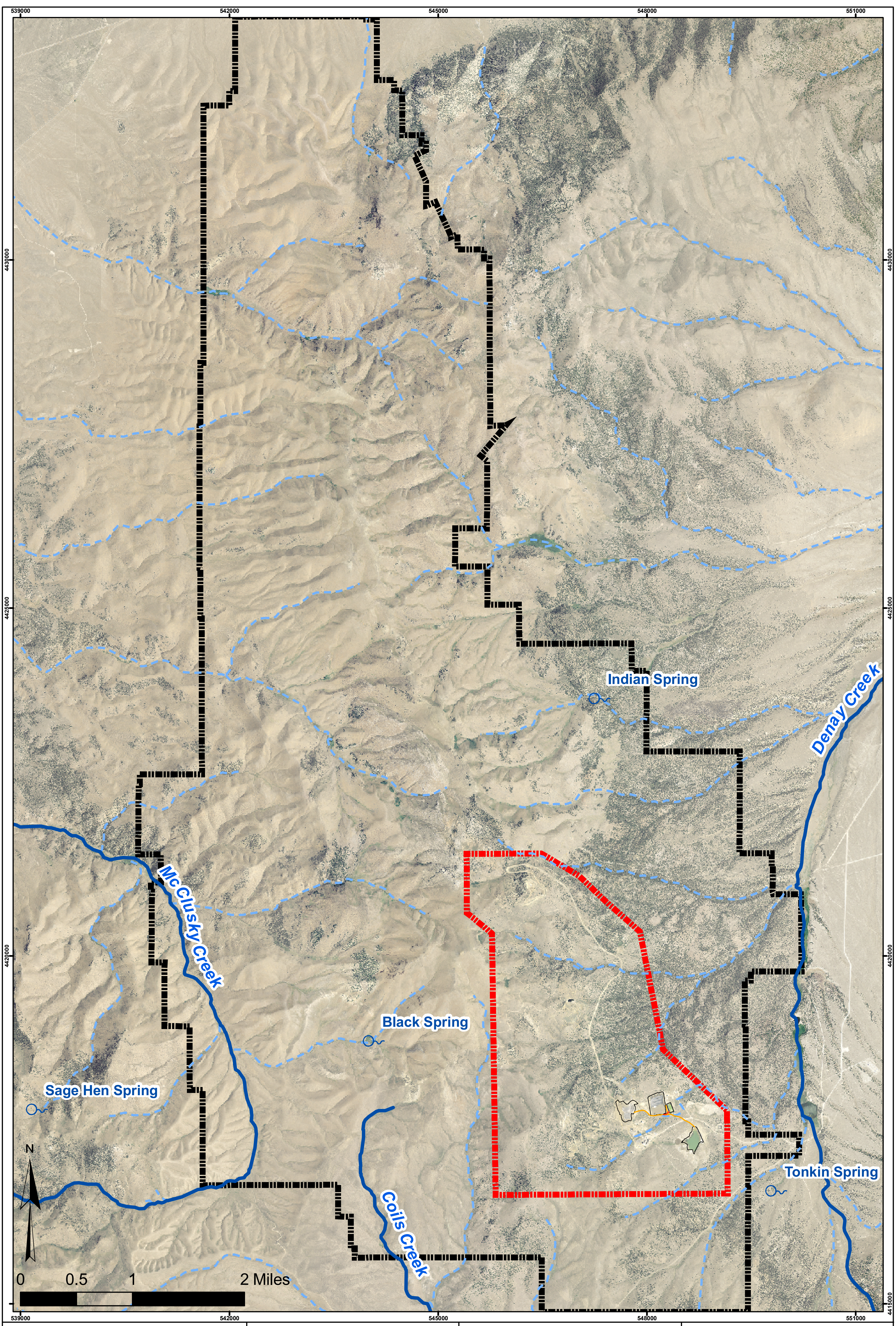
ENVIRONMENTAL ASSESSMENT

Figure 10

PYGMY RABBIT RANGE



Project Area
Mine Plan Area
Springs
Streams
Ephemeral Drainage

Datum: NAD 83 Zone 11, UTM, Meters 1:48,000

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Mount Lewis Field Office

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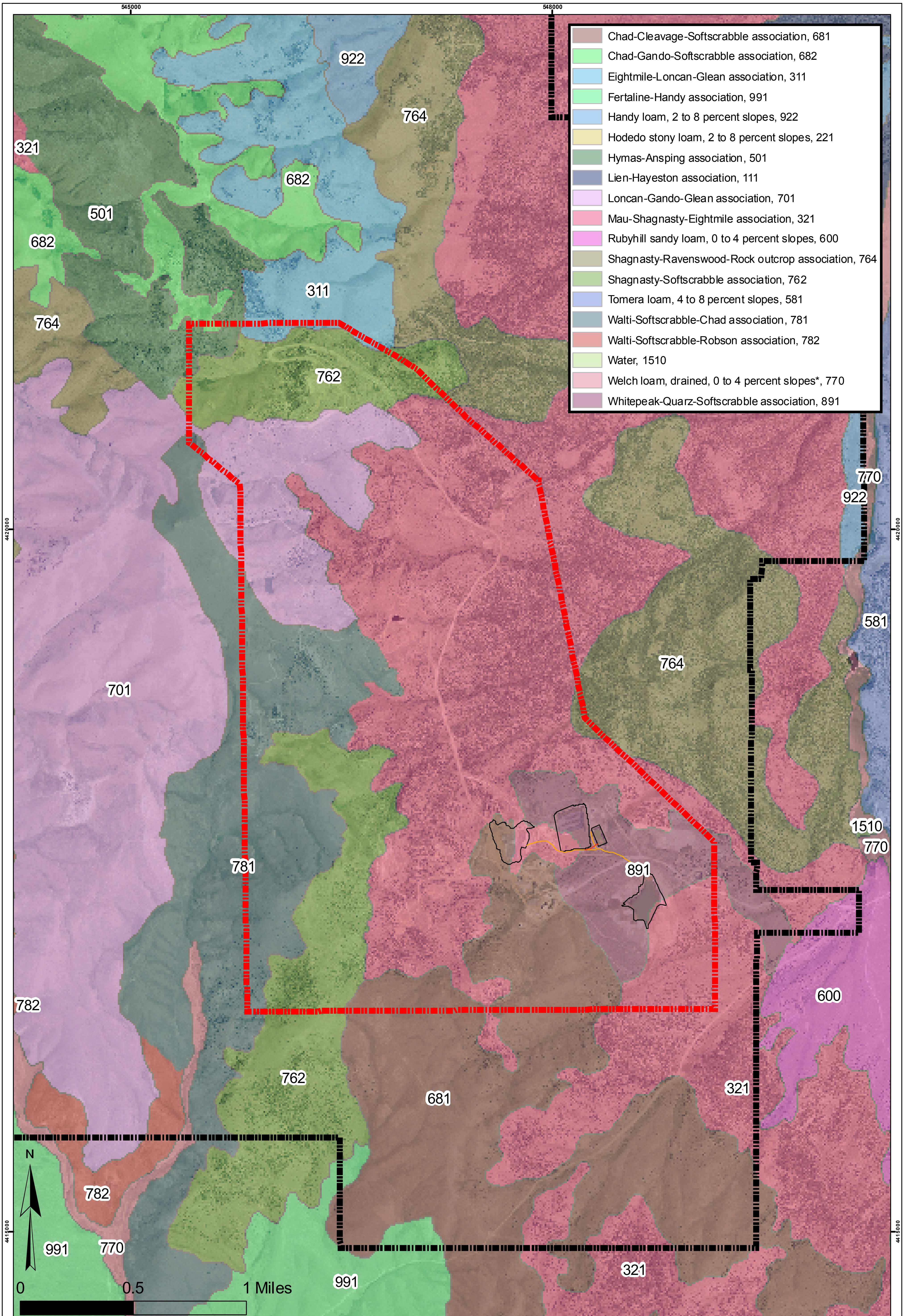
2008 PoO AMENDMENT
ENVIRONMENTAL ASSESSMENT

Figure 11

SURFACE WATER



Project Area
Mine Plan Area

Datum: NAD 83 Zone 11, UTM, Meters 1:24,000

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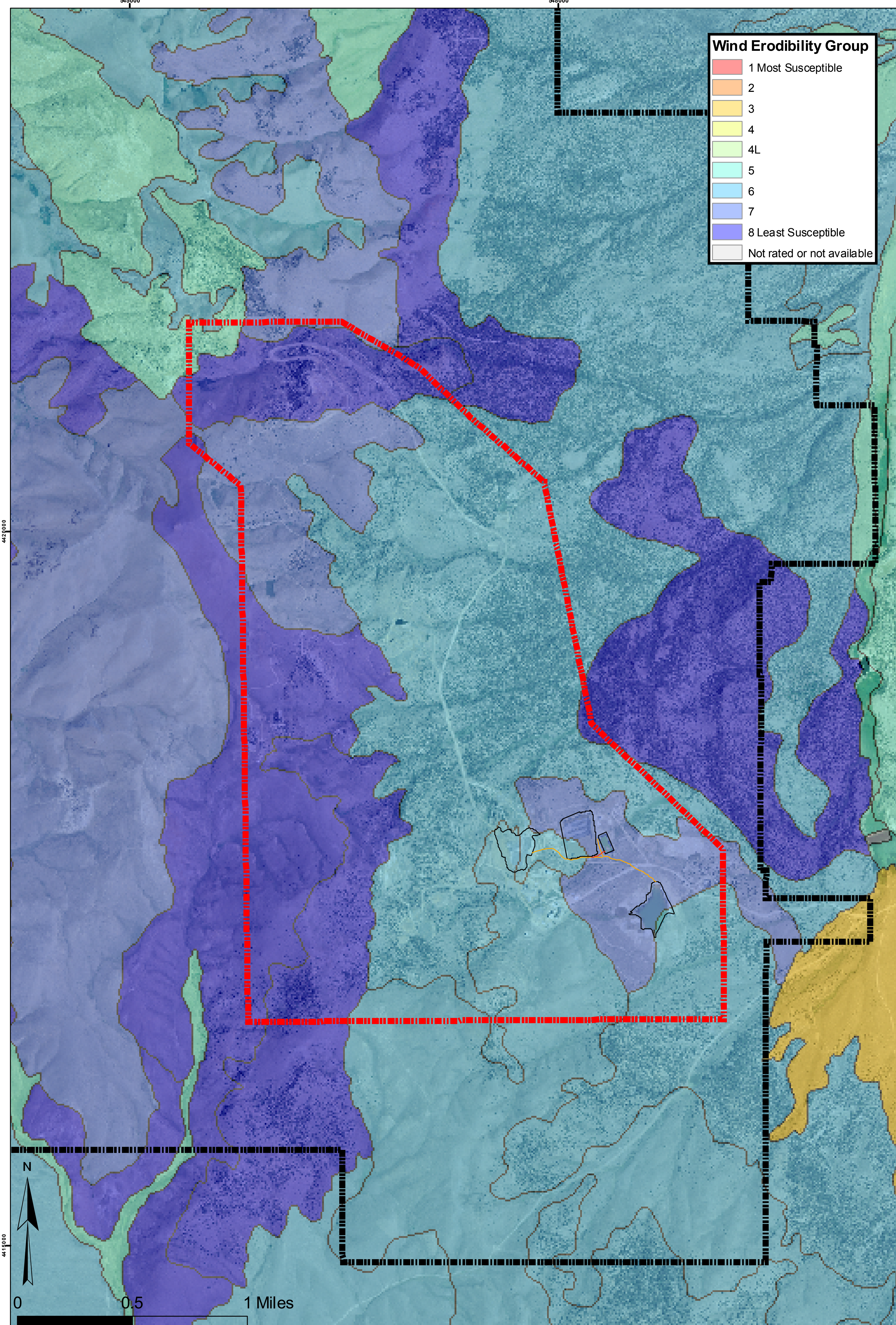
ENVIRONMENTAL ASSESSMENT

Figure 12

SOIL MAP UNITS



Project Area
Mine Plan Area

Datum: NAD 83 Zone 11, UTM, Meters 1:24,000

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2008 PoO AMENDMENT
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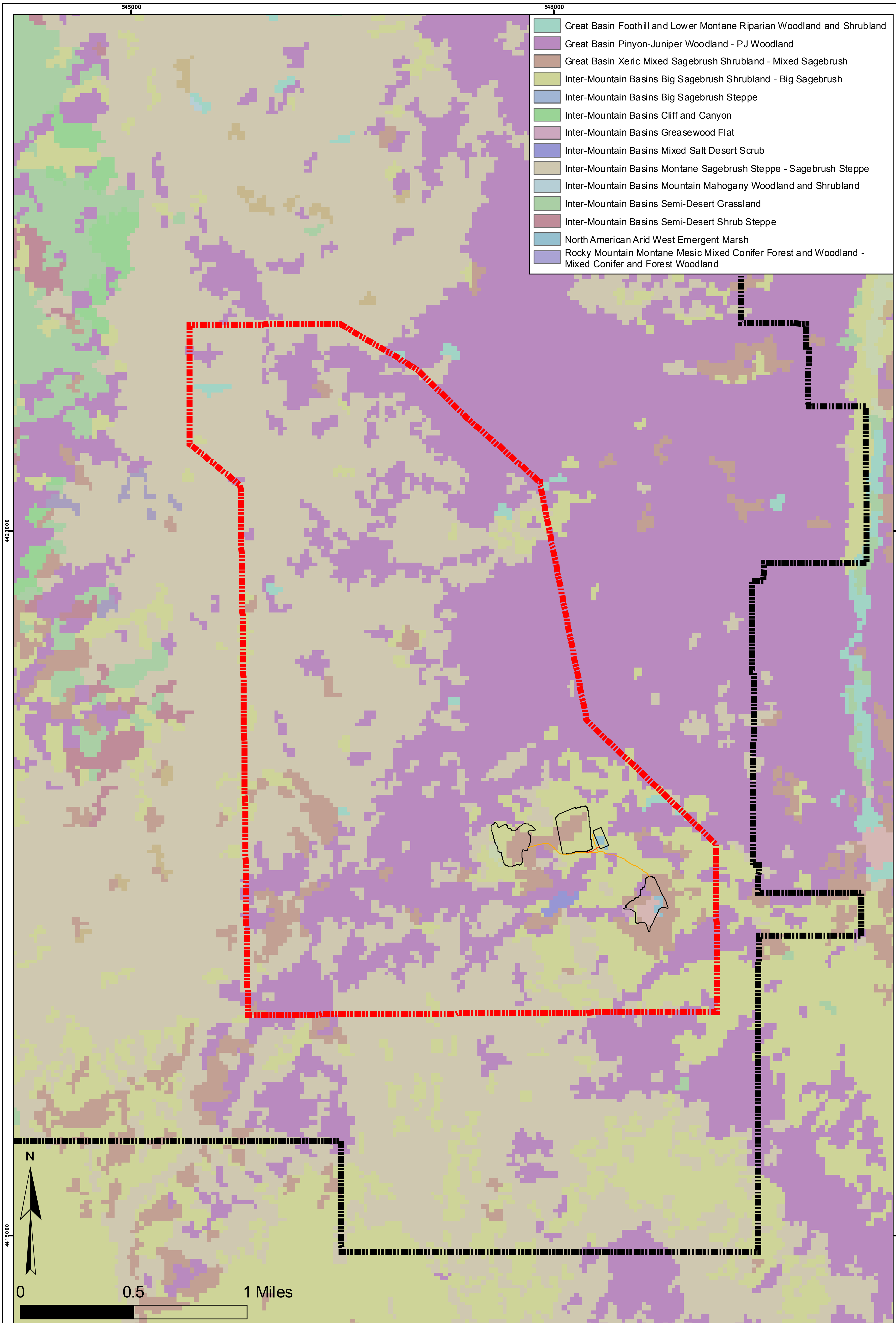
Figure 13

SOIL EROSION POTENTIAL



Project Area
Mine Plan Area

Datum: NAD 83 Zone 11, UTM, Meters 1:24,000

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Mount Lewis Field Office

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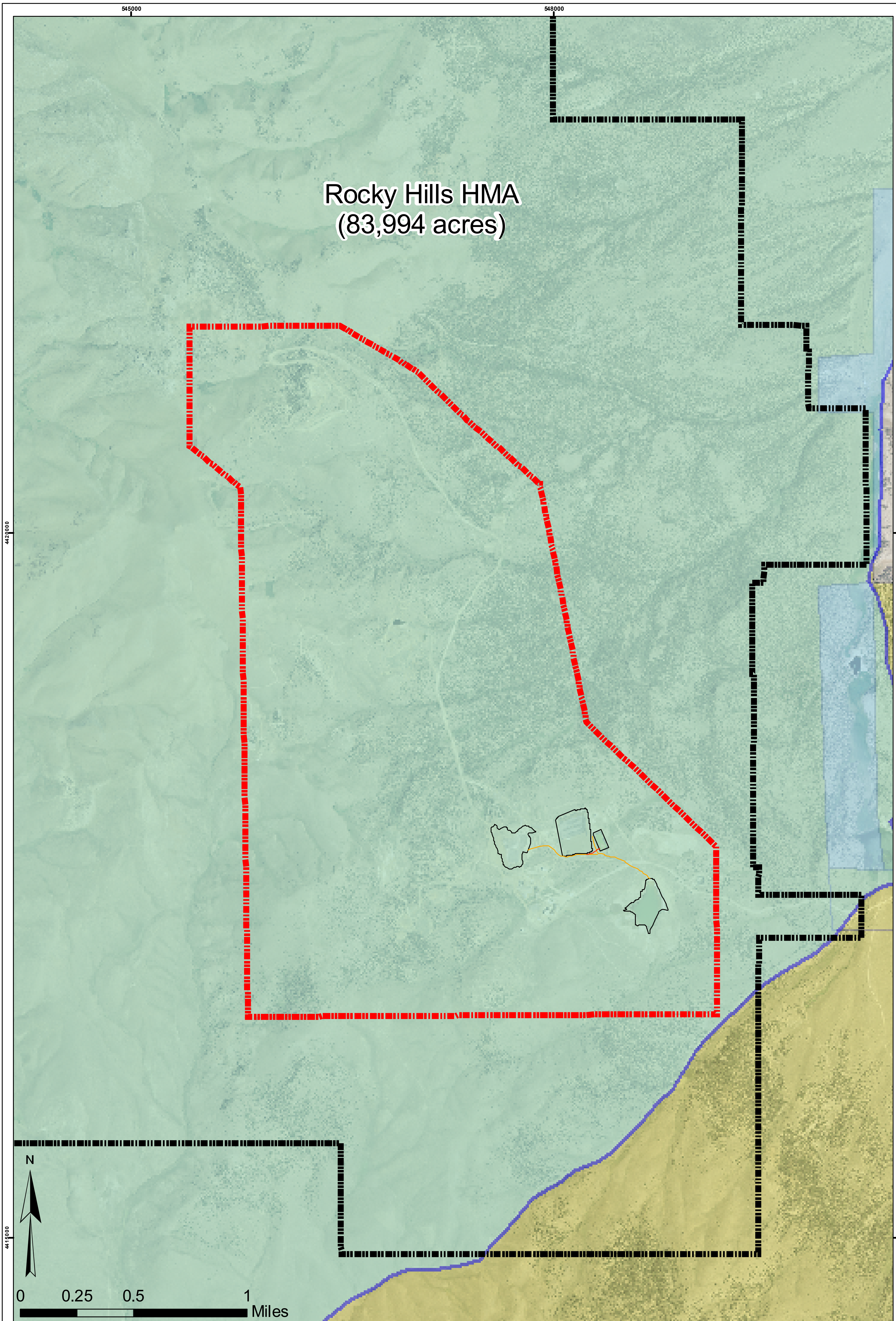
Figure 14

VEGETATIVE COVER TYPE



Project Area
Mine Plan Area
Rocky Hills HMA - NV0605
Public
Private

Datum: NAD 83 Zone 11, UTM, Meters 1:24,000

Bureau of Land Management
Mount Lewis Field Office

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2008 PoO AMENDMENT
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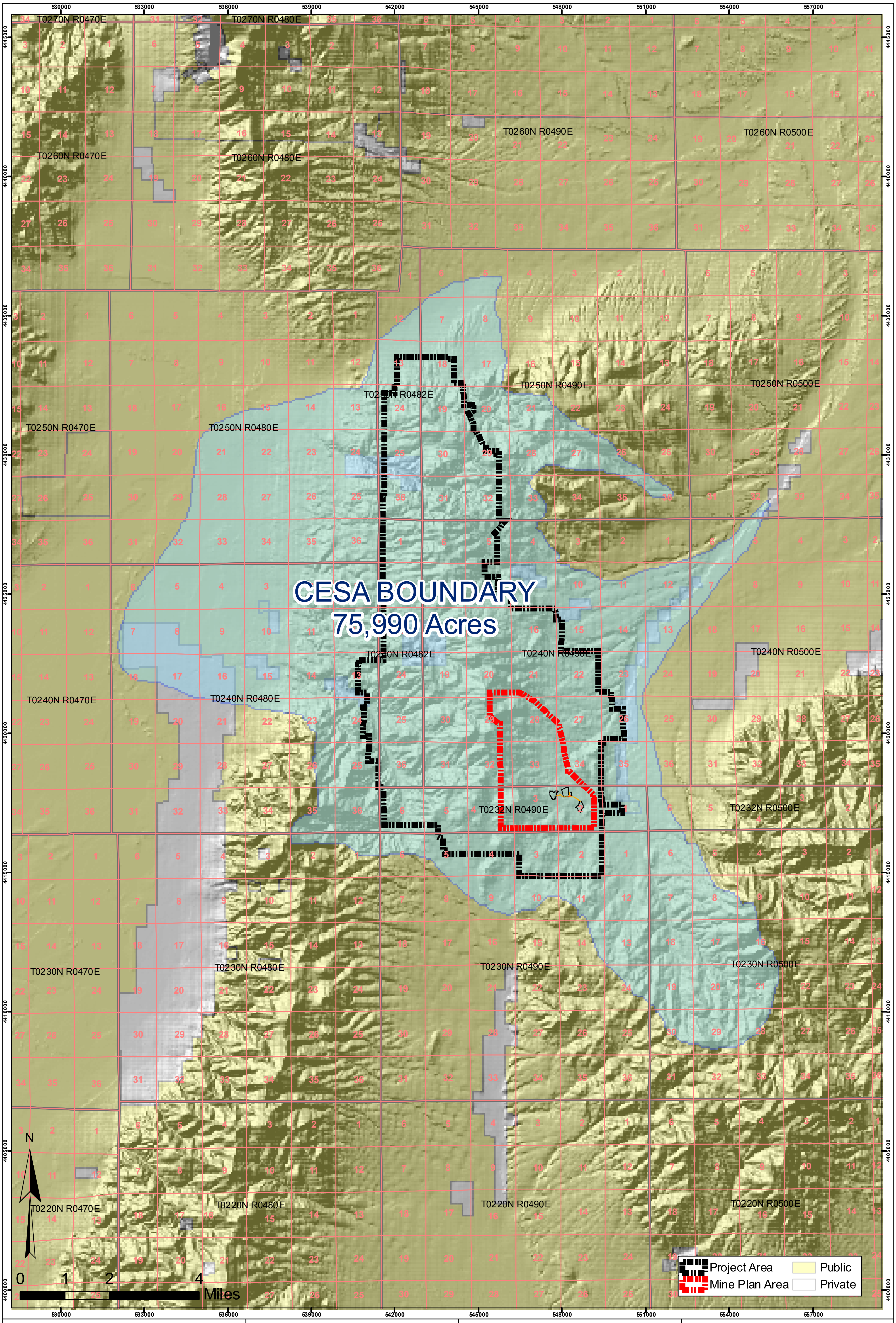
Figure 15

HERD MANAGEMENT AREAS



CESA Boundary - Immediate Watershed

Bureau of Land Management (BLM). 2007. Tonkin Springs Exploration Project- Environmental Assessment NV063-EA06-172. United States Department of the Interior, Bureau of Land Management, Battle Mountain Field Office, Nevada. December, 2007.

Datum: NAD 83 Zone 11, UTM, Meters 1:120,000

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Figure 16

CESA BOUNDARY

Appendix A

Table A-1: Site Water Quality and Ecological Screening-Level Criteria

Chemical Constituent (mg/L)	**TSP-1 NaOH Treated**	**TSP-1 $CaOH_2$ Treated**	**Heap Leach Pad Effluent (HLPE)**	**SLERA Criteria - Mammalian Receptor Species**						**SLERA Criteria - Avian Receptor Species**				
(*Total* unless noted)	5/12/2008	8/24/2006	5/12/2008	**Little Brown Bat**	**White-Footed Mouse**	**Cottontail Rabbit**	**Yellow-bellied Marmot**	**Coyote**	**White-Tailed Deer**	**Red-Tailed Hawk**	**Mallard Duck**	**Canada Goose**	**Common Barn Owl**	**Rough-Winged Swallow**
Aluminum	*3.1*	***16***	*<0.2*	***17.1***	***7.0***	***7.9***	***3.6***	***2.6***	***4.5***	*1,930*	*1,001*	*721*	*1,460*	*471*
Antimony	*<0.01*	*<0.01*	*0.011*	*1.1*	*0.5*	*0.5*	*0.2*	*0.2*	*0.3*	--	--	--	--	--
Arsenic	***2.7***	***1.9***	***0.83***	***1.1***	***0.5***	***0.5***	***0.2***	***0.2***	***0.3***	*90.4*	*87.3*	*63*	*68.4*	*22.1*
Barium	*0.01*	*0.09*	*0.047*	*88.0*	*35.8*	*40.9*	*21.5*	*15.7*	*23.1*	*366*	*175*	*126*	*277*	*89.4*
Beryllium	*<0.01*	*<0.01*	*<0.004*	*10.8*	*4.4*	*5.0*	*2.8*	*2.0*	*2.8*	--	--	--	--	--
Boron	*0.8*	*1.7*	*0.4*	*457*	*186*	*213*	*118*	*86*	*120*	*507*	*479*	*345*	*383*	*124*
Cadmium	*0.05*	*0.03*	*<0.004*	*15.8*	*6.4*	*7.3*	*4.2*	*3.1*	*4.1*	*25.5*	*25.8*	*19*	*19.3*	*6.2*
Calcium	*340*	*930*	*210*	--	--	--	--	--	--	--	--	--	--	--
Chloride	*29*	*7.5*	*90*	--	--	--	--	--	--	--	--	--	--	--
Chromium	*<0.01*	*<0.01*	*<0.004*	*53.6*	*21.8*	*24.9*	*13.8*	*10.1*	*14.1*	*17.6*	*18.3*	*13*	*13.3*	*4.3*
Cobalt	*0.28*	*0.1*	*0.61*	--	--	--	--	--	--	--	--	--	--	--
Copper	*0.05*	*0.11*	*0.011*	*249*	*101*	*116*	*70.0*	*51.0*	*65.2*	*827*	*648*	*466*	*626*	*202*
Cyanide (WAD)	*0.12*	*0.05*	*0.25*	*1,054*	*430*	*491*	*290*	*210.9*	*277*	--	--	--	--	--
Fluoride	***18***	***12***	***2***	*666*	*272*	*310*	*188*	*137*	*175*	*137*	***75.0***	***54***	*104*	***33.5***
Iron	*67*	*24*	*1*	--	--	--	--	--	--	--	--	--	--	--
Lead	*<0.01*	*<0.01*	*<0.004*	*131*	*53.3*	*60.8*	*34*	*24.6*	*34.3*	*67.7*	*33.1*	*24*	*51.3*	*16.5*
Lithium	*<0.4*	*<1*	*<0.4*	*154*	*62.6*	*71.5*	*40*	*28.9*	*40.3*	--	--	--	--	--
Magnesium	*160*	*230*	*49*	--	--	--	--	--	--	--	--	--	--	--
Manganese	*5.5*	*3*	*0.009*	*1,438*	*586*	*669*	*371*	*270*	*377*	*17,540*	*7,047*	*5,072*	*13,270*	*4,284*
Mercury	*<0.0002*	*<0.0002*	*<0.0002*	*21*	*8.7*	*9.9*	*6.0*	*4.4*	*5.6*	*7.9*	*0.1*	*0*	*6.0*	*1.9*
Molybdenum	*0.01*	*<0.01*	*0.037*	*2.3*	*0.9*	*1.1*	*0.5*	*0.4*	*0.6*	*61.6*	*68.1*	*49*	*46.6*	*15.0*
Nickel	*1*	*0.42*	*0.012*	*653*	*266*	*304*	*169*	*123*	*171*	*1,361*	*1,212*	*872*	*1,030*	*333*
Phosphorous	*11*	*0.12*	*0.61*	--	--	--	--	--	--	--	--	--	--	--
Potassium	*15*	*26*	*5.7*	--	--	--	--	--	--	--	--	--	--	--
Selenium	*<0.05*	*<0.05*	*0.03*	*3.3*	*1.3*	*1.5*	*0.8*	*0.6*	*0.9*	*8.8*	*8.5*	*6*	*6.7*	*2.1*
Silver	*<0.01*	*<0.01*	*<0.004*	--	--	--	--	--	--	--	--	--	--	--
Sodium	*550*	*45*	*790*	--	--	--	--	--	--	--	--	--	--	--
Strontium	*2.6*	*4.9*	*0.9*	*4,296*	*1,751*	*1,999*	*1,109*	*807*	*1,127*	--	--	--	--	--
Sulfate	*2,700*	*3,500*	*1,600*	--	--	--	--	--	--	--	--	--	--	--
Thallium	***0.15***	***0.25***	*0.002*	***0.122***	***0.050***	***0.057***	***0.03***	***0.02***	***0.03***	--	--	--	--	--
Tin	*<0.4*	*<1*	*<0.4*	*207*	*84.3*	*96.3*	*44*	*31.7*	*54.2*	*120*	*61.4*	*44*	--	*29.2*
Vanadium	*<0.01*	*0*	*0.005*	*3.2*	*1.3*	*1.5*	*0.9*	*0.6*	*0.8*	*201*	*204*	*147*	*152*	*49.0*
Zinc	*2.9*	*1.7*	*<0.04*	*2,613*	*1,065*	*1,216*	*675*	*491*	*685*	*255*	*307*	*221*	*193*	*62.3*
pH (s.u.)	*6.67*	*7.54*	*8.23*	--	--	--	--	--	--	--	--	--	--	--
Total Dissolved Solids	*4,400*	*4,500*	*3,300*	--	--	--	--	--	--	--	--	--	--	--
Alkalinity- Total	*38*	*14*	*330*	--	--	--	--	--	--	--	--	--	--	--
Alkalinity-HCO_3	*38*	*14*	*330*	--	--	--	--	--	--	--	--	--	--	--
Nitrate (as N)	*24*	*<0.5*	*92*	*10,360*	*4,226*	*4,826*	*2,885*	*2,100*	*2,719*	--	--	--	--	--

[a] Nevada standards for toxic materials applicable to designated waters; Watering of Livestock. Source: NAC 445A.144. Based on National Academy of Sciences, *Water Quality Criteria* (Blue Book) (1972), and expressed as Total Recoverable, unless otherwise

[b] Draft Rationale For Proposed Changes to NAC 445A119, Water Quality Criteria for Designated Beneficial Uses (August 2002).

ES/ER/TM-86/R3

Toxicological Benchmarks for Wildlife: 1996 Revision

This document has been approved by the
K-25 Site Technical Information Office
for release to the public. Date: ________

ES/ER/TM-86/R3

Toxicological Benchmarks for Wildlife: 1996 Revision

B. E. Sample
D. M. Opresko
G. W. Suter II

Date Issued—June 1996

Prepared by the
Risk Assessment Program
Health Sciences Research Division
Oak Ridge, Tennessee 37831

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LOCKHEED MARTIN ENERGY SYSTEMS, INC.
managing the
Environmental Management Activities at the
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PREFACE

The purpose of this report is to present toxicological benchmarks for assessment of effects of certain chemicals on mammalian and avian wildlife species. This work was performed under Work Breakdown Structure 1.4.12.2.3.04.07.02 (Activity Data Sheet 8304, “Technical Integration”). Publication of this document meets a milestone for the Environmental Restoration (ER) Risk Assessment Program. This document provides the ER Program with toxicological benchmarks that may be used as comparative tools in screening assessments as well as lines of evidence to support or refute the presence of ecological effects in ecological risk assessments. The chemicals considered in this report are some that occur at U.S. Department of Energy waste sites, and the wildlife species evaluated herein were chosen because they are widely distributed and represent a range of body sizes and diets.

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TABLES

ACRONYMS

BAF	bioaccumulation factor
BCF	bioconcentration factor
COPC	contaminant of potential concern
DOE	U.S. Department of Energy
EPA	U.S. Environmental Protection Agency
FCM	food chain multiplier
FEL	frank effects level
HQ	hazard quotient
LD_{50}	lethal dose to 50% of the population
LC_{50}	lethal concentration to 50% of the population
LOAEL	lowest observed adverse effects level
NOAEL	no observed adverse effects level
P_{oct}	Octanol/Water Partition Coefficient
PCB	polychlorinated biphenyl
RfD	reference dose
RTECS	Registry of Toxic Effects of Chemical Substances
TCDD	tetrachlorodibenzodioxin
TCDF	tetrachlorodibenzofuran
TWA	time weighted average

EXECUTIVE SUMMARY

The process of evaluating ecological risks of environmental contaminants comprises two tiers. The first tier is a screening assessment where concentrations of contaminants in the environment are compared to no observed adverse effects level (NOAEL)-based toxicological benchmarks that represent concentrations of chemicals in environmental media (water, sediment, soil, food, etc.); these concentrations are presumed to be nonhazardous to the surrounding biota. The second tier is a baseline ecological risk assessment where toxicological benchmarks are one of several lines of evidence used to support or refute the presence of ecological effects.

This report presents NOAEL- and lowest observed adverse effects level (LOAEL)-based toxicological benchmarks for assessment of effects of 85 chemicals on 9 representative mammalian wildlife species or 11 avian wildlife species. The chemicals are some of those that occur at U.S. Department of Energy waste sites; the wildlife species were chosen because they are widely distributed and provide a representative range of body sizes and diets. Further descriptions of the chosen wildlife species and chemicals are also provided in this report. The NOAEL-based benchmarks represent values believed to be nonhazardous for the listed wildlife species; LOAEL-based benchmarks represent threshold levels at which adverse effects are likely to become evident. These benchmarks consider contaminant exposure through oral ingestion of contaminated media; however, exposure through inhalation and/or direct dermal exposure are not considered in this report.

1. INTRODUCTION

Ecological risks of environmental contaminants are evaluated by using a two-tiered process. In the first tier, a screening assessment is performed where concentrations of contaminants in the environment are compared to no observed adverse effects level (NOAEL)-based toxicological benchmarks. These benchmarks represent concentrations of chemicals (i.e., concentrations presumed to be nonhazardous to the biota) in environmental media (water, sediment, soil, food, etc.). While exceedance of these benchmarks does not indicate any particular level or type of risk, concentrations below the benchmarks should not result in significant effects. In practice, when contaminant concentrations in food or water resources are less than these toxicological benchmarks, the contaminants may be excluded from further consideration. However, if the concentration of a contaminant exceeds a benchmark, that contaminant should be retained as a contaminant of potential concern (COPC) and investigated further.

The second tier in ecological risk assessment, the baseline ecological risk assessment, may use toxicological benchmarks as part of a weight-of-evidence approach (Suter 1993). Under this approach, based toxicological benchmarks are one of several lines of evidence used to support or refute the presence of ecological effects. Other sources of evidence include media toxicity tests, surveys of biota (abundance and diversity), measures of contaminant body burdens, and biomarkers.

This report presents NOAEL- and lowest observed adverse effects level (LOAEL)-based toxicological benchmarks for assessment of effects of 85 chemicals on 9 representative mammalian wildlife species (short-tailed shrew, little brown bat, meadow vole, white-footed mouse, cottontail rabbit, mink, red fox, and whitetail deer) or 11 avian wildlife species (American robin, rough-winged swallow, American woodcock, wild turkey, belted kingfisher, great blue heron, barred owl, barn owl, Cooper's hawk, and red-tailed hawk, osprey) (scientific names for both the mammalian and avian species are presented in Appendix B). [In this document, NOAEL refers to both dose (mg contaminant per kg animal body weight per day) and concentration (mg contaminant per kg of food or L of drinking water)].

The 20 wildlife species were chosen because they are widely distributed and provide a representative range of body sizes and diets. The chemicals are some of those that occur at U.S. Department of Energy (DOE) waste sites. The NOAEL-based benchmarks presented in this report represent values believed to be nonhazardous for the listed wildlife species; LOAEL-based benchmarks represent threshold levels at which adverse effects are likely to become evident. These benchmarks consider contaminant exposure through oral ingestion of contaminated media only. Exposure through inhalation and/or direct dermal exposure are not considered in this report.

2. AVAILABILITY AND LIMITATIONS OF TOXICITY DATA

Information on the toxicity of environmental contaminants to terrestrial wildlife can be obtained from several sources including the U.S. Environmental Protection Agency (EPA) Terrestrial Toxicity Data Base (TERRE-TOX; Meyers and Schiller 1986), U. S. Fish and Wildlife Service reports, EPA assessment and criteria documents, and Public Health Service toxicity profiles. In addition, many refereed journals (e.g., Environmental Toxicology and Chemistry, Archives of Environmental Contamination and Toxicology, Journal of Wildlife Management, etc.) regularly publish studies concerning contaminant effects on wildlife. Selected data from these sources are presented in tabular form in Appendix C.

Pesticides were excluded from this compilation except for those considered to be likely contaminants on DOE reservations, such as the persistent organochlorine compounds (e.g., chlordane, DDT, endrin, etc.). Most of the available information on the effects of environmental contaminants on wildlife pertains to agricultural pesticides and little to industrial and laboratory chemicals of concern to DOE. Furthermore, the toxicity data that are available are often limited to severe effects of acute exposures [e.g., concentration or dose levels causing 50% mortality to a test population (LC_{50} and LD_{50})].

Relatively few studies have determined safe exposure levels (NOAELs) for situations in which wildlife have been exposed over an entire lifetime or several generations. Consequently, for nearly all wildlife species, a NOAEL for chronic exposures to a particular chemical must be estimated from toxicity studies of the same chemical conducted on a different species of wildlife or on domestic or laboratory animals or from less than ideal data (e.g., LD_{50} values). In many cases, the only available information is from studies on laboratory species (primarily rats and mice). These studies may be of short-term or subchronic duration and may identify a lowest-observed-adverse-effect-level (LOAEL) only and not a NOAEL. Estimating a NOAEL for a chronic exposure from such data can introduce varying levels of uncertainty into the calculation (Sect. 3.2); however, such laboratory studies represent a valuable resource whose use should be maximized.

Wildlife NOAELs estimated from data on laboratory animals must be evaluated carefully while considering the possible limitations of the data. Variations in physiological or biochemical factors may exist among species; these factors may include uptake, metabolism, and disposition, which can alter the potential toxicity of a contaminant to a particular species. Inbred laboratory strains may have an unusual sensitivity or resistance to the tested compound. Behavioral and ecological parameters (e.g., stress factors such as competition, seasonal changes in temperature or food availability, diseased states, or exposure to other contaminants) may make a wildlife species' sensitivity to an environmental contaminant different from that of a laboratory or domestic species.

Available studies on wildlife or laboratory species may not include evaluations of all significant endpoints for determining long-term effects on natural populations. Important data that may be lacking are potential effects on reproduction, development, and population dynamics following multigeneration exposures. In this report, endpoints such as reproductive and developmental toxicity and reduced survival were used whenever possible; however, for some contaminants, limitations in the available data necessitated the use of endpoints such as organ-specific toxic effects. It should be emphasized that in such cases the resulting benchmarks represent conservative values whose relationships to potential population level effects are uncertain. These benchmarks will be recalculated if and when more appropriate toxicity data become available.

If fewer steps are involved in the extrapolation process, then the uncertainty in estimating the wildlife NOAEL will be lower. For example, extrapolating from a NOAEL for an appropriate toxic endpoint (i.e., reproductive or population effects) for white laboratory mice to white-footed mice that are relatively closely related and of comparable body size would have a high level of reliability. Conversely, extrapolating from a LOAEL for organ-specific toxicity (e.g., liver or kidney damage) in laboratory mice to a nonrodent wildlife species such as mink or fox would have a low level of reliability in predicting population effects among these species. Because of the differences in avian and mammalian physiology and to reduce extrapolation uncertainty, studies performed on mammalian test species are used exclusively to estimate NOAELs for mammalian wildlife, and studies performed on avian test species are used exclusively to estimate NOAELs for avian wildlife; interclass extrapolations were not performed for this document.

In this report, benchmarks for mammalian species of wildlife have been estimated from studies conducted primarily on laboratory rodents, and benchmarks for avian species have been estimated from studies on domestic and wild birds. Few experimental toxicity data are available for other groups of wildlife such as reptiles and amphibians, and it is not considered appropriate to apply benchmarks across different groups. Models for such wildlife extrapolations have not been developed as they have for aquatic biota (Suter 1993).

3. METHODOLOGY

The general method used in this report is one based on EPA methodology for deriving human toxicity values from animal data (EPA 1992, 1995). For this report, experimentally derived NOAELs or LOAELs were used to estimate NOAELs for wildlife by adjusting the dose according to differences in body size. The concentrations of the contaminant in the wildlife species' food or drinking water that would be equivalent to the NOAEL were then estimated from the species' rate of food consumption and water intake. For wildlife species that feed primarily on aquatic organisms, a benchmark that combines exposure through both food and water is calculated based on the potential of the contaminant to bioconcentrate and bioaccumulate through the food chain.

NOAELs and LOAELs for mammals and domestic and wild birds were obtained from the primary literature, EPA review documents, and secondary sources such as the Registry of Toxic Effects of Chemical Substances and the Integrated Risk Information System (IRIS) (EPA 1994). Appendix A provides a brief description of these studies and discusses the rationale for their use in deriving benchmarks. The selection of a particular study and a particular toxicity endpoint and the identification of NOAELs and LOAELs were based on an evaluation of the data. Emphasis was placed on those studies in which reproductive and developmental endpoints were considered (endpoints that may be directly related to potential population-level effects), multiple exposure levels were investigated, and the reported results were evaluated statistically to identify significant differences from control values. It is recognized that other interpretations of the same data may be possible and that future research may provide more comprehensive data from which benchmarks might be derived. Therefore, it is anticipated that the development of these screening benchmarks will be an ongoing process, and consequently, the values presented in this report are subject to change.

3.1 ESTIMATING NOAELS AND LOAELS FOR WILDLIFE

NOAELs and LOAELs are daily dose levels normalized to the body weight of the test animals (e.g., milligrams of chemical per kilogram body weight per day). The presentation of toxicity data on a mg/kg/day basis allows comparisons across tests and across species with appropriate consideration for differences in body size. Studies have shown that numerous physiological functions such as metabolic rates, as well as responses to toxic chemicals, are a function of body size. Smaller animals have higher metabolic rates and usually are more resistant to toxic chemicals because of more rapid rates of detoxification. (However, this may not be true if the toxic effects of the compound are produced primarily by a metabolite). For mammals, it has been shown that this relationship is best expressed in terms of body weight (bw) raised to the 3/4 power ($bw^{3/4}$) (Travis and White 1988, Travis et al. 1990, EPA 1992a). If the dose (d) has been calculated in terms of unit body weight (i.e., mg/kg), then the metabolic rate-based dose (D) equates to:

$$D = \frac{d \times bw}{bw^{3/4}} = d \times bw^{1/4}. \qquad (1)$$

The assumption is that the dose per body surface area (Eq. 1) for species "a" and "b" would be equivalent:

$$d_a \times bw_a^{1/4} = d_b \times bw_b^{1/4}. \qquad (2)$$

Therefore, knowing the body weights of two species and the dose (d_b) producing a given effect in species "b," the dose (d_a) producing the same effect in species "a" can be determined:

$$d_a = d_b \times \frac{bw_b^{1/4}}{bw_a^{1/4}} = d_b \times \left(\frac{bw_b}{bw_a}\right)^{1/4}. \qquad (3)$$

If a NOAEL (or LOAEL) is available for a mammalian test species ($NOAEL_t$), then the equivalent NOAEL (or LOAEL) for a mammalian wildlife species ($NOAEL_w$) can be calculated by using the adjustment factor for differences in body size:

$$NOAEL_w = NOAEL_t \left(\frac{bw_t}{bw_w}\right)^{1/4}. \qquad (4)$$

Recent research suggests that physiological scaling factors developed for mammals may not be appropriate for interspecies extrapolation among birds. Mineau et al. (1996) developed body weight-based scaling factors for birds using LC_{50} data for 37 pesticides. Scaling factors ranged from 0.63 to 1.55 with a mean of 1.15. However, scaling factors for the majority of the chemicals evaluated (29 of 37) were not significantly different from 1. A scaling factor of 1 was therefore considered most appropriate for interspecies extrapolation among birds. If the dose (d) itself has been calculated in terms of unit body weight (i.e., mg/kg), then the extrapolated dose (D) equates to:

$$D = \frac{d \times bw}{bw^{1}} = d \times bw^{0}. \qquad (5)$$

For birds, if a NOAEL was available for an avian test species ($NOAEL_t$), the equivalent NOAEL for an avian wildlife species ($NOAEL_w$) would be calculated by using the adjustment factor for differences in body size:

$$NOAEL_w = NOAEL_t \left(\frac{bw_t}{bw_w}\right)^{0} = NOAEL_t\ (1) = NOAEL_t \qquad (6)$$

EPA uses this scaling methodology in carcinogenicity assessments and reportable quantity documents for adjusting from animal data to an equivalent human dose (EPA 1992). The same approach has also been proposed for use in extrapolating from one animal species to another as part of the Great Lakes Water Quality Initiative (EPA 1995).

The ideal data set to use in the calculation would be the actual average body weights of the test animals used in the bioassay. When this information is not available, standard reference body weights for laboratory species can be used as indicated previously (EPA 1985a; see Table 1). Body weight data for wildlife species are available from several secondary sources (i.e., the Mammalian Species series, published by the American Society of Mammalogists, Burt and Grosseneider 1976, Dunning 1984, Dunning 1993, Silva and Downing 1995, Whitaker 1980). Often, only a range of adult body weight values is available for a species, in which case an average value must be estimated. A time-weighted average body weight for the entire life span of a species would be the most appropriate data set to use for chronic exposure situations; however, such data usually are not available. Body weight of a species can vary geographically, as well as by sex. Sex-specific data may be needed depending on the toxicity endpoints used. Body weight data for the mammalian wildlife species considered in this report are given in Table 1.

Table 1. Reference values for mammalian species

Species	Body weight (kg)	Food intake (kg/day)	Food factor[a] *f*	Water intake (L/day)[(19)]	Water factor[b] ω
rat	0.35[c]	0.028[d]	0.08	0.046[e]	0.13
mouse	0.03[c]	0.0055[d]	0.18	0.0075[e]	0.25
rabbit	3.8[c]	0.135[d]	0.034	0.268[e]	0.070
dog	12.7[c]	0.301[d]	0.024	0.652[e]	0.051
short-tailed shrew	0.015[f]	0.009[f]	0.6	0.0033[f]	0.22
meadow vole	0.044[f]	0.005[f]	0.114	0.006[g]	0.136
white-footed mouse	0.022[f]	0.0034[f]	0.155	0.0066[f]	0.3
cotton rat	0.15	0.010[h]	0.07	0.018[g]	0.12
cottontail rabbit	1.2[f]	0.237[f]	0.198	0.116[g]	0.013
mink	1.0[f]	0.137[f]	0.137	0.099[g]	0.099
red fox	4.5[f]	0.45[f]	0.1	0.38[g]	0.084
whitetail deer	56.5[f]	1.74[f]	0.031	3.7[g]	0.065

[a] The food factor is the daily food intake divided by the body weight.
[b] The water factor is the daily water intake divided by the body weight.
[c] EPA reference values (EPA 1985a).
[d] Calculated using reference body weight and Eq. 10.
[e] Calculated using reference body weight and Eq. 21.
[f] See Appendix B for data source.
[g] Calculated according to Calder and Braun, 1983; see Eq. 24.
[h] Calculated using Eq. 14.

3.2 DERIVING A CHRONIC NOAEL FROM OTHER ENDPOINTS

In cases where a NOAEL for a specific chemical is not available for either wildlife or laboratory species, but a LOAEL has been determined experimentally, the NOAEL can be estimated by applying an uncertainty factor (UF) to the LOAEL. In the EPA methodology (EPA 1995), the LOAEL can be reduced by a factor of up to 10 to derive the NOAEL.

$$\mathrm{NOAEL} = \frac{\mathrm{LOAEL}}{\leq 10}. \tag{7}$$

Although a factor of 10 is usually used in the calculation, the true NOAEL may be only slightly lower than the experimental LOAEL, particularly if the observed effect is of low severity. A thorough analysis of the available data for the dose-response function may reveal whether a LOAEL to NOAEL uncertainty factor of <10 should be used. No data were found for any of the contaminants considered suggesting the use of a LOAEL-NOAEL adjustment factor of <10.

If the only available data consist of a NOAEL (or a LOAEL) for a subchronic exposure, then the equivalent NOAEL or LOAEL for a chronic exposure can be estimated by applying a UF of $\leq$ 10 (EPA 1995):

$$\mathrm{chronic\ NOAEL} = \frac{\mathrm{subchronic\ NOAEL}}{\leq 10}. \tag{8}$$

EPA has no clear guidance on the dividing line between a subchronic exposure and a chronic exposure. For studies on laboratory rodents, EPA generally accepts a 90-day exposure duration as a standard for a subchronic exposure. In the technical support for the Great Lakes Water Initiative Wildlife Criteria, EPA (1995) indicates that a chronic exposure would be equivalent to at least 50% of a species' lifespan. Since most of the NOAELS and LOAELS available for calculated benchmarks for mammalian wildlife are from studies on laboratory rodents (with lifespans of approximately 2 years), 1 year has been selected as the minimum required exposure duration for a chronic exposure (approximately one-half of the lifespan). Little information is available concerning the lifespans of birds used in toxicity tests, and little standardization of study duration for avian toxicity tests has been conducted. In addition, few long-term, multigeneration avian toxicity tests have been performed. Therefore, avian studies where exposure duration was 10 weeks or less were considered to be subchronic, and those where the exposure duration was greater than 10 weeks were considered chronic studies.

In addition to duration of exposure, the time when contaminant exposure occurs is critical. Reproduction is a particularly sensitive lifestage due to the stressed condition of the adults and the rapid growth and differentiation occurring within the embryo. For many species, contaminant exposure of a few days to as little as a few hours during gestation and embryo development may produce severe adverse effects. Because these benchmarks are intended to evaluate the potential for adverse effects on wildlife populations and impaired reproduction is likely to affect populations, contaminant exposures that are less than one year or 10 weeks, but occur during reproduction, were considered to represent chronic exposures.

If the available data are limited to acute toxicity endpoints [frank-effects level (FEL)] or to exposure levels associated with lethal effects (LD_{50}s), the estimation of NOAELs for chronic exposures are likely to have a wide margin of error because no standardized mathematical correlation exists between FEL or LD_{50} values and NOAELs that can routinely be applied to all chemicals (i.e., exposure levels associated with NOAELs may range from 1/10 to 1/10,000 of the acutely toxic dose, depending on the chemical and species). However, if both an LD_{50} and a NOAEL have been determined for a related chemical *a*, then this ratio could be used to estimate a $NOAEL_w$ using the $(LD_{50})_w$ for the compound of interest.

$$NOAEL_w = (LD_{50})_w \frac{NOAEL_a}{(LD_{50})_a}. \tag{9}$$

3.3 NOAEL EQUIVALENT CONCENTRATION IN FOOD

The dietary level or concentration in food (C_f, in mg/kg food) of a contaminant that would result in a dose equivalent to the NOAEL or LOAEL (assuming no exposure through other environmental media) can be calculated from the food factor f:

$$C_f = \frac{NOAEL_w}{f}. \tag{10}$$

The food factor, f, is the amount of food consumed (F, in g/day or kg/day) per unit body weight (bw, in g or kg):

$$f = \frac{F}{bw}. \tag{11}$$

In the absence of empirical data, rates of food consumption (F, in kg/day) for laboratory mammals can be estimated from allometric regression models based on body weight (in kg) (EPA 1988a):

$$F = 0.056(bw)^{0.6611} \quad \text{(laboratory mammals)}. \tag{12}$$

$$F = 0.054(bw)^{0.9451} \quad \text{(moist diet)}. \tag{13}$$

$$F = 0.049(bw)^{0.6087} \quad \text{(dry diet)}. \tag{14}$$

In the absence of specific information on the body weights of the test animals, EPA (1985a) uses default values (see Table 1). In this report, F was estimated using Eq. 10 and the default body weights. Reference body weights for particular strains of laboratory animals and for specific age groups corresponding to subchronic or chronic exposures are available (EPA 1988a), and these can also be used in the equations. Default values for food consumption and food factors for common laboratory species (rats, mice, dogs, rabbits, etc.) have also been used by EPA (1988b) for estimating equivalent dose levels for laboratory studies in which the exposure is reported only as a dietary concentration. Generally, the rates of food consumption for laboratory species, as derived from Eqs. 10–12, are higher then the EPA default values.

Food consumption rates are available for some species of wildlife (EPA 1993a, 1993b; Table 1). In the absence of experimental data, F values (g/day) can be estimated from allometric regression models based on metabolic rate and expressed in terms of body weight (g) (Nagy 1987):

$$F = 0.235(bw)^{0.822} \quad \text{(placental mammals).} \tag{15}$$

$$F = 0.621(bw)^{0.564} \quad \text{(rodents).} \tag{16}$$

$$F = 0.577(bw)^{0.727} \quad \text{(herbivores).} \tag{17}$$

$$F = 0.492(bw)^{0.673} \quad \text{(marsupials).} \tag{18}$$

$$F = 0.648(bw)^{0.651} \quad \text{(birds).} \tag{19}$$

$$F = 0.398(bw)^{0.850} \quad \text{(passerine birds).} \tag{20}$$

It should be noted that F values estimated using these allometric equations are expressed as g/day dry *weight*. Because wildlife do not consume dry food, these estimates must be adjusted to account for the water content of food. Water contents of selected wildlife foods are given in the *Wildlife Exposures Factors Handbook* (EPA 1993a).

3.4 NOAEL EQUIVALENT CONCENTRATION IN DRINKING WATER

The concentration of the contaminant in the drinking water of an animal (C_w, in mg/L) resulting in a dose equivalent to a $NOAEL_w$ or $LOAEL_w$ can be calculated from the daily water consumption rate (W, in L/day) and the average body weight (bw_w) for the species:

$$C_w = \frac{NOAEL_w \text{ x } bw_w}{W}. \tag{21}$$

If known, the water factor ω [= the rate of water consumption per unit body weight (W/bw)] can be used in a manner identical to that for the food factor:

$$C_w = \frac{NOAEL_w}{\omega}. \tag{22}$$

If empirical data are not available, W (in L/day) can be estimated from allometric regression models based on body weight (in kg) (EPA 1988a):

$$W = 0.10(bw)^{0.7377} \quad \text{(laboratory mammals).} \tag{23}$$

$$W = 0.009(bw)^{1.2044} \quad \text{(mammals, moist diet).} \tag{24}$$

$$W = 0.093(bw)^{0.7584} \quad \text{(mammals, dry diet).} \tag{25}$$

In the absence of specific information on the body weights of the test animals, EPA (1985a) uses default values (see Table 1). In this report, W was estimated using Eq. 21 and the default body weights. Reference body weights for particular strains of laboratory animals and for specific age groups corresponding to subchronic or chronic exposures are available (EPA 1988a), and these can also be used in the equations. Default values for water consumption and ω for common laboratory species have been used by EPA (1988b) for estimating equivalent dose levels for laboratory studies in which the exposure was given only as a concentration in the animals' drinking water. Generally, the rates of water consumption for laboratory species, as derived from Eqs. 21–23, are higher than the EPA default values.

Water consumption rates are available for some species of mammalian wildlife (Table 1). Water consumption rates (in L/day) can also be estimated from allometric regression models based on body weight (in kg) (Calder and Braun 1983):

$$W = 0.099(bw)^{0.90} \tag{26}$$

A similar model has also been developed for birds (Calder and Braun 1983):

$$W = 0.059(bw)^{0.67} \tag{27}$$

3.5 COMBINED FOOD AND WATER BENCHMARKS FOR PISCIVOROUS WILDLIFE

If a wildlife species (such as mink, river otter, belted kingfisher, great blue heron, or osprey) feeds primarily on aquatic organisms and the concentration of the contaminant in the food is proportional to the concentration in the water, then the food consumption rate (F, in kg/day) and the aquatic life bioaccumulation factor can be used to derive a C_w value that incorporates both water and food consumption (EPA 1995a, 1995b, 1995c):

$$C_w = \frac{NOAEL_w \times bw_w}{W + (F \times BAF)} \tag{28}$$

The bioaccumulation factor (BAF) is the ratio of the concentration of a contaminant in tissue (mg/kg) to its concentration in water (mg/L), where both the organism and its prey are exposed, and is expressed as L/kg. BAFs may be predicted by multiplying the bioconcentration factor for the contaminant [bioconcentration factor (BCF), ratio of concentration in food to concentration in water; i.e., (mg/kg)/(mg/L) = L/kg] by the appropriate food chain multiplying factor (FCM) (see Table 2). For most inorganic compounds, BCFs and BAFs are assumed to equal; however, an FCM may be applicable for some metals if the organometallic form biomagnifies (EPA 1995c).

Table 2. Aquatic food chain multiplying factors[a]

	Prey Trophic Level[b]		
Log P_{oct}	**2**	**3**	**4**
2	1	1.005	1
2.5	1	1.01	1.002
3	1	1.028	1.007
3.1	1	1.034	1.007
3.2	1	1.042	1.009
3.3	1	1.053	1.012
3.4	1	1.067	1.014
3.5	1	1.083	1.019
3.6	1	1.103	1.023
3.7	1	1.128	1.033
3.8	1	1.161	1.042
3.9	1	1.202	1.054
4	1	1.253	1.072
4.1	1	1.315	1.096
4.2	1	1.38	1.13
4.3	1	1.491	1.178
4.4	1	1.614	1.242
4.5	1	1.766	1.334
4.6	1	1.95	1.459
4.7	1	2.175	1.633
4.8	1	2.452	1.871
4.9	1	2.78	2.193
5	1	3.181	2.612
5.1	1	3.643	3.162
5.2	1	4.188	3.873
5.3	1	4.803	4.742
5.4	1	5.502	5.821
5.5	1	6.266	7.079
5.6	1	7.096	8.551
5.7	1	7.962	10.209
5.8	1	8.841	12.05
5.9	1	9.716	13.964
6	1	10.556	15.996
6.1	1	11.337	17.783
6.2	1	12.064	19.907
6.3	1	12.691	21.677
6.4	1	13.228	23.281
6.5	1	13.662	24.604
6.6	1	13.98	25.645

Table 2. (continued)

Log P_{oct}	Prey Trophic Level[b] 2	3	4
6.7	1	14.223	26.363
6.8	1	14.355	26.669
6.9	1	14.388	26.669
7	1	14.305	26.242
7.1	1	14.142	25.468
7.2	1	13.852	24.322
7.3	1	13.474	22.856
7.4	1	12.987	21.038
7.5	1	21.517	18.967
7.6	1	11.708	16.749
7.7	1	10.914	14.388
7.8	1	10.069	12.05
7.9	1	9.162	9.84
8	1	8.222	7.798
8.1	1	7.278	6.012
8.2	1	6.361	4.519
8.3	1	5.489	3.311
8.4	1	4.683	2.371
8.5	1	3.949	1.663
8.6	1	3.296	1.146
8.7	1	2.732	0.778
8.8	1	2.246	0.521
8.9	1	1.837	0.345
9	1	1.493	0.226

[a]From EPA 1993c.
[b]Trophic level: 2 = zooplankton; 3 = small fish; 4 = piscivorous fish, including top predators.

In cases where the BCF for a particular compound is not available, it can be estimated from the octanol-water partition coefficient of the compound by the following relationship (Lyman et al. 1982):

$$\log BCF = 0.76 \log P_{oct} - 0.23. \qquad (29)$$

The BCF can also be estimated from the water solubility of a compound by the following regression equation (Lyman et al. 1982):

$$\log BCF = 2.791 - 0.564 \log WS \qquad (30)$$

where WS is the water solubility in mg/L water.

Log P_{oct} values, reported or calculated BCF values, and estimated BAF values for chemicals for which benchmarks have been derived are included on Table 3. Reported BCFs represent the maximum value listed for fish. An FCM of 1 was applied to all reported BCFs for inorganic compounds (EPA 1993c). Mink, belted kingfisher, great blue heron, and osprey consume 100% trophic level 3 fish (EPA 1995d); the trophic level 3 FCM appropriate for the log P_{oct} of the chemical was applied as appropriate. River otter were assumed to consume 80% trophic level 3 and 20% trophic level for fish (EPA 1995d). To calculate the final piscivore benchmark for river otter, the level 3 BAF was applied to 80% of the diet, and the level 4 BAF was applied to the remaining 20%.

Table 3. Octanol-water partition coefficients, bioconcentration factors, and bioaccumulation factors for selected chemicals

Chemical and Form	Log P_{oct}	BCF	Trophic Level 3 FCM	Trophic Level 3 BAF	Trophic Level 4 FCM	Trophic Level 4 BAF	Source[b]
Acetone	-0.24	0.39[a]	1	0.39	1	0.39	EPA 1995e
Aldrin	6.5	51286.14[a]	13.662	700671.22	24.604	1261844.15	EPA 1995e
Aluminum		231	1	231.00	1	231.00	EPA 1988c
Antimony		1	1	1.00	1	1.00	EPA 1980b
Aroclor 1016	5.6	10616.96[a]	7.096	75337.92	8.551	90785.59	ATSDR 1989
Aroclor 1242	5.6	10616.96[a]	7.096	75337.92	8.551	90785.59	ATSDR 1989
Aroclor 1248	6.2	30338.91[a]	12.064	366008.63	19.907	603956.72	ATSDR 1989
Aroclor 1254	6.5	51286.14[a]	13.662	1850000.00	24.604	6224000.00	ATSDR 1989, EPA 1995b[c]
Arsenic (arsenite)		17.00	1	17.00	1	17.00	EPA 1984g
Benzene	2.13	24.48[a]	1.005	24.60	1	24.48	EPA 1995e
beta-BHC	3.81	463.02[a]	1.161	537.56	1.042	482.47	EPA 1995e
BHC-mixed isomers	5.89	17636.00[a]	9.716	171351.34	13.964	246269.05	EPA 1995e
Benzo(a)pyrene	6.11	25917.91[a]	11.337	293831.36	17.783	460898.22	EPA 1995e
Beryllium		19.00	1	19.00	1	19.00	EPA 1980c
Bis(2-ethylhexyl) phthalate	7.3	207969.67[a]	13.747	2858959.04	22.856	4753354.75	EPA 1995e
Cadmium		12400.00	1	12400.00	1	12400.00	EPA 1984f
Carbon Tetrachloride	2.73	69.95[a]	1.01	70.65	1.002	70.09	EPA 1995e
Chlordane	6.32	37428.29[a]	12.691	475002.44	21.677	811333.07	EPA 1995e
Chlordecone (kepone)	5.3	6280.58[a]	4.803	30165.64	4.742	29782.53	EPA 1995e
Chloroform	1.92	16.95[a]	1.005	17.04	1	16.95	EPA 1995e
Chromium (Cr+6)		3.00	1	3.00	1	3.00	EPA 1985d
Copper		290.00	1	290.00	1	290.00	EPA 1985e
o-Cresol	1.99	19.16[a]	1.005	19.26	1	19.16	EPA 1995e
Cyanide		0.00	1	0.00	1	0.00	EPA 1985c
DDT (and metabolites)	6.53	54050.54[a]	13.662	1336000.00	24.604	3706000.00	EPA 1995e, EPA 1995b[c]
1,2-Dichloroethane	1.47	7.71[a]	1	7.71	1	7.71	EPA 1995e
1,1-Dichloroethylene	2.13	24.48[a]	1.005	24.60	1	24.48	EPA 1995e
1,2-Dichloroethylene	1.86	15.26[a]	1.006	15.35	1	15.26	EPA 1995e
Dieldrin	5.37	7099.05[a]	7.962	56522.61	10.209	72474.16	EPA 1995e
Diethylphthalate	2.5	46.77[a]	1.01	47.24	1.002	46.87	EPA 1995e
Di-n-butyl phthalate	4.61	1877.59[a]	1.95	3661.29	1.459	2739.40	EPA 1995e
1,4-Dioxane	-0.39	0.30[a]	1	0.30	1	0.30	EPA 1995e
Endosulfan	4.1	769.13[a]	1.315	1011.41	1.096	842.97	EPA 1995e
Endrin	5.06	4126.67[a]	3.643	15033.47	3.162	13048.54	EPA 1995e
Ethanol	-0.31	0.34[a]	1	0.34	1	0.34	EPA 1992b

Chemical and Form	Log P_{oct}	BCF	Trophic Level 3 FCM	Trophic Level 3 BAF	Trophic Level 4 FCM	Trophic Level 4 BAF	Source[b]
Ethyl Acetate	0.69	1.97[a]	1	1.97	1	1.97	EPA 1995e
Formaldehyde	-0.05	0.54[a]	1	0.54	1	0.54	EPA 1995e
Heptachlor	6.26	33697.68[a]	12.691	427657.26	21.677	730464.61	EPA 1995e
Lead		45.00	1	45.00	1	45.00	EPA 1985b
Lindane (Gamma-BHC)	3.73	402.53[a]	1.128	454.06	1.033	415.82	EPA 1995e
Mercury (Methyl Mercury Chloride)				27900.00		140000.00	EPA 1995b[c]
Methanol	-0.71	0.17[a]	1	0.17	1	0.17	EPA 1995e
Methoxychlor	5.08	4273.66[a]	3.643	15568.94	3.162	13513.31	EPA 1995e
Methylene Chloride	1.25	5.25[a]	1	5.25	1	5.25	EPA 1995e
Methyl Ethyl Ketone	0.28	0.96[a]	1	0.96	1	0.96	EPA 1995e
4-Methyl 2-Pentanone	1.19	4.73[a]	1	4.73	1	4.73	EPA 1992b
Nickel		106.00	1	106.00	1	106.00	EPA 1986f
Pentachloro-nitrobenzene	4.64	1978.79[a]	1.95	3858.64	1.459	2887.06	EPA 1995e
Pentachlorophenol	5.09	1000.00[a]	3.643	3643.00	3.162	3162.00	EPA 1995e
Selenium				2600.00		6800.00	Peterson and Nebeker 1992[c]
2,3,7,8-Tetrachloro-Dibenzodioxin	6.53	54050.54[a]	13.662	172100.00	24.604	264100.00	EPA 1995e, EPA 1995b[c]
1,1,2,2-Tetrachloro-ethylene	2.67	62.98[a]	1.01	63.61	1.002	63.11	EPA 1995e
Thallium		34.00	1	34.00	1	34.00	EPA 1980d
Toluene	2.75	72.44[a]	1.028	74.47	1.007	72.95	EPA 1995e
Toxaphene	5.5	8912.51[a]	6.266	55845.78	7.079	63091.65	EPA 1995e
1,1,1-Trichloroethane	2.48	45.16[a]	1.01	45.62	1.002	45.26	EPA 1995e
Trichloroethylene	2.71	67.55[a]	1.01	68.22	1.002	67.68	EPA 1995e
Vinyl Chloride	1.5	8.13[a]	1	8.13	1	8.13	EPA 1995e
Xylene (mixed isomers)	3.2	159.22[a]	1.042	165.91	1.009	160.65	EPA 1995e
Zinc		966.00	1	966.00	1	966.00	EPA 1987

[a] Values estimated using Eq. 29
[b] Citation for P_{oct} values unless otherwise noted.
[a] Source for BAF values.

4. APPLICATION OF THE METHODOLOGY

This chapter will present two examples that illustrate the application of the methodology for deriving NOAELs and screening benchmarks. In one example (inorganic trivalent arsenic), the estimated values were derived primarily from data on laboratory species. In the second example [Aroclor 1254, a polychlorinated biphenyl (PCB)], experimental data were available for two species of mammalian wildlife. While the examples focus on mammals, derivation of NOAELs and screening benchmarks for birds is performed in an identical manner.

4.1 INORGANIC TRIVALENT ARSENIC

The toxicity of inorganic compounds containing arsenic depends on the valence or oxidation state of the arsenic as well as on the physical and chemical properties of the compound in which it occurs. Trivalent (As^{+3}) compounds such as arsenic trioxide (As_2O_3), arsenic trisulfide (As_2S_3), and sodium arsenite ($NaAsO_2$), are generally more toxic than pentavalent (As^{+5}) compounds such as arsenic pentoxide (As_2O_5), sodium arsenate (Na_2HAsO_4), and calcium arsenate [$Ca_3(AsO_4)_2$]. The relative toxicity of the trivalent and pentavalent forms may also be affected by factors such as water solubility; the more toxic compounds are generally more water soluble. In this analysis, the effects of the trivalent form of arsenic in water soluble inorganic compounds will be evaluated. In many cases, only total arsenic concentrations are reported so the assessor must assume conservatively that it is all trivalent.

4.1.1 Toxicity to Wildlife

The only wildlife toxicity information available for trivalent inorganic arsenic compounds pertains to acute exposures (Table 4; the values listed are those reported in the literature except where noted).

For whitetail deer, the estimated lethal dose is 34 mg sodium arsenite/kg or 19.5 mg arsenic/kg (NAS 1977). For birds, estimated LD_{50} values for sodium arsenite range from 47.6 to 386 mg/kg body weight. Median lethality was also reported at a dietary level of 500 mg/kg food for mallard ducks. No information was found in the available literature regarding chronic toxicity or reproductive or developmental effects.

4.1.2 Toxicity to Domestic Animals

The toxicity of inorganic trivalent arsenic to domestic animals is summarized in Table 5 (the values listed are those given in the source). For assessment purposes, the most useful study is the one identifying a dietary NOAEL of 50 ppm arsenic in dogs following a 2-year exposure to sodium arsenite. This dietary concentration was estimated to be equivalent to 1.2 mg/kg bw/day.

4.1.3 Toxicity to Laboratory Animals (Rodents)

Selected acute and chronic toxicity data for trivalent arsenic in rats and mice are summarized in Table 6 (dietary or drinking water concentrations were converted to daily dose levels using reference body weights and Eqs. 12 and 23). For assessment purposes, the studies of Byron et al. (1967) and Schroeder and Mitchener (1971) provide the most useful data. In the study of Bryon et al. (1967), a dietary concentration of 62.5 ppm arsenic for 2 years caused no adverse effects in rats other than a slight reduction in growth of females. This dietary level, which can be considered a NOAEL, is equivalent to a daily dose of 5 mg arsenic/kg bw/day. In the Schroeder and Mitchener study (1971), a concentration of 5 mg arsenic/L in the drinking water of mice over three generations was associated with a decrease in litter size and therefore is considered a potential population level LOAEL. The equivalent dose was estimated to be 1.26 mg/kg bw/day; therefore, using Eq. 5, the NOAEL is estimated to be 0.126 mg/kg bw/day.

Table 4. Toxicity of trivalent arsenic compounds to wildlife[a]

Species	Chemical	Conc. in Diet (mg/kg food)	Dose (mg/kg)	Effect	Reference
Whitetail deer *(Odocoileus virginianus)*	sodium arsenite	NR	34	Lethal dose	NAS 1977
Mallard duck *(Anas platyrhynchos)*	sodium arsenite	NR	323	LD_{50} (single dose)	NAS 1977
	sodium arsenite	500	NR	32-day LD_{50}	NAS 1977
California quail *(Callipepla californica)*	sodium arsenite	NR	47.6	LD_{50}	Hudson et al. 1984
Ring-necked pheasant *(Phasianus colchicus)*	sodium arsenite	NR	386	LD_{50} (single dose)	Hudson et al. 1984

[a] Source of data and references: Eisler 1988.
NR. Not reported.

Table 5. Toxicity of trivalent arsenic compounds to domestic animals[a]

Species	Chemical	Conc. in Diet[b] or Water[c]	Dose[d]	Effect	Reference
Cattle	arsenic trioxide	NR	33–55 mg/kg (single dose)	toxic	Robertson et al. 1984
	sodium arsenite	NR	1–4 g/animal	lethal	NRCC 1978
Sheep	sodium arsenite	NR	5–12 mg/kg (single dose)	acutely toxic	NRCC 1978
	"total arsenic"	58 mg As/kg food (3 wk)	NR	no adverse effects	Woolson 1975
Horse	sodium arsenite	NR	2–6 mg/kg/day (14 wk)	lethal	NRCC 1978
Pig	sodium arsenite	500 mg As/L	100–200 mg/kg	lethal	NAS 1977
Cat	arsenite	NR	1.5 mg/kg/day	chronic toxic effects	Pershagen and Vahter 1979
Dog	sodium arsenite	NR	50–150 mg/animal	lethal	NRCC 1978
	sodium arsenite	125 mg As/kg food (2 year)	3.0 mg As/kg/day[e]	reduced survival	Byron et al. 1967
	sodium arsenite	50 mg As/kg food (2 year)	1.2 mg As/kg/day[e]	NOAEL	Byron et al. 1967
	sodium arsenite	NR	4 mg/kg/day (58 days) + 8 mg/kg (125 days)	LOAEL; liver enzyme changes	Neiger and Osweiler 1989

Table 5. (continued)

Species	Chemical	Conc. in Diet[b] or Water[c]	Dose[d]	Effect	Reference
Mammals	arsenic trioxide	NR	3–250 mg/kg	lethal	NAS 1977
Mammals	sodium arsenite	NR	1–25 mg/kg	lethal	NAS 1977
Chicken *(Gallus gallus)*	arsenite	NR	0.01–1.0 μg As/embryo	$\leq$34% dead	NRCC 1978
	arsenite	NR	0.03–0.3 μg As/embryo	malform.	NRCC 1978

[a] Sources of data and references: USAF 1990; Eisler 1988. NR
[b] Dietary level given as mg/kg food.
[c] Concentration in water given as mg/L.
[d] Dose, in mg/kg bw/day, refers to compound unless otherwise stated.
[e] Calculated using body weight of 12.7 kg and Eqs. 12, 13, and 14.
Not reported.

Table 6. Toxicity of trivalent arsenic compounds to laboratory animals

Species	Chemical	Conc. in Diet[a] or Water[b]	Dose (mg As/kg)	Effect	Reference
Rat	arsenic trioxide	NR	15.1 (1 dose)	LD_{50}	Harrison et al. 1958
	sodium arsenite	125 mg As/kg food (2 year)	10[c]	FEL, bile duct enlargement	Byron et al. 1967
	sodium arsenite	62.5 mg As/kg food (2 year)	5[c]	reduced growth in females; no effect on survival	Byron et al. 1967
	sodium arsenite	31.25 mg As/kg food (2 year)	2.5[c]	NOAEL	Byron et al. 1967
	sodium arsenite	5 mg As/L (lifetime)	0.65[d]	NOAEL	Schroeder et al. 1968a
Mouse	arsenic trioxide	NR	39.4 (1 dose)	LD_{50}	Harrison et al. 1958
	sodium arsenite	NR	a. 23 (1 dose) b. 11.5 (1 dose)	a. Fetal mortality b. NOAEL	Baxley et al. 1981
	arsenic trioxide	75.8 mg As/L (lifetime)	18.95[d]	LOAEL; mild hyperkeratosis/epidermal hyperplasia	Baroni et al. 1963
	soluble arsenite	5 mg As/L + 0.06 mg As/kg food (3 generations)	1.26[c,d]	LOAEL; incr. in male to female ratio; decr. in litter size	Schroeder and Mitchener 1971

Table 6. (continued)

Species	Chemical	Conc. in Diet[a] or Water[b]	Dose (mg As/kg)	Effect	Reference
	sodium arsenite	5 mg As/L + 0.46 mg As/kg food (lifetime)	0.44[c,d]	LOAEL; slight decr. in median life span; no effect on growth	Schroeder and Balassa, 1967
	sodium arsenite	0.5 mg As/L (3 weeks)	0.125[d]	LOAEL; immunosuppressive effects	Blakely et al. 1980

[a] Dietary level in mg/kg food.
[b] Concentration in water given as mg/L.
[c] Estimated using reference body weight (see Table 1) and Eqs. 12, 13, and 14.
[d] Estimated using reference body weight (see Table 1) and Eqs. 23, 24 and 25.

4.1.4 Extrapolations to Wildlife Species

Estimates of benchmarks for wildlife are shown in Table 7, and the values derived from laboratory studies are shaded. The NOAELs for dose (mg/kg bw/day) were estimated using Eq. 4. Concentrations in food (C_f) equivalent to the NOAEL were calculated using the food factors listed in Table 1 and Eq. 10. Similarly, concentrations in water (C_w) equivalent to the NOAELs were estimated from the water factors given in Table 1 and Eq. 22.

Three of the toxicity values listed in Tables 5 and 6 were used to estimate benchmarks for wildlife, the drinking water LOAEL of 5 mg/L for mice (Schroeder and Mitchener 1971), the dietary NOAEL of 62.5 ppm for rats (Byron et al. 1967), and a dietary NOAEL of 50 ppm for dogs (Bryon et al. 1967). These values were used to estimate NOAELs, C_f, and C_w for the white-footed mouse, cotton rat, red fox, and whitetail deer (Table 7).

As expected, benchmarks derived from related species are similar because of similarities in body weight and food and water consumption. Wildlife benchmarks derived from the mouse study are substantially lower than the corresponding NOAELs, C_fs, and C_ws derived from the rat or dog studies. These differences may be have several explanations. For example, mice may be unusually sensitive to trivalent arsenic; however, the LD_{50} data for rats and mice suggest a similar level of tolerance. The mouse study was a three-generation bioassay in which reproductive effects (reduced litter size) were identified. Although both the rat and dog studies involved chronic exposure durations, neither evaluated potential reproductive effects. Therefore, it is possible that reproductive effects similar to those seen in mice might occur in rats and dogs at or below the experimental NOAELs for these species if multigeneration studies were conducted. Another possibility is that trivalent arsenic may be relatively more toxic in drinking water than food, which might be the case if there were significant differences in rates of gastrointestinal absorption. If this can be shown to be the case, then benchmarks based on media-specific studies would be appropriate. Because there is insufficient information to determine which of these factors is responsible, the conservative approach would be to use the mouse data to estimate the benchmarks for the wildlife species.

Table 7. Selected wildlife toxicity values for trivalent inorganic arsenic[a,b]

Species	BW (kg)	Food factor f[c]	Water factor ω[c]	LOAEL	NOAEL (as arsenic) Dose (mg/kg)	C_f[(8)] (mg/kg)	C_w[(20)] (mg/L)	**LD$_{50}$ (mg As/kg)**	**NOAEL / LD$_{50}$**
Mouse	0.030	0.18	0.25	5.0 mg/L + 0.06 mg/kg	0.126[(10)]	0.7	0.5[(5)]	39.4	0.002
White-footed mouse	0.022	0.155	0.3						
	Extrapolated from data for laboratory mice →				0.13[(4)]	0.88	0.45		
Rat	0.35	0.05	0.13		5[(10)]	62.5	38.5	15.1	0.21
Cotton rat	0.15	0.070	0.12						
	Extrapolated from data for laboratory rat →				6.2[(4)]	88	51.5		
	Extrapolated from data for laboratory mouse →				0.08[(4)]	1.2	0.7		
Dog	12.7	0.024	0.051		1.2[(10)]	50	26		
Red fox	4.5	0.1	0.084						
	Extrapolated from data for dog →				1.7[(4)]	17	20		
	Extrapolated from data for laboratory mouse →				0.036[(4)]	0.36	0.43		
Whitetail deer	56.5	0.031	0.065					>19.5	
	Extrapolated from data for laboratory rat →				1.4[(4)]	45.5	21.4		
	Extrapolated from data for dog →				0.83[(4)]	26.8	12.6		
	Extrapolated from data for laboratory mice →				0.02[(4)]	0.62	0.29		

[a] Numbers in parentheses refer to equations in text used to derive the values.
[b] Shaded values are experimentally derived.
[c] see Table 1.

4.2 POLYCHLORINATED BIPHENYLS

PCBs occur in a variety of different formulations consisting of mixtures of individual compounds. The most well-known of these formulations is the Aroclor series (i.e., Aroclor 1016, Aroclor 1242, Aroclor 1248, Aroclor 1254, etc.). The Aroclor formulations vary in the percent chlorine, and generally, the higher the chlorine content the greater the toxicity. This analysis will focus on Aroclor 1254 for which chronic toxicity data are available for three species of wildlife.

4.2.1 Toxicity to Wildlife

Toxicity data for Aroclor 1254 are available for three species of wildlife: white-footed mice, oldfield mice (*Peromyscus poliontus*), and mink (Table 8). In these species, the reproductive system and developing embryos are adversely affected by both acute and chronic exposures. A dietary LOAEL of 10 ppm was reported for white-footed mice (Linzey 1987). Using Eq. 5, a body weight of 0.22 kg (Table 1) and a food consumption rate of 3.4 g/day (Table 1), the estimated NOAEL for this species would be $\geq$0.155 mg/kg bw/day. A dietary LOAEL of 5 ppm was reported for oldfield mice (McCoy et al. 1995). Using Eq. 5, a body weight of 0.014 kg (see Appendix A) and a food consumption rate of 1.9 g/day (Appendix A), the estimated NOAEL for this species would be $\geq$0.068 mg/kg bw/day. A dietary NOAEL of 1 ppm was reported for mink (Aulerich and Ringer, 1977). Using a time-weighted average body weight of 0.8 kg (Bleavins et al. 1980) and a food consumption rate of 110 g/day (137 g/kg bw/day × 0.8 kg bw; Bleavins and Aulerich 1981), the NOAEL is 0.137 mg/kg/day.

4.2.2 Toxicity to Domestic Animals

No information was found in the available literature on the toxicity of Aroclor 1254 to domestic animals.

4.2.3 Toxicity to Laboratory Animals

As shown in Table 9, laboratory studies have identified a dietary NOAEL of 5 ppm (= 0.4 mg/kg bw/day) for rats exposed to Aroclor 1254 over two generations (Linder et al. 1974). Reported LOAELs are 4–10 times higher than the NOAEL, and the single-dose LD_{50} is about 4000-fold higher than the NOAEL. As shown by the dose levels that produce fetotoxicity during gestation, rabbits appear to be less sensitive than rats.

4.2.4 Extrapolations to Wildlife Species

Experimentally derived and extrapolated toxicity values for Aroclor 1254 for representative wildlife species are shown in Table 10. Empirical data are available for four species: laboratory rat (Linder et al. 1974), white-footed mouse (Linzey 1987), oldfield mouse (McCoy et al. 1995) and mink (Aulerich and Ringer 1977). Reproductive and/or developmental changes were the endpoints evaluated in each of these studies. The calculated NOAELs are 0.4 mg/kg bw/day for the rat, 0.155 mg/kg bw/day for the white-footed mouse, 0.068 mg/kg bw/day for the oldfield mouse, and 0.137 mg/kg bw/day for mink. These data indicate that the laboratory rat is less sensitive to the toxicity of Aroclor 1254 than white-footed or oldfield mice or mink.

Table 8. Toxicity of Aroclor 1254 to wildlife

Species	Concentration in Food	Daily Dose (mg/kg)	Expos. Period	Effect	Reference
White-footed mouse	400 ppm	62[a]	2-3 wk	FEL, reprod.	Sanders and Kirkpatrick 1975
	200 ppm	31[a]	60 d	LOAEL, reproduction	Merson and Kirkpatrick 1976
	10 ppm	1.55[a]	18 mo	LOAEL, reproduction	Linzey 1987
Oldfield mouse	5 ppm	0.68[b]	12 mo.	LOAEL, reproduction	McCoy et al. 1995
Mink	6.5 ppm	0.89[c]	9 mo	LC_{50}	Ringer et al. 1981; ATSDR 1989
	2 ppm	0.38[c] 0.28[d]	9 mo	FEL/LOAEL, fetotoxicity	Aulerich and Ringer 1977
	1 ppm	0.137[d]	5 mo	NOAEL	Aulerich and Ringer, 1977

[a] Estimated from Eq. 10 using a food factor of 0.155.
[b] See Appendix A for estimation procedure.
[c] Reported by ATSDR (1989); based on food intake of 150 g/day and mean body weight of 0.8 kg
[d] Estimated a food consumption rate of 110 g/day and a body weight of 0.8 kg (as reported by Bleavins et al. 1980).

Table 9. Toxicity of Aroclor 1254 to laboratory animals

Species	Concentration in Diet	Daily Dose (mg/kg)	Exposure Period	Effect	Reference
Rat		1010	1 day	LD_{50}	Garthoff et al. 1981
	50 ppm	4[a]	During gestation	LOAEL, for fetotoxicity	Collins and Capen 1980
	25 ppm	2[a]	104 week	LOAEL, reduced survival	NCI 1978, ATSDR 1989a
	20 ppm	1.6[a]	2 generations	FEL/LOAEL, reduced litter size	Linder et al. 1974
	5 ppm	0.4[a]	2 generations	NOAEL	Linder et al. 1974
Rabbit		10.0	During gestation (28 days)	NOAEL for fetoxicity	Villeneuve et al. 1971
		12.5	During gestation (28 days)	FEL, fetal deaths	Villeneuve et al. 1971

[a] Calculated using a food factor of 0.08 (see Table 1) and Eq. 10.

Table 10. Selected wildlife toxicity values for Aroclor 1254[a,b]

Species	bw (kg)	Food factor f	Water factor ω	LOAEL (ppm diet)	NOAEL (mg/kg/d)	Benchmarks: C_f (mg/kg food)	Benchmarks: C_w (mg/L)	LD_{50} (mg/kg)	NOAEL/LD_{50}
Rat (lab)	0.35	0.08	0.13		0.4(10)	5.0	3.1	1,010	0.0004
Oldfield Mouse	0.014			5	≥0.068(10)				
White-footed mouse	0.022	0.155	0.3	10	≥0.155(10)	1.0	0.52		
	Extrapolated from oldfield mouse data →				0.061(4)	0.39(10)	0.20(22)		
	Extrapolated from rat data →				0.8(4)	5.2(10)	2.66(22)		
	Extrapolated from mink data →				0.34(4)	2.2(10)	1.12(22)		
Mink	0.80[c]	0.137	0.099		0.137(10)	1	0.71	1.25	0.06
	Extrapolated from white-footed mouse data →				0.06(4)	0.46(10)	0.63(22)		
	Extrapolated from oldfield mouse data →				≥0.025(4)	0.18(10)	0.25(22)		
	Extrapolated from rat data →				0.33(4)	2.37(10)	3.29(22)		
Cotton rat	0.15	0.07	0.12						
	Extrapolated from white-footed mouse data →				≥0.096(4)	1.37(10)	0.8(22)		
	Extrapolated from oldfield mouse data →				0.038(4)	0.54(10)	0.31(22)		
	Extrapolated from rat data →				0.49(4)	7.06(10)	4.12(22)		
	Extrapolated from mink data →				0.21(4)	3.0(10)	1.73(22)		
Whitetail deer	56.5	0.031	0.065						
	Extrapolated from white-footed mouse data →				≥0.022(4)	0.71(10)	0.33(22)		
	Extrapolated from oldfield mouse data →				0.009(4)	0.28(10)	0.13(22)		
	Extrapolated from rat data →				0.11(4)	3.64(10)	1.71(22)		
	Extrapolated from mink data →				0.05(4)	1.53(10)	0.72(22)		

[a] Numbers in parentheses refer to equations in text.
[b] Shaded values are experimentally derived.
[c] TWA bw for females to 10 mo (reproductive maturity) (EPA 1988a).

The most conservative benchmark for Aroclor 1254 would be the NOAEL for whitetail deer (0.009 mg/kg bw/day) extrapolated from the data for the oldfield mouse. The NOAEL derived from the mink data (0.05 mg/kg) may be more reliable because it was based on an experimentally derived NOAEL, whereas the white-footed mouse value was based on an experimentally derived LOAEL. However, because metabolism and physiology are more likely to be similar between an omnivore (mouse) and an herbivore (deer) than between a carnivore (mink) and herbivore, the oldfield mouse NOAEL may be a better estimate of toxicity to whitetail deer than the mink NOAEL.

5. SITE-SPECIFIC CONSIDERATIONS

The examples given in this report for trivalent inorganic arsenic and Aroclor 1254 illustrate the extent of the analysis that is required for an understanding of the toxicity of environmental contaminants to wildlife and for the development of benchmark values. For a complete risk assessment at a particular site, similar analyses would be needed for all the chemicals present, as well as information on their physical and chemical state, their concentration in various environmental media, and their bioavailability. The last factor is especially important in estimating environmental impacts. For example, insoluble substances tightly bound to soil particles are unlikely to be taken up by organisms even if ingested. In addition, the chemical or valence state of a contaminant may alter its toxicity such that the different chemical or valence states may have to be treated separately as in the case of trivalent arsenic. Similar problems can be encountered with formulations consisting of mixtures of compounds such as the Aroclors, and each may have to be evaluated separately, unless the relative potency of each of the components can be determined.

For a site-specific assessment, information on the types of wildlife species present, their average body size, and food and water consumption rates would also be needed for calculating NOAELs and environmental criteria. Use of observed values for food and water consumption (if available) are recommended over rates estimated by allometric equations. A list of pertinent exposure parameters (body weights, food and water consumption rates) for selected avian and mammalian species for the DOE Oak Ridge site is given in Appendix B. Exposure information for additional wildlife species may be found in the *Wildlife Exposure Factors Handbook* (EPA 1993a, 1993b). Because body size of some species can vary geographically, the more specific the data are to the local population, the more reliable will be the estimates. Data on body size are especially important in the extrapolation procedure, particularly if calculations of the NOAEL and environmental concentrations are based solely on the adjustment factor as shown in Eq. 4. In such cases the lowest NOAEL will be derived from the species with the largest body size. Estimates of average body weights for wildlife species used herein were obtained from the available literature (Appendix B, see also Table 1).

Table 11. Body size scaling factors

Experimental Animals		Wildlife		
Species	**Body Weight[a] (bw_t, in kg)**	**Species**	**Body weight[b] (bw_w in kg)**	**Scaling factor $(bw_t/bw_w)^{1/4}$**
rat	0.35	short-tailed shrew	0.015	2.2
rat	0.35	white-footed mouse	0.022	2.0
rat	0.35	meadow vole	0.044	1.68
rat	0.35	cottontail rabbit	1.2	0.73
rat	0.35	mink	1.0	0.77

Table 11. (continued)

Experimental Animals		Wildlife		
Species	Body Weight[a] (bw_t, in kg)	Species	Body weight[b] (bw_w in kg)	Scaling factor $(bw_t/bw_w)^{1/4}$
rat	0.35	red fox	4.5	0.53
rat	0.35	whitetail deer	56.5	0.28
mouse	0.03	short-tailed shrew	0.015	1.19
mouse	0.03	white-footed mouse	0.022	1.08
mouse	0.03	meadow vole	0.044	0.91
mouse	0.03	cottontail rabbit	1.2	0.40
mouse	0.03	mink	1.0	0.42
mouse	0.03	red fox	4.5	0.29
mouse	0.03	whitetail deer	56.5	0.15

[a] Standard reference values used by EPA.
[b] From Appendix B.

Information on physiological, behavioral, or ecological characteristics of these species can also be of special importance in determining if certain species are particularly sensitive to a particular chemical or groups of chemicals. If one species occurring at a site is known to be unusually sensitive to a particular contaminant, then the criteria should be based on data for that species (with exceptions noted in the following paragraphs). Similarly, extrapolations from studies on laboratory animals should be based on the most sensitive species unless there is evidence that this species is unusually sensitive to the chemical.

Physiological and biochemical data may be important in determining the mechanism whereby a species' sensitivity to a chemical may be enhanced or diminished. Such information would aid in determining whether data for that species would be appropriate for developing criteria for other species.

For example, if the toxic effects of a chemical are related to the induction of a specific enzyme system, as is the case with PCBs, then it would be valuable to know whether physiological factors (enzyme activity levels per unit mass of tissue or rates of synthesis of the hormones affected by the induced enzymes) in the most sensitive species are significantly different from those of other species of wildlife. Furthermore, if the most sensitive species, or closely related species, do not occur at a particular site, then a less stringent criterion might be acceptable.

Physiological data may also reveal how rates of absorption and bioavailability vary with exposure routes and/or exposure conditions. Gastrointestinal absorption may be substantially different depending on whether the chemical is ingested in the diet or in drinking water. Therefore, a NOAEL based on a laboratory drinking water study may be inappropriate to use in extrapolating to natural populations that would only be exposed to the same chemical in their diet. The diet itself may affect gastrointestinal absorption rates. In the case of the mink exposed to PCBs, a diet consisting primarily of contaminated fish in which the PCBs are likely to be concentrated in fatty tissues may result in a different rate of gastrointestinal absorption than that occurring in laboratory rodents dosed with PCBs in dry chow.

Behavioral and ecological data might also explain differences in sensitivity between species. Certain species of wildlife may be more sensitive because of higher levels of environmental stress to which they are subjected. This may be especially true of populations occurring at the periphery of their normal geographic range. Conversely, laboratory animals maintained under stable environmental conditions of low stress may have higher levels of resistance to toxic chemicals.

As a first step in developing wildlife criteria for chemicals of concern at DOE sites, relevant toxicity data for wildlife and laboratory animals have been compiled (Appendixes A and C). These data consist primarily of NOAELs, LOAELs, and LD_{50}s for avian and mammalian species. No methodology is currently available for extrapolating from avian or mammalian studies to reptiles and amphibians, and no attempt has been made to do so in this report. No pertinent data on nonpesticide chemicals were found for amphibians, reptiles, or terrestrial invertebrates. Additional chronic exposure studies are needed before toxicological benchmarks can be developed for these groups.

6. RESULTS

The results of the analyses are presented in Table 12 (NOAELs and LOAELs) (**presented in Appendix D**). Because of the consistency of the body weight differences for the selected mammalian wildlife species, the calculated NOAELs and LOAELs exhibit about a 15-fold range between the species of smallest body size (little brown bat) and that of the largest body size (whitetail deer). In terms of dietary intake, the range in values is much less (2 to 3 fold) thereby indicating that equivalent dietary levels of a chemical result in nearly equivalent doses between species because food intake is a function of metabolic rate which, in turn, is a function of body size. However, according to EPA (1980a), the correlation is not exact because food intake also varies with moisture and caloric content of the food, and it should be noted that in laboratory feeding experiments, the test animals are usually dosed with the chemical in a dry chow. Therefore, it would be expected that the food factor for a species of wildlife would be relatively higher than that of a related laboratory species of comparable body size, resulting in a lower dietary benchmark for wildlife species as compared to that for the related laboratory species.

6.1 CHANGES IN BENCHMARKS

In this revision of the toxicological benchmarks for wildlife, new studies were selected as the basis for the mammalian benchmarks for cadmium and selenium. The logic for the selection of the new studies is outlined in the following sections.

6.2 CADMIUM

A total of six studies were evaluated for the revision of the cadmium benchmark (Schroeder and Mitchner 1971, Baranski et al. 1983, Webster 1978, Wills et al. 1981, Machemer and Lorke 1981, and Sutou et al. 1980a). Detailed summaries of the results of each study are listed in Appendix E. All studies considered reproductive effects to rats or mice following oral exposure to cadmium salts. Study durations extended from mating through gestation to up to 4 generations. Two studies report only experimental NOAELs (Baranski et al. 1983, Webster 1978). Because these studies did not identify a LOAEL, they were considered inadequate for benchmark derivation.

The 1994 benchmark was based by Schroeder and Mitchner (1971). In this study, only one dose level was administered and only an experimental LOAEL is reported. Using Eq. 7, a NOAEL was estimated. Because this study considered only one dose level, requiring the estimation of the NOAEL, it was considered inappropriate for benchmark derivation if high quality studies with both a NOAEL and LOAEL are available. Experimental NOAELs and LOAELs were observed in three studies (Wills et al. 1981, Machemer and Lorke 1981, and Sutou et al. 1980a).

The 1995 cadmium benchmark was based on the results of Wills et al. (1981). The NOAELs and LOAELs from this study were much lower than those from other studies, and when they were used in risk assessments performed at Oak Ridge National Laboratory, the results indicated that cadmium toxicity should be expected at uncontaminated background locations. Because exposures at uncontaminated background locations are assumed to be nonhazardous, the results of Wills et al. (1981) were believe to be too conservative and therefore inappropriate for benchmark derivation.

Both the remaining studies (Machemer and Lorke 1981, Sutou et al. 1980a) were considered suitable for benchmark derivation (considered multiple dose levels, identified experimental NOAELs and LOAELs, and were greater than background exposure). Of the two studies, the lowest NOAELs and LOAELs were reported by Sutou et al. (1980a). To be conservative, the results of this study were selected for derivation of the 1996 cadmium benchmark.

6.3 SELENIUM

A total of six studies were evaluated for the revision of the selenium benchmark (Schroeder and Mitchner 1971, Rosenfeld and Beath 1954, Nobunga et al. 1979, Chiachun et al. 1991, Tarantal et al. 1991, and Chernoff and Kavlock 1982). Detailed summaries of the results of each study are listed in Appendix E. All studies considered reproductive effects following oral exposure to organic or inorganic selenium compounds. Study durations extended from mating through gestation to up to 3 generations. Two studies report only experimental NOAELs (Nobunga et al. 1979, Chiachun et al. 1991). Because these studies did not identify a LOAEL, they were considered inadequate for benchmark derivation.

Two studies report only experimental LOAELs (Schroeder and Mitchner 1971, Chernoff and Kavlock 1982). In both studies, only one dose level was administered and only an experimental LOAEL is reported. Because these studies considered only one dose level, requiring the estimation of the NOAEL, they were considered inappropriate for benchmark derivation if high quality studies with both a NOAEL and LOAEL are available. Experimental NOAELs and LOAELs were observed in two studies (Rosenfeld and Beath 1954, Tarantal et al. 1991).

Tarantal et al. (1991) exposed pregnant female long-tailed macaques to three dose levels of selenomethionine for 30 days during gestation. While no adverse effects were observed at the lowest dose level (0.025 mg/kg/d), fetal mortality was 30% and 20%, and adult toxicity was observed in the 0.15 and 0.3 mg/kg/d groups. Because the fetal mortality observed at the higher doses are within the range observed among the macaque colony at large, they may not be the result of selenium toxicity. Because a definitive LOAEL could not be established, this study was determined to be inappropriate for benchmarks derivation.

In the last study, Rosenfeld and Beath (1954) exposed rats to 1.5, 2.5, or 7.5 mg selenium/L in drinking water for two generations. While no adverse effects on reproduction were observed among rats exposed to 1.5 mg /L in drinking water, the number of second-generation young was reduced by 50% among females in the 2.5 mg/L group. In the 7.5 mg/L group, fertility, juvenile growth, and survival were reduced. In addition, the LOAEL observed in this study is lower than the LOAELs observed by Schroeder and Mitchner (1971) and Chernoff and Kavlock (1982). Because the study by Rosenfeld and Beath (1954) considered multiple dose levels over two generations and identified experimental NOAELs and LOAELs that were consistent with results of other studies, it was selected as the most appropriate for derivation of the 1996 selenium benchmark.

7. APPLICATION OF THE BENCHMARKS

As stated in Sect. 1, ecological risk assessment is a tiered process. As part of the first tier or screening assessment, toxicological benchmarks are used to identify COPCs and focus future data collection. In the second tier or baseline assessment, toxicological benchmarks are one of several lines of evidence used to determine if environmental contaminant concentrations are resulting in ecological effects. In a screening assessment, general, conservative assumptions are made so that all chemicals that may be present at potentially hazardous levels in the environment are retained for future consideration. In contrast, in a baseline assessment, more specific assumptions are made so that an accurate estimate of the contaminant exposure that an individual may experience and potential effects that may result from that exposure may be made.

7.1 SCREENING ASSESSMENT

Screening assessments serve to identify those contaminants whose concentrations are sufficiently high such that they may be hazardous to wildlife. The primary emphasis of a screening assessment is to include all potential hazards while eliminating clearly insignificant hazards. To prevent any potential hazards from being overlooked, assumptions made in a screening assessment are conservative. NOAEL-based benchmarks are used in screening assessments because they are conservative and represent maximum concentrations that are believed to be nonhazardous. Exceedance of a NOAEL-based benchmark does not suggest that adverse effects are likely; it simply indicates contamination is sufficiently high to warrant further investigation.

Questions that drive a screening assessment include (1) which media (water, soil, etc.) are contaminated such that they may be toxic?, (2) what chemicals are involved? (which contaminants are COPCs)?, (3) what are the concentrations and spatial and temporal distributions of these contaminants?, and (4) what organisms are expected to be significantly exposed to the chemicals? To answer these questions, diet, water, and combined food and water (for aquatic feeding species) benchmark values are compared to the contaminant concentrations observed in the media from the site. If the concentration of a contaminant exceeds the benchmark, it should be retained as a COPC. By comparing contaminant concentrations from several locations within a site to benchmarks for several endpoint species, the spatial extent of potentially hazardous contamination, which media are contaminated, and the species potentially at risk from contamination may be identified.

In a screening assessment, it is generally assumed that wildlife species reside and therefore forage and drink exclusively from the contaminated site. That is, approximately 100% of the food and water they consume is contaminated. While this assumption simplifies the assessment, due to the mobility and the diverse diets of most wildlife, it is likely to overestimate the actual exposure experienced. It should be remembered, however, that the purpose of the screening assessment is to identify potential risks and data gaps to be filled. Once these data gaps are filled, a definitive evaluation of risk may be made as part of the baseline assessment.

In most screening assessments, because they rely on existing data, available data are likely to be restricted to contaminant concentration in abiotic media (e.g., soil and water). Contaminant concentrations in wildlife foods may need to be estimated using contaminant uptake models such as those described in Baes et al. (1984), Travis and Arms (1988), or Menzies et al. (1992).

Table 13 provides a simplified example of the use of NOAEL-based benchmarks in a screening assessment. The purpose of the assessment in this example is to identify the contaminants and media with concentrations sufficiently high to present a hazard to a representative endpoint species (meadow vole). This information will be used to identify gaps in data needed for the baseline assessment. Data consists of the concentrations of four metals in soil and water. These data were compared to values observed at a representative background location and found to be higher. (Screening contaminant concentrations against background helps provide a context for the data and aids in the identification of anthropogenic contamination. This is particularly important in areas where metal concentrations in native soils are naturally high.) Because dietary exposure cannot be evaluated directly from soil concentrations, metal concentrations in the voles' food (plant foliage) was estimated using plant uptake factors for foliage from Baes et al. (1984). To determine which contaminants pose a risk, an HQ was calculated, where HQ = media concentration/benchmark. If the HQ ≥ 1, contaminant concentrations are sufficiently high that they may produce adverse effects. Contaminants with HQs ≥ 1 should be retained as COPCs. In this example, while metal concentrations in water did not exceed any water benchmarks, estimated concentrations of arsenic and mercury in plant foliage exceeded dietary benchmarks. These metals should therefore be retained as COPCs in food but not in water. Because contaminant concentrations in plant foliage were estimated, one data need for the baseline assessment consists of actual, measured concentrations in plants. In addition, the form of the metals (i.e., inorganic vs. methyl mercury) should be identified so the most appropriate benchmark may be used in the baseline assessment.

Table 13. Use of benchmarks in a screening assessment

Analyte	Contaminant Concentrations in Media			NOAEL-based Benchmarks for Meadow Vole		Comparison of Media Concentrations to Benchmarks			
	Water (mg/L)	Soil (mg/kg)	Estimated in Plants[a] (mg/kg)	Water (mg/L)	Diet (mg/kg)	Water		Diet	
						HQ[b]	Retain as COPC	HQ[b]	Retain as COPC
Arsenic	0.038	131	5.24	0.84	1.01	0.045	NO	5.2	YES
Lead	0.069	18.8	0.85	98.5	118.2	0.0007	NO	0.007	NO
Mercury[c]	0.005	0.71	0.64	0.39	0.47	0.013	NO	1.35	YES
Selenium	0.02	14.8	0.37	2.46	2.96	0.008	NO	0.125	NO

[a] Estimates using plant uptake factors for foliage from Baes et al. (1984).
[b] HQ = Hazard Quotient = Media Concentration/Benchmark.
[c] Mercury assumed to be in the form of methyl mercury.

7.2 BASELINE ASSESSMENT

In contrast to the screening assessment that defines the scope of the assessment, the baseline assessment uses new and existing data to evaluate the risk of leaving the site unremediated. The purposes of the baseline assessment are to determine (1) if significant ecological effects are occurring at the site, (2) the causes of these effects, (3) the source of the causal agents, and (4) the consequences of leaving the system unremediated. The baseline assessment provides the ecological basis for determining the need for remediation.

Because the baseline assessment focuses on a smaller number of contaminants and species than the screening assessment, it can provide a higher level of characterization of toxicity to the species and communities at the site. In the baseline ecological risk assessment, a weight-of-evidence approach (Suter 1993) is employed to determine if and to what degree ecological effects are occurring or may occur. The lines of evidence used in a baseline assessment consist of (1) toxicity tests using ambient media from the site, (2) biological survey data from the site, and (3) the comparison of contaminant exposure experienced by endpoint species at the site to wildlife LOAELs.

Estimating the contaminant exposure experienced by wildlife at a waste site consists of summing the exposure received from each separate source. While wildlife may be exposed to contaminants through oral ingestion, inhalation, and dermal absorption, the benchmarks in this document are only applicable to the most common exposure route—oral ingestion. Exposure through inhalation and dermal absorption are special cases that must be considered independently.

The primary routes of oral exposure for terrestrial wildlife are through ingestion of food (either plant or animal) and surface water. In addition, some species may ingest soil incidentally while foraging or purposefully to meet nutrient needs. The total exposure experienced by terrestrial wildlife is represented by the sum of the exposures from each individual source. Total exposure may be represented by the following generalized equation:

$$E_{total} = E_{food} + E_{water} + E_{soil} \; , \tag{31}$$

where

E_{total} = exposure from all sources
E_{food} = exposure from food consumption
E_{water} = exposure from water consumption
E_{soil} = exposure through consumption of soil (either incidental or deliberate)

Building on the screening assessment example, Table 14 provides an example of the use of benchmarks in a baseline assessment. The purpose of the assessment in this example is to ascertain the level of exposure and risk experienced by a representative endpoint species (meadow vole). In addition to soil and water contaminant data, concentrations of arsenic, lead, mercury, and selenium were measured in plants on which meadow voles forage. Exposure parameters for each medium were calculated according to the following equation:

$$E_{medium} = \frac{\text{Medium Consumption Rate (kg or L/d) x Analyte Concentration in Medium (mg/kg or mg/L}}{\text{Body Weight (kg)}} \tag{32}$$

where E_{medium} = estimated exposure (mg analyte/kg body weight/day) for each medium (e.g., food, water, and soil). Body weight (0.044 kg), food (0.005 kg/day) and water (0.006 L/day) consumption rates for meadow voles were obtained from Appendix B. Beyer et al. (1992) states that soil consumption by meadow voles is 2% of food consumption. Therefore, soil consumption was estimated to be 2% of 0.005 k/day or 0.0001 kg/day. As in the screening assessment, an HQ was calculated in which total exposure was compared to the LOAEL for each contaminant. Total exposure from all sources exceeded the LOAELs for selenium only.

Table 14. Use of benchmarks in a baseline assessment

Analyte	Contaminant Concentrations in Media			Contaminant Exposure (mg/kg bw/d)				LOAEL for Meadow Vole	HQ[a]
	Water (mg/L)	Soil (mg/kg)	Plants (mg/kg)	Water	Soil	Diet	Total		
Arsenic	0.038	131	1.77	0.0052	0.298	0.201	0.504	1.145	0.44
Lead	0.069	18.8	1.07	0.0094	0.043	0.122	0.174	134.35	0.0013
Mercury[b]	0.005	0.71	0.06	0.0007	0.0016	0.007	0.0093	0.27	0.035
Selenium	0.02	14.8	23.61	0.003	0.034	2.68	2.717	0.55	4.9

[a] HQ = Hazard Quotient = Total Exposure/Benchmark.
[b] Mercury assumed to be in the form of methyl mercury.

By comparing the exposure from each source (e.g., water, soil, diet) to the LOAEL, the relative contribution of each to the total can be determined. For example, virtually all selenium exposure (98.6%) was obtained through food consumption; selenium exposures from soil and water were both less then the LOAEL. This information serves not only to identify contaminants that present a risk, but by identifying the media that account for the majority of exposure, these data may be used to guide remediation.

In the preceding example, the species used has a small home range (< 1 ha) and a diet restricted to grassy and herbaceous plant material (Reich 1981). Therefore, it was assumed that voles would reside and forage exclusively on the hypothetical waste site and that 100% of the food, water, and soil consumed would be contaminated. Because most wildlife are mobile and many species have varied diets, it is not likely that all food, water, or soil ingested by individuals of other wildlife endpoint species would be obtained from contaminated sources. In the case of species with large home ranges, because they may spend only a portion of their time on a contaminated site (and may receive exposure from multiple, spatially separate locations), their exposure should be represented by the proportion of food, water, or soil obtained from contaminated sources. For species with diverse diets, the contaminant concentrations in the different food types consumed is likely to differ. Dietary exposure for these species would be represented by the sum of the contaminant concentrations in each food type multiplied by the proportion of each food type in the species diet.

Ideally, site-specific information on home ranges, diet composition, and use of waste sites by endpoint species should be collected. In the absence of site specific data, information to estimate exposure for selected wildlife species may be found in the *Wildlife Exposure Factors Handbook* (EPA 1993a and 1993b)or in other published literature.

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