339724

ADMINISTRATIVE RECORD

SDMS Document ID
2004003

RECORD OF DECISION

KENNECOTT NORTH ZONE SITE
KENNECOTT SOUTH ZONE SITE

Waste Water Treatment Plant and Sludge Ponds (OU 8), North Zone
Magna Soils (OU 9), North Zone
Smelter and Acid Plants (OU 13), North Zone
Refinery (OU 14), North Zone
Mills and Tailings Pond (OU15), North Zone
Acid Mine Drainage (OU18), South Zone
Smelter Fallout (OU 19), North Zone
Great Salt Lake and Associated Wetlands (OU 22), North Zone
North End Ground Water (OU 23), North Zone
Precipitation Plant (OU 24), South Zone

September 26, 2002

U. S. Environmental Protection Agency
Region VIII
999 - 18th St., Suite 300
Denver, CO 80202

DECLARATION

1. Site Name and Location

This Record of Decision covers the entire Kennecott[1] North Zone Site, including Operable Units 8 (WWTP Sludge Ponds), 9 (Magna Soils), 13 (Smelter and Acid Plants), 14 (Refinery), 15 (Mills and Tailings Pond), 19 (Smelter Fallout), 22 (Great Salt Lake and Associated Wetlands), and 23 (North End Ground Water). All of these operable units are located near the town of Magna, Utah. This Record of Decision also covers selected operable units of the Kennecott South Zone Site including Operable Units 20 (Pine Canyon), the Tooele County portions of OU 18 (Acid Mine Drainage), and OU 24 (Precipitation Plant). OU's 18 and 20 are located in Tooele County, Utah, and OU 24 is located near Copperton, Utah. This is the fourth and final Record of Decision at the Kennecott North Zone and South Zone Sites.

2. Statement of Basis and Purpose

This decision document presents the Selected Remedy for the Kennecott North Zone and portions of the Kennecott South Zone Sites located in Magna, Copperton, and Tooele County, Utah, which was chosen in accordance with CERCLA, as amended by SARA, and, to the extent practicable, the NCP. This decision is based on the Administrative Record file for this site.

The State of Utah concurs with the Selected Remedy.

3. Assessment of the site

The response action selected in this Record of Decision is necessary to protect the public health or welfare or the environment from actual or threatened releases of hazardous substances into the environment. The primary chemicals of concern were lead and arsenic for human health and selenium for ecological impacts.

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[1]The name "Kennecott" has been used by various entities, some of which were associated with mining, milling, smelting, and refining activities in the western Salt Lake Valley. There are other entities that use the name "Kennecott", but may not have been associated with these activities. The entity known as Kennecott Utah Copper Corporation did not exist prior to 1989. "Kennecott" as used in this document refers to Kennecott Utah Copper Corporation and/or other entities using the name "Kennecott" that were connected with historical activities described in this document.

4. Description of the Selected Remedy

The overall site cleanup strategy was to address surface materials which posed a current threat to industrial workers and wildlife resources through removal actions followed by addressing long term threats to workers and wildlife by treatment of ground water, cleanup of currently inaccessible mining wastes following facility closure and mapping of buried wastes for use by future land use planners and developers.

The principal threats were addressed by a previous emergency response action which removed and/or capped wastes which were contributing to ground water contamination.

Major components of the selected remedy include:

- In-situ treatment of selenium-tainted ground water coupled with collection of contaminated spring and well water for industrial use.

- Demolition of unneeded facilities, characterization of underlying soils, and removal of contaminated soils to an engineered repository.

- Continued use of the Arthur Stepback Repository to store contaminated soils as they are discovered following demolition activities and/or following facility closure.

- Development of a monitoring plan to evaluate progress toward ecological improvement.

- Mapping of locations of buried wastes and locations where future unrestricted land use is not appropriate.

5. Statutory Determinations

The Selected Remedy is protective of human health and the environment, complies with Federal and State requirements that are applicable or relevant and appropriate to the remedial action, is cost-effective, and utilizes permanent solutions and alternative treatment (or resource recovery) technologies to the maximum extent practicable.

The remedy also satisfies the statutory preference for treatment as the principal element of the remedy in that it reduces the toxicity and mobility of the hazardous substances.

Because this remedy will result in hazardous substances, pollutants, or contaminants remaining on-site above levels that allow for unlimited use and unrestricted exposure, a statutory review will be conducted within five years after initiation of the remedial action to ensure that the remedy is, or will be, protective of human health and the environment.

6. ROD Data Certification Checklist

The following information is included in the Decision Summary section of this Record of Decision. Additional information can be found in the administrative Record file for this site.

- Chemicals of concern and their respective concentrations
- Baseline risk represented by the chemicals of concern
- Cleanup levels established for chemicals of concern and the basis for these levels.
- How source materials constituting principal threats are addressed
- Current and reasonably anticipated future land use assumptions and current and potential future beneficial uses of groundwater used in the baseline risk and ROD
- Potential land and ground water use that will be available at the site as a result of the selected remedy
- Estimated capital, annual operations and maintenance (O&M), and total present worth costs, discount rate, and the number of years over which the remedy cost estimates are projected
- Key factors that led to selecting the remedy.

7. Authorizing signatures

The following authorized officials at EPA Region VIII and the State of Utah approve the selected remedy as described in this Record of Decision.

Max H. Dodson — 9-26-2002
Date

Max H. Dodson
Assistant Regional Administrator
Office of Ecosystems Protection and Remediation
U. S. EPA, Region VIII

Dianne R. Nielson — 10-04-02
Date

Dianne R. Nielson, Ph.D.
Executive Director
Utah Department of Environmental Quality

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DECISION SUMMARY

Section 1: Introductory Information Relevant to all Operable Units

A. Sites Covered in this Record of Decision

This Record of Decision covers a number of Operable Units within the Kennecott[1] North Zone and South Zone sites. The Kennecott North and South Zones were proposed for the National Priorities List in January, 1994. Final listing was deferred in September 1995 in accordance with the terms of a three-party Memorandum of Understanding (MOU) signed by officials at the U. S. Environmental Protection Agency (EPA), the Utah Department of Environmental Quality (UDEQ), and Kennecott Utah Copper Corporation ("Kennecott"). Studies, demolition and cleanup activities began in this area in 1991-2. Some of the investigations were part of studies supervised by the Army Corps of Engineers as part of the Environmental Impact Statement (EIS) required during a Clean Water Act (CWA) 404 permit application to fill wetlands during the North Expansion of the Magna Tailings Pond (North Tailings Impoundment). Other studies were conducted as part of an Engineering Evaluation/Cost Analysis (EE/CA) and other removal assessments. There were studies to develop water quality information for the purposes of an Utah Pollution Discharge Elimination System (UPDES) permit renewal application. Several Remedial Investigations (RI's) were started and one Remedial Investigation/Feasibility Study (RI/FS) was completed. Cleanups were supervised by a variety of federal and state agencies using a variety of environmental statues including Emergency Response and Remedial studies provisions of the Comprehensive Environmental, Response, and Liability Act (CERCLA), the Resource Conservation and Recovery Act (RCRA) corrective action, UPDES permit provisions, and CWA-404 permit provisions.

The following operable units are included in this Record of Decision (Table 1.1):

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[1]The name "Kennecott" has been used by various entities, some of which were associated with mining, milling, smelting, and refining activities in the western Salt Lake Valley. There are other entities that use the name "Kennecott", but may not have been associated with these activities. The entity known as Kennecott Utah Copper Corporation did not exist prior to 1989. "Kennecott" as used in this document refers to Kennecott Utah Copper Corporation and/or other entities using the name "Kennecott" that were connected with historical activities described in this document.

TABLE 1.1
OPERABLE UNITS IN THIS RECORD OF DECISION

OU	Site	Section of ROD	Name of OU
OU8	Kennecott North Zone*	Section 6	Wastewater Treatment Plant and Sludge Ponds (WWTP Sludge)
OU9	Kennecott North Zone*	Section 3	Magna Soils
OU13	Kennecott North Zone*	Section 4	Smelter and Acid Plants
OU14	Kennecott North Zone*	Section 5	Refinery
OU15	Kennecott North Zone*	Section 2	Magna Tailings Pond (Mills and power plants)
OU18	Kennecott South Zone	Section 10	Acid Mine Drainage (Tooele County discharges portion)
OU 19	Kennecott North Zone*	Section 9	Atmospheric Fallout
OU 20	Kennecott South Zone	Section10	Pine Canyon
OU22	Kennecott North Zone*	Section 7	Great Salt Lake and associated wetlands
OU23	Kennecott North Zone*	Section 8	North End Ground Water
OU24	Kennecott South Zone	Section 11	Precipitation Plant

* The Kennecott North Zone is sometimes known as "Kennecott Tailings"

Because each operable unit has its own unique history, operational processes, environmental problems and location, each of these are described in a separate chapter of this ROD. However, all of the operable units are connected to each other in an operational sense. For example, ore is mined and milled in the Kennecott South Zone but the tailings and concentrates are sent via slurry pipelines to the Kennecott North Zone. Water from the North Zone is recycled back to the South Zone for reuse. A map of the areas covered in this Record of Decision is shown on Figure 1.1.

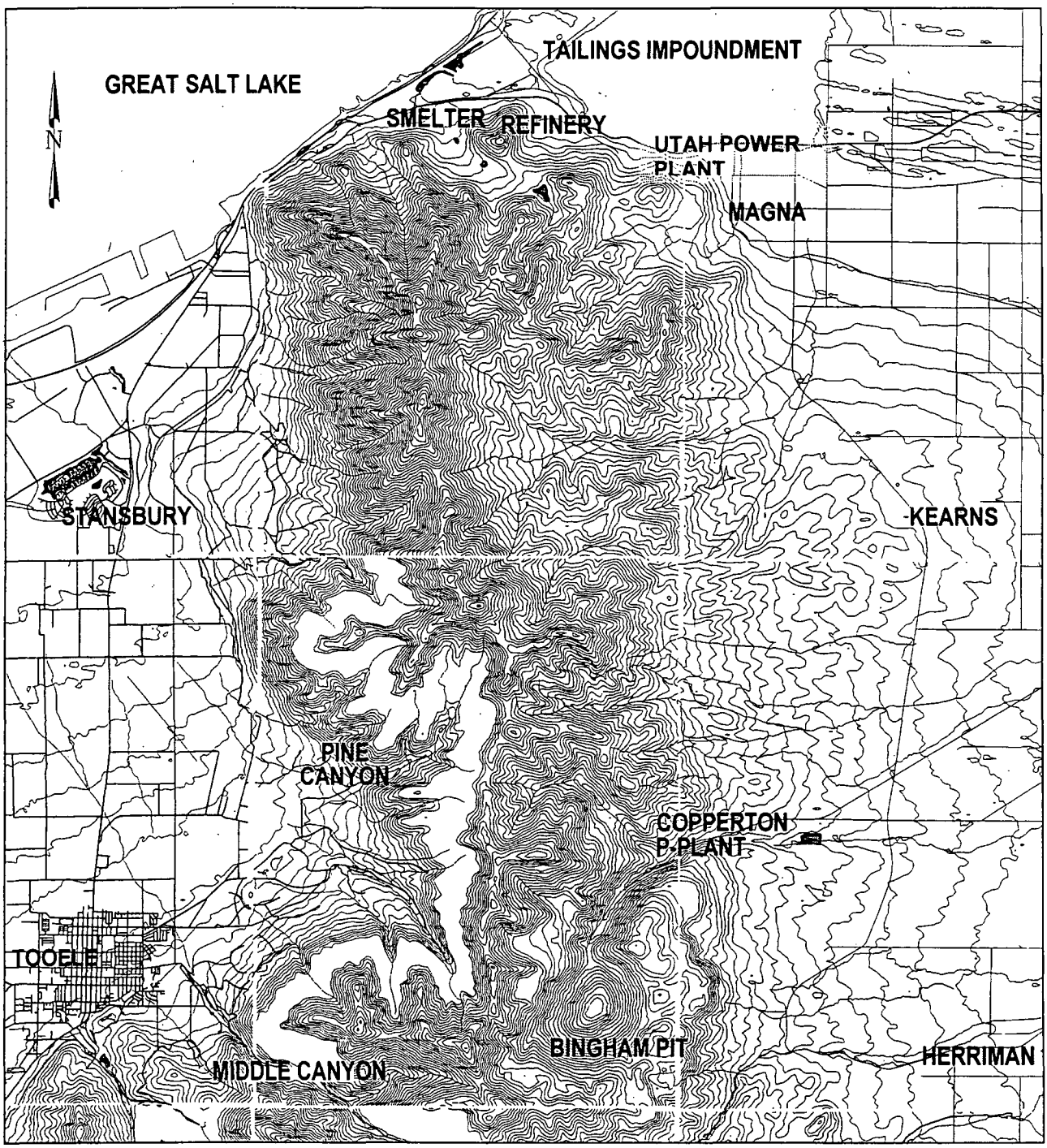
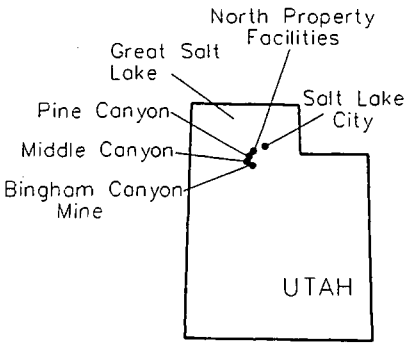


Figure1.1

KENNECOTT NORTH FACILITIES SITES AND NORTHERN OQUIRRH MTNS



This Record of Decision is the fourth and final Record of Decision for the Kennecott North and South Zone sites. The first, issued by EPA in September, 1998, covered the Bingham Creek and Bingham Canyon area (with the exception of the Proler and Precipitation Plant sites). The second, issued by EPA in December 2000, covered the groundwater problems in the South Zone area. The third, issued by EPA in September, 2001, addressed the southern portions of the Kennecott South Zone (with the exception of Pine Canyon and Tooele County mine drainage), including Herriman, Lark, South Jordan and the Butterfield Canyon. It also included Proler. The present ROD, the fourth for the site, covers the entire North Zone site (including both surface and ground water) and all remaining facilities in the South Zone including Pine Canyon, Tooele County mine drainage, and the Precipitation Plant.

The entire site is an EPA enforcement lead site with support of the Utah Department of Environmental Quality. Aiding EPA in oversight of the various CERCLA projects were other federal agencies including the U. S. Bureau of Reclamation, the U. S. Geological Survey, and the U. S. Fish and Wildlife Service. Other nearby cleanups or studies were supervised by the Army Corps of Engineers, and State of Utah RCRA and Water Quality staffs. Some subsets of operable units were studied under provisions of the Historic Sites provisions of the Kennecott Memorandum of Understanding. The study phases and any cleanups of the historic sites performed the ROD were supervised as a state lead activity.

B. Community Participation

Community participation occurred using a variety of approaches. The most significant form of participation was the North End Technical Review Committee which is composed of representatives from several federal and state agencies, Kennecott, consultants, university professors, environmental activists and local residents. This committee met at least annually and sometimes much more frequently to discuss the issues and monitor the studies and cleanups. The committee did some coordination between on-going projects being conducted by different agencies and different groups within Kennecott. A second form of community relations was regular briefings to the Magna Area Community Council, especially when new activities were planned.

A third form of community help was the aid of community leaders when EPA collected samples in Magna. EPA especially acknowledges the help of the late Jim Brussato, Sr. Mr. Brusatto, a former state legislator, member of the Technical Review Committee, and well respected in the community, accompanied the sampling teams in Magna. As a result of his help, all of the property owners cooperated and provided information regarding past environmental problems in the town. Mr. Brusatto also aided the ATSDR when they conducted their health assessment for the site.

A fourth form of participation proved to be very popular – site tours of the facilities and cleanups. Many local citizens are retired from Kennecott or worked there at one time.

They were interested in the new facilities, the old facilities, the cleanups, and the plans for the future. The fifth technique was the invitation of community, business, and environmental leaders to a Land Use Workshop for the Kennecott wetland areas. Among the 78 total participants, eight Magna citizens attended the workshop. Finally, copies of important documents, plans, and meeting minutes were kept for public use at Denver by EPA, at Salt Lake City by UDEQ, and at Magna at the Magna Salt Lake County Branch Library.

The availability of the proposed plan and hearing announcement was published in the Salt Lake Tribune and the Deseret News on June 10, 2002. A public hearing was held in Magna on June 12, 2002 at the Magna Branch of the Salt Lake County Library. The public comment period ended on August 11, 2002. Three letters were received during the public comment period. A list of concerns raised in these letters and EPA's response is given in Appendix A.

C. Scope and Role of the Proposed Action

This is the fourth and final Record of Decision for the Kennecott Sites. This Record of Decision covers the entirety of the Kennecott North Zone, including both the surface and groundwater, and all remaining areas of the Kennecott South Zone not addressed by the previous Records of Decision.

D. Current and Future Land Use

Virtually the entire area addressed in this ROD is zoned M-2 (manufacturing, heavy industrial, mining). The current land uses are pockets of heavy industrial complexes separated by areas of open spaces. Over the years, the open spaces were used as buffer zones (to absorb smoke damages from the smelter), as laydown yards (for equipment storage), for dumping grounds for slag and other wastes, for storage of concentrates, matte and other products, for gravel and sand mining, and for slag storage. (The upper reaches of a few of the canyons and the Wetlands Mitigation Area on the north side of I-80 are zoned agricultural, and the Great Salt Lake is zoned commercial.) The zoning map for the Kennecott North Zone is given in Figure 1.2.

The patchwork of industrial operations and open space is likely to continue for the next 10 years, perhaps much longer. The only changes will be the demolition of unneeded facilities and infrastructure. The future land use of the triangle of open space between I-80, SH 201 and SH 202 has been the topic of much discussion by the property owner and its neighbors. On one hand, the land is serviced by a network of highways and mainline transcontinental rail routes making the land attractive for industrial development. On the other hand, ponds which were created mostly due to sand mining, have evolved over the years as wetland habitat between waste areas. The wetlands have become quite scenic when viewed from the Interstate 80 approaching Salt Lake City. Located just across the

Color Chart(s)

The following pages contain color that does not appear in the scanned images.

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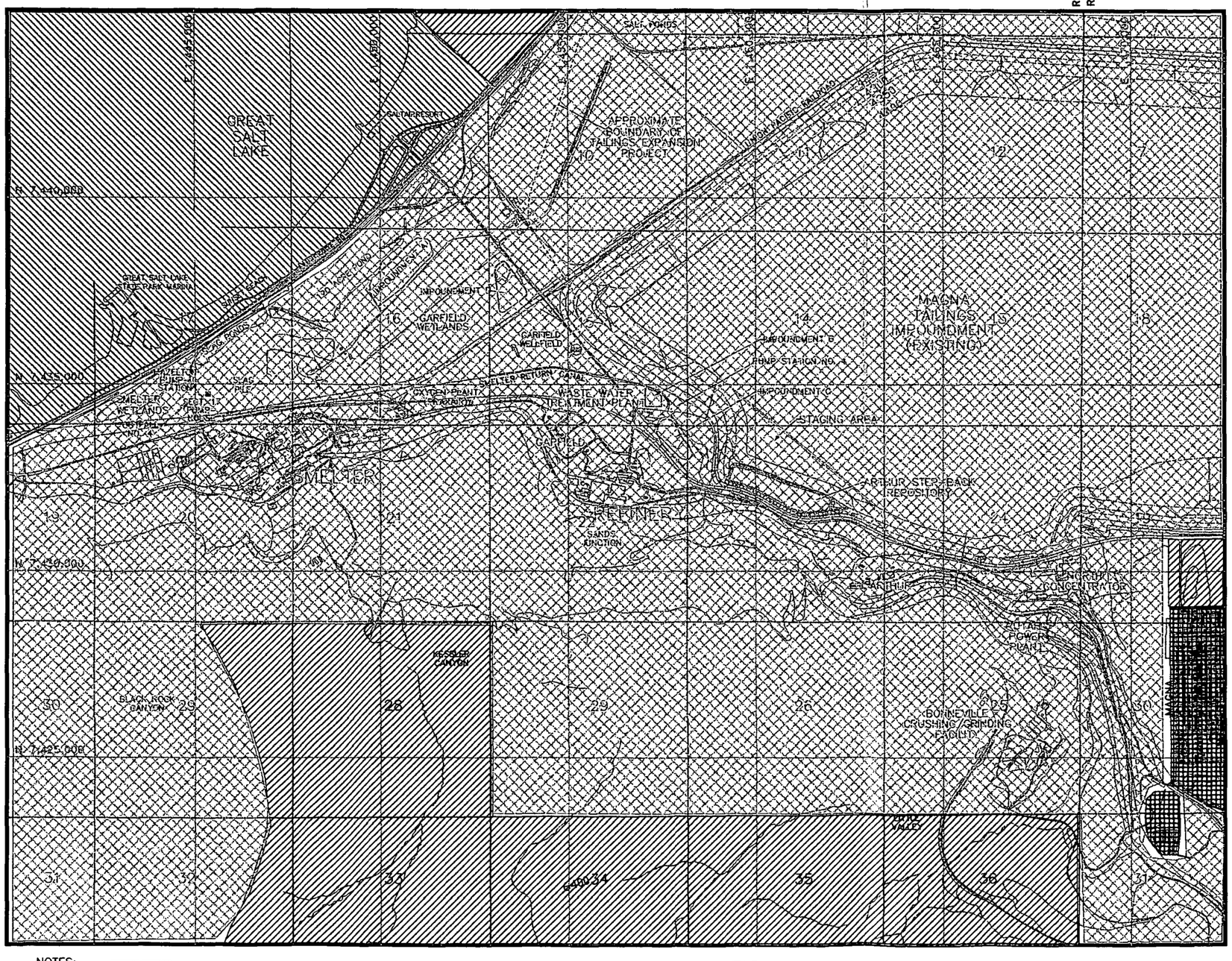
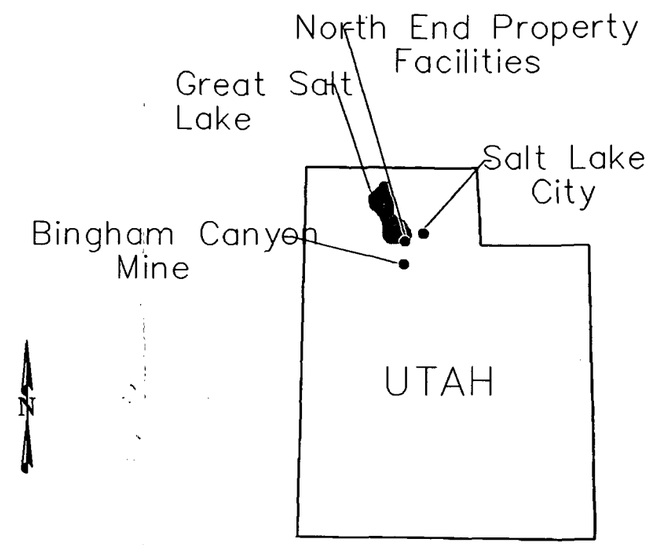
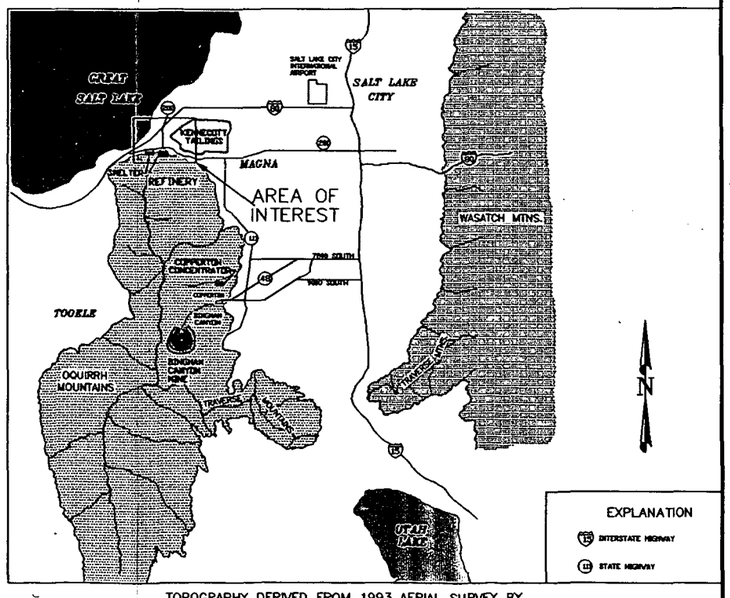






TOPOGRAPHY DERIVED FROM 1993 AERIAL SURVEY BY OLYMPUS AERIAL SURVEY INC. MAP DRAWN WITH 10 FOOT CONTOUR INTERVALS.

GRID SHOWN BASED ON STATE PLANE COORDINATE SYSTEM.
USGS NAD 1983 HORIZONTAL DATUM.
USGS NAVD 1988 VERTICAL DATUM.

NOTES:

A–20 AGRICULTURE

C–V COMMERCIAL

M–2 MANUFACTURING

RESIDENTIAL

ENVIRONMENTAL ENGINEERING SERVICES			KENNECOTT UTAH COPPER
SCALE: 1" = 3000'		DATE	FIGURE 1.2 NORTH END LAND USE / ZONING MAP
DESIGNED BY	J. CHERRY	06/00	
DRAWN BY	B. SCOTT	06/00	
CHECKED BY	J. CHERRY	07/00	
PROJECT ENGINEER	J. CHERRY	07/00	
PROJECT MANAGER	J. CHERRY	07/00	Job No. --- Dwg. No. 451-T-4952 REV 0 DATE 07/00

highway from the Great Salt Lake, a wide variety of birds inhabit the area.

In order to flesh out ideas for future development of this area, the property owner, Kennecott, sponsored a workshop with participants from Magna, business leaders, real estate specialists, urban planners, state and local governments, and environmentalists. In small groups with professionals and citizens with diverse interests, conceptual ideas were proposed for future land use. Most groups proposed retention of the wetland areas coupled with other development nearby. Some proposed an intermodal transportation center taking advantage of the transcontinental rail junction and highways on the site. Others proposed education facilities based on wetland studies. Another proposed tourist attractions and services using the Gateway approach to Salt Lake City from the west.

For the purposes of planning, EPA assumed that the footprint of the slag pile (after removal of the surface slag) would be appropriate for industrial redevelopment and the land immediately adjacent to SH 201 on the south side could also be converted to water management or industrial development. (This area, the location of Kessler Springs and other seeps, is the location where the selenium-tainted ground water plume daylights and is likely to present a threat to wildlife for some years to come. The area could be needed for selenium treatment facilities, but could also be used for other development as well.) With the exception of the western end of the slag pond (which is a storage pond for smelter intake water), EPA assumes the remainder of the triangle will be open space/wetlands/buffer land used as wildlife habitat and perhaps equipped with public access and exhibit areas.

The valleys south of the refinery and smelter are currently zoned for agriculture and manufacturing. This area is quite scenic and could be used for recreation at some point in the future. Kennecott has indicated that they are considering Little Valley as a potential site for residential development.

E. Summary of Site Risks

1. Human Health Risk Assessment

The entire area covered in this Record of Decision is zoned M-2 (heavy industrial, manufacturing, mining), and the current land use is either heavy industrial or open space buffers surrounding the industrial areas. All residents were moved from the site (Town of Garfield) in the 1960s. Current receptors at risk for exposures are industrial workers during their lunch hour or after work, construction workers, occasional visitors, and a few ranchers. Future land use is uncertain, but is likely to remain in industrial land use for the foreseeable future due to nearby highway, rail and utility infrastructure.

A portion of the site is leased to ranchers for raising livestock (reclaimed areas of

the South Tailings Impoundment). In the past, sheep grazing has occurred in Little Valley and areas east of the Tailings Impoundments.

To establish preliminary remediation goals for protection of human health, EPA and its contractor, CDM Federal Programs, conducted a risk assessment focusing on non-residential land uses such as industrial, commercial, recreation, and agricultural land uses (*Final Preliminary Remediation Goals Report for Addressing Risks to Human Health from Exposures to chemicals in Kennecott Soils, Dec. 30, 1999.*) A risk assessment task force composed of toxicologists and health professionals from EPA, the Utah Department of Health, the Utah Department of Environmental Quality, the Salt Lake Valley Health Department, local communities, and Kennecott, aided EPA in developing realistic assumptions for the exposure duration and frequency. Kennecott aided by providing exposure information for its current workers.

Note that while working on the job, Kennecott and contract employees on the site are governed by OSHA and/or MSHA worker protection standards, and Kennecott provides the necessary PPE and safety equipment. It also requires medical monitoring for its workers and contractors. The EPA risk calculations apply to those situations where the workers are on break and may take a hike or eat lunch on the grounds outside the normal work areas and while there may come in contact with contamination inadvertently, and, perhaps, unknowingly.

The Risk Assessment Task Force made the following exposure duration and frequency assumptions for the different current and potential land uses at the site (Tables 1.2, 1.3, 1.4, 1.5, and 1.6).

TABLE 1.2
FREQUENCY OF EXPOSURE ASSUMPTIONS

ACTIVITY	NORTH ZONE	SOUTH ZONE
Recreation		
Horseback riding	20 days/yr	10 days/yr
Hiking	10 days/yr	5 days/yr
Hunting	2 days/yr	8 days/yr
Picnicking	5 days/yr	5 days/yr
ATV use		10 days/yr
Camping		5 days/yr

ACTIVITY	NORTH ZONE	SOUTH ZONE
Employees on break	150 days/yr	150 days/yr
Commercial/industrial		
Central Tendency Estimate	219 days/yr	219 days/yr
Reasonable Maximum Estimate	250 days/yr	250 days/yr
Agricultural		
Normal agricultural activity	183 days/yr	183 days/yr
Extra dust days (plowing) - Central Tendency Estimate	15 days/yr	15 days/yr
Extra dust days (plowing) - Reasonable Maximum Estimate	30 days/yr	30 days/yr

TABLE 1.3
EXPOSURE DURATION ASSUMPTIONS

Activity	Central Tendency duration	Reasonable Maximum duration
Recreational users - adults	9 yrs	30 yrs
Recreational users - children	2 yrs	6 yrs
Commercial/industrial	5 years	25 yrs
Agricultural users	10 yrs	25 yrs

TABLE 1.4
EXPOSURE TIME (used in inhalation calculations)

Activity	North Zone	South Zone
Recreational		
ATV	-	4 hrs/day
horseback	4 hrs/day	4 hrs/day

Activity	North Zone	South Zone
Commercial	8 hrs/day	8 hrs/day
Agricultural (CTE)	4 hrs/day	4 hrs/day
Agricultural (RME)	12 hrs/day	12 hrs/day

TABLE 1.5
SOIL AND DUST INGESTION RATE
(Assumes 45% of total is outside soils and 55% is indoor dust)

Activity	Central Tendency	Reasonable Maximum
Recreational		
Moderate	25 mg/day	50 mg/day
High (ATV, camping)	50 mg/day	100 mg/day
Children	100 mg/day	200 mg/day
Commercial/Industrial workers	50 mg/day	100 mg/day
Agricultural workers	65 mg/day	273 mg/day

TABLE 1.6
INHALATION RATE ASSUMPTIONS

Activity	Central Tendency	Reasonable Maximum
Recreational	1.3 m^3/hr	2.5 m^3/hr
Commercial and industrial	0.83 m^3/hr	1.25 m^3/hr
Agricultural workers	0.83 m^3/hr	1.25 m^3/hr

Bioavailability is a factor considered in the preliminary remediation goal calculations for lead and arsenic. At the Kennecott South Zone residential areas, the soils were dosed to juvenile pigs and the bioavailability was directly measured. However, for the North Zone, it is suspected that the chemical forms of lead and arsenic would be quite diverse from operable unit to operable unit and even from pile to pile, depending on the type of waste. Therefore, for the North Zone, EPA is using 100% relative bioavailability (relative to the soluble form) for

the calculations.

For cancer risk, EPA is using the Central Tendency Exposure calculations with the mid-range of cancer probability at 10^{-5} (or 1 in 100,000). The acceptable cancer risk range in the National Contingency Plan is 10^{-4} to 10^{-6}. The choice of 10^{-5} provides human health protection with a safety factor of 10 and is still within acceptable protection guidelines dictated in EPA regulations. For non-cancer risk, the calculations indicate the concentration at which Hazard Quotients exceed 1. For lead, the EPA adult lead model was used, but could not accommodate the episodic exposures typical of non-residential land uses. In this case, the exposure frequencies were assumed to be one day/week throughout the year. A summary of preliminary remediation goals for the various potential site activities in given in Table 1.7.

TABLE 1.7
PRELIMINARY REMEDIATION GOALS FOR CHEMICALS OF CONCERN AT NON-RESIDENTIAL LAND USE EXPOSURE ASSUMPTIONS (Units are part per million except where noted)

Activity	As	Cd	Cr^{+6}	Cu	Mo	Pb	Se	Zn
Industrial/commercial Cancer	261	pure	26.6%	Pure	-	-	-	-
Industrial/commercial Non-cancer	838	2794	8381	10.3%	13972	4414	13972	83%
Agricultural - cancer	100	pure	pure	-	-	-	-	-
Agricultural - Non-cancer	644	2148	6444	79689	10740	8500	10740	64%
Recreational - adults								
ATV South Zone - Cancer	283	758	114	-	-	-	-	-
ATV South Zone - Non-cancer	15330	51100	18853	pure	25.6%	4414	25.6%	Pure
Horseback North Zone Cancer	2648	pure	-	-	-	-	-	-
Horseback North Zone Non-cancer	15330	51100	pure	pure	25.6%	4414	25.6%	Pure
Horseback South Zone Cancer	5297	pure	pure	-	-	-	-	-

Activity	As	Cd	Cr^{+6}	Cu	Mo	Pb	Se	Zn
Horseback South Zone Non-cancer	30600	10.2%	30.6%	Pure	51.1%	4414	51.1%	Pure
Campers South Zone Cancer	5299	-	-	-	-	-	-	-
Campers South Zone Non-cancer	30600	10.2%	30.6%	Pure	51.1%	4414	51.1%	Pure
Hikers and Picnickers Cancer	10599	-	-	-	-	-	-	-
Hikers and Picnickers Non-cancer	61320	20.4%	61.3%	Pure	pure	4414	pure	pure
Employees on break Cancer	353	-	-	-	-	-	-	-
Employees on break Non-cancer	2044	6813	20440	25.2%	34067	4414	34067	pure
Recreational - adults and children								
Hikers - North Zone Cancer	1136	-	-	-	-	-	-	-
Hikers - North Zone Non-cancer	6570	21900	65700	81.2%	10.9%	2207	10.9%	Pure
Hikers - South Zone Cancer	2271	-	-	-	-	-	-	-
Hikers - South Zone Non-cancer	13140	43800	13.1%	Pure	21.9%	2207	21.9%	Pure
Campers - South Zone Cancer	1947	-	-	-	-	-	-	-
Campers - South Zone Non-cancer	11263	37543	11.2%	Pure	18.7%	2207	18.7%	Pure

Because it is unwieldy to have so many remediation goals at a given site, EPA has summarized the remediation goals into broad categories using the highest exposure situation yielding the lowest soil concentrations (Table 1.8). If this goal is met, the soil concentrations should be clean enough for protectiveness in all activities.

TABLE 1.8
SUMMARY OF REMEDIATION GOALS FOR LAND USES (ppm in soil, unless otherwise noted)

Land Use	As	Cd	Cr	Cu	Mo	Pb	Se	Zn
Industrial/Commercial	261	2764	8381	10.3%	13972	4414	13972	83%
Agricultural	100	2148	6444	79689	10740	8500	10740	64%
Recreational (ATV)	283	758	114	25.2%	34067	2207	34067	pure
Unrestricted Land Use	50	-	-	-	-	500	-	-
North Zone Removal Action Level	200	1000	-	-	-	2000	1000	-

For most of the chemicals of concern, the removal action levels were sufficient to protect human health with the possible exception of arsenic for agricultural land use. However, the exposure assumptions were based on farming rather than ranching where tilling the soil is a major exposure pathway. For the areas considered in this Record of Decision, the primary activity is ranching and exposures and risks should be lower. In addition, as can be observed in the later site descriptions it is not uncommon to find isolated locations where the soil concentrations exceed 100 mg/kg arsenic, but the average concentrations are well beneath that level, typically around 30 mg/kg arsenic.

Although most of the metals were monitored at the site, only lead and arsenic were found at concentrations of health concern at industrial sites. Therefore, only lead and arsenic are routinely reported in this Record of Decision. (Selenium is also reported for ecological risk reasons.)

The groundwater contamination does not pose a human health risk because all of the water rights in the area are owned by Kennecott, and the water is not used for culinary purposes. In addition, because of the proximity to the Great Salt Lake, the ground water is not likely to be useful for culinary purposes in the future because of its high salinity. Wells farther away from the lake must produce water meeting the MCLs in quality before the use designation can change.

2. Ecological Risk Assessment

In accordance with EPA policy, Kennecott and its contractors performed the ecological risk assessment for the entire Kennecott North and South Zones. A site Biological Technical Advisory Group (BTAG) was formed to advise EPA with regard to the sensitive habitats and risks. The BTAG was composed of EPA

North of Garfield Smelter: Wetlands

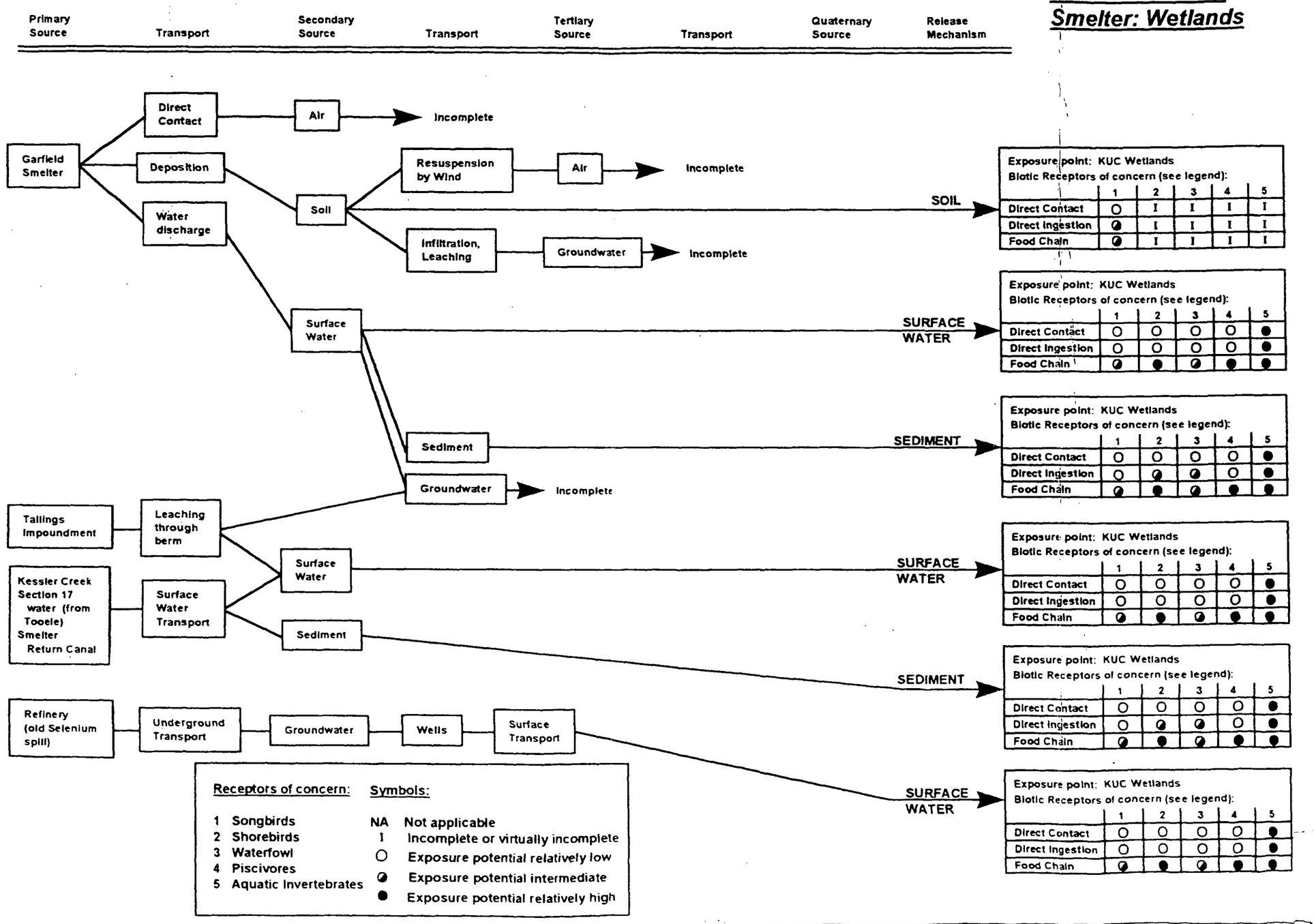


Figure 1.3 Conceptual Site Model for wetlands north of the Garfield Smelter.

biologists from the region and headquarters, USFWS biologists and toxicologists, state wildlife experts, and Kennecott consultants. The project managers from EPA, Utah and Kennecott typically attended the meetings of the BTAG so that there could be an ongoing dialogue and sharing of the data as the cleanup projects and studies proceeded. Exposure models were developed which aided the group in understanding the sources, pathways, and exposures (see Figure 1.3). Sometimes, after some cleanup projects had been completed and a pathway interrupted, the project managers requested that the biologists return to the site to determine if the efforts had made measurable impacts on the site biota. Reports included *Problem Formulation Report, Screening Level for the Ecological Risk Assessment* (Jan. 1995), *Risk Characterization Report, Screening Level for the Ecological Risk Assessment* (Jan. 1995), *Analysis Report, Screening Level for the Ecological Risk Assessment* (Jan. 1995), *Ecological Risk Assessment, Southshore Wetlands* (Mar. 1996), *Ecological Risk Assessment, Northern Oquirrh Mountains* (Mar. 1996), *Ecological Risk Assessment, Great Salt Lake* (Mar. 1996), *Evaluation of Selenium Toxicity to the Algae, Dunaliella Viridis* (Mar. 1998), *Evaluation of Selenate Toxicity to the Larvae of the Brine Fly, Ephydra Cinerea* (Mar. 1998), *Selenium Ecological Risk Assessment for Kennecott Southshore Wetlands* (Dec. 1998), *The Acute Toxicity of Selenium to the Brine Shrimp, Artemia Franciscana* (Jan. 1999), *Chronic Toxicity of Selenium to Brine Shrimp Artemia Franciscana* (Feb. 1999), *Evaluation of Selenium Bioaccumulation in Brine Shrimp Near the Kennecott Utah Copper WC-7 Discharge to the Great Salt Lake* (Feb. 2000), *Changes and Current Status of CoC in Wetlands near Industrial Sites of Kennecott Utah Copper* (Mar. 2000), and other references in the scientific literature.

In a manner analogous to the human risk assessment, the site was divided into different habitats present at the site and each habitat was studied separately. The habitats included upland, riparian, south shore wetlands, and the Great Salt Lake. For each habitat, literature information on contaminant toxicity was compiled and then used to establish screening values for soils and vegetation (diet). Then these literature values were compared to conditions at the site. Efforts were then made to determine if excesses over the literature information translated to actual impacts at the site.

For some habitats, such as the Great Salt Lake, biologists could not find sufficient relevant information in the literature. The investigators then conducted bioassays on the several species in order to get the information needed. Although this approach was originally designed to support CERCLA cleanup decisions and performance standards, the data were used for other programs as well, including requirements in the Magna Tailings Pond Expansion Project CWA 404 permit and as technical support for Kennecott's discharge limitations in their UPDES surface water discharge permit.

a. Uplands

The literature search phase of the upland habitat summarized the studies which had investigated the impact of soil metal concentrations on a variety of plants including grains, grasses, and garden vegetables. Both lethal concentrations and sublethal effects such as reduced growth rates were evaluated. Table 1.9 (Table 5 in the Problem Formulation Report, 1995) gives a summary.

TABLE 1.9
PHYTOTOXICITY THRESHOLD VALUES (PPM)

Range	As	Cd	Cr	Cu	Pb	Se	Zn
Low	10	3	75	60	100	4	70
Medium	50	17	100	100*	400	6	200
High	100	100*	500	150	500*	10	400*

*values used as threshold at the Bunker Hill Superfund site.

The next effort was to determine at what concentration of contaminants wildlife grazing on impacted vegetation would begin to experience adverse reactions. Emphasis was placed on studies using wildlife, but sometimes the only data available were for domesticated species (Table 1.10).

TABLE 1.10
MAXIMUM TOLERABLE CONCENTRATIONS IN FOOD (ppm dry weight)
(no = NOAEL, low = LOAEL)*

Type of animal	As		Cd		Cr		Cu		Pb		Se		Zn	
	no	low	no	low	no	low	no	low	no	low	no	low	no	low
Herbivorous birds	112	200	10	12	1000	2000	500	800	100	1000	2.5	5	125	250
Insectivorous birds	-	-	-	-	-	-	-	-	94	-	-	--	-	-
Carnivorous birds	-	-	-	-	-	-	-	-	448	-	-	-	-	-
Ruminants	285	570	15	30	3000	-	7.3-30	26.6-38	1000	-	4	10	692	750
Other herbivorous mammals	50	-	47.1	50	300	-	250	425	30	325	4.8	6.4	500	1000

Type of animal	As		Cd		Cr		Cu		Pb		Se		Zn	
	no	low	no	low	no	low	no	low	no	low	no	low	no	low
Insectivorous mammals									250		140			
Carnivorous mammals		10							6			7 2	500	1500
Invertebrates					287	972	300	355	550				150	5000

*NOAEL = No Observable Adverse Effects Level, LOAEL = Lowest Observed Adverse Effect Level

In the Problem Formulation report, KUC investigators catalogued the different species of plants and animals reported or observed at the site (Table 1.11).

TABLE 1.11
PLANTS AND ANIMALS IN UPLAND AREAS OF THE SITE

Plants and Animals	Number of species
Plants	321
Birds	177
Insectivore mammals (bats, shrews)	20
Carnivore mammals (cougars, raccoons)	12
Rodents (mice, squirrels)	32
Rabbits	6
elk, deer	2
amphibians	8
reptiles	17

The next step included field observations in the areas of interest to determine if the plant communities exhibited disturbances. The investigators measured the number of taxa (richness), the proportion of weedy taxa, the proportion of native vs. non-native taxa. These indicators are measures of disturbance, but disturbances can be either due to contamination or physical features, such as the tailings pond berms or cattle grazing. A summary of the plant community

structure as a function of location is given in Table 1.12.

TABLE 1.12
PLANT DISTURBANCE AREAS

Location	Lower species diversity	High % weedy taxa	Low native %	Dominance distributions
*Black Rock		x	x	
*Kessler	x	x		
*Little Valley	x	x	x	
Coon				
Harkers				
*Pine				x
Spine				
Butterfield				x
@Tailings Berm	x	x	x	x

*known plant damages due to smelter smoke sulfur gases from historic smelters
@ revegetation with non-native, fast growing species to stabilize slopes and reduce erosion

Investigators also compared their biological data with a similar survey conducted by Utah State University in 1974. The floristics richness (number of taxa identified) increased from 159 species to 335, perhaps the result of successional changes over the 20 years. Some species from 1974 were not found in 1994 including spring blooming wildflowers (observations in 1994 were made in late summer), rare species, and a range of grasses and forbs not related to any specific plant community. EPA concludes that there is evidence that the plant communities were disturbed at areas known to have been impacted with sulfur gases (sulfur dioxide, for example) from the older smelter facilities. Plant distributions are also affected where revegetation projects used a predominance of non-native species. However, there is also strong evidence that these impacted areas are slowly recovering.

In the Analysis Report, the investigators used site specific data to estimate exposures to herbivorous animals. They assumed that the diet of a herbivore would be comprised of 98% vegetation and 2% soil and used the upper confidence level (UCL) of the soil and vegetation concentrations for each canyon. Another method to calculate exposures was a probability-based estimate which

produced a distribution of exposures (concentrations in diet) based on the distributions of contaminants in soils and vegetation at each site (Table 1.13).

TABLE 1.13
PROBABILITY THAT DIETS FOR ANIMALS WILL EXCEED BENCHMARKS

Location	Arsenic		Cadmium		Copper		Lead		Selenium		Zinc	
	loael	noael	loael	noael	loael	noael	loael	noael	loael	noael	loael	noael
HERBIVORE DIET												
Impacted areas												
Black Rock	<5%	<5%	<5%	<5%	60%	60%	<5%	<5%	75%	>95%	<5%	<5%
Kessler	<5%	<5%	<5%	<5%	65%	85%	<5%	<5%	55%	>95%	<5%	<5%
Little Valley	<5%	<5%	<5%	<5%	<5%	<5%	<5%	<5%	10%	60%	<5%	<5%
Pine Canyon	<5%	<5%	<5%	<5%	<5%	<5%	<5%	<5%	40%	>95%	<5%	<5%
Tailings Berm	<5%	<5%	<5%	<5%	<5%	<5%	<5%	<5%	40%	>95%	<5%	<5%
Relatively unimpacted areas												
Spine	<5%	<5%	<5%	<5%	<5%	<5%	<5%	<5%	<5%	<5%	<5%	<5%
Coon	<5%	<5%	<5%	<5%	<5%	<5%	<5%	<5%	5%	90%	<5%	<5%
Harkers	<5%	<5%	<5%	<5%	<5%	<5%	<5%	<5%	40%	90%	<5%	<5%
CARNIVORE DIET												
Impacted areas												
Black Rock	<5%	<5%	<5%	<5%	60%	65%	<5%	<5%	>95%	>95%	<5%	<5%
Kessler	<5%	<5%	<5%	<5%	60%	70%	<5%	<5%	>95%	>95%	<5%	<5%
Little Valley	<5%	<5%	<5%	<5%	30%	35%	<5%	<5%	90%	>95%	<5%	<5%
Pine Canyon	<5%	<5%	<5%	<5%	15%	20%	<5%	<5%	45%	65%	<5%	<5%
Tailings Berm	<5%	<5%	<5%	<5%	15%	15%	<5%	<5%	>95%	>95%	<5%	<5%
Relatively unimpacted areas												
Spine	<5%	<5%	<5%	<5%	10%	15%	<5%	<5%	<5%	<5%	<5%	<5%
Coon	<5%	<5%	<5%	<5%	25%	30%	<5%	<5%	>95%	>95%	<5%	<5%
Harkers	<5%	<5%	<5%	<5%	25%	30%	<5%	<5%	90%	>95%	<5%	<5%

Although the frequencies were based on observed concentrations in the soil and vegetation at the site, the benchmarks (LOAELs and NOAELs) were based on literature values, sometimes using species observed at the site, sometimes not. It is also clear that these benchmarks may be overly conservative at this site

resulting in risks to wildlife even in unimpacted areas. For example, selenium appears to present a risk to herbivores even in unimpacted areas such as Coon Canyon and Harkers Canyon. Selenium, and to a lesser extent copper, presents a calculated risk to carnivores in Coon Canyon and Harkers Canyon.

In the final phase of the study, the investigators attempted to correlate observed effects on animals from those areas which were potential threats to wildlife based on the comparisons to LOAELs and NOAELs. In this final phase, "Ecological Risk Assessment, Northern Oquirrh Mountains", the investigators trapped small mammals and invertebrates and compared their observations with colocated samples of soils and vegetation. The most predominant small mammals studied were deer mice and pinon mice. The animals were necropsied, and subsets were analyzed for body burden levels of contaminants. Tissues were studied for histopathology (tumors, disease, etc.).

The body burden contaminant analyses were used to calculate trophic level transfer factors for following each contaminant as it moved up the food chain. A simple table shows a summary of results showing the locations where the highest concentrations at each trophic level were found (Table 1.14).

TABLE 1.14
LOCATIONS OF HIGHEST CONCENTRATIONS
S = Highest soil concentrations
P = Highest common plant concentrations
I = Highest body burden in invertebrates
M = Highest body burden in mice

Location	As	Cd	Cu	Pb	Se	Zn
Coon #1						
Coon #2						M
Little Valley #1	P				S	
Little Valley #2						
Kessler #1	M		M		M	
Kessler #2	M		M		SPIM	
Black Rock #1	I		SPI		I	M

Location	As	Cd	Cu	Pb	Se	Zn
Black Rock #2	I		SI			
Pine #1	P	SPI		PIM		PI
Pine #2	S	IM		SPIM	P	SI
Pine #3	S	SPM	P	S		SP

For some contaminants, the highest soil concentrations produced the highest plant concentrations, the highest invertebrate concentrations and the highest contaminants in the mice. Cadmium and lead fit this model, more or less. But the other contaminants, the relationship, if it exists, was unclear. For As, there was no relationship at all. For Cu and Zn, the concentrations in mice were not associated with the soil, plants, or invertebrate rankings.

The data, however, were used to calculate a food web model for each sampling site (Table 1.15).

TABLE 1.15
COMPARTMENTS WITH DIETS EXCEEDING NOAELS

Location	As	Cd	Cu	Pb	Se	Zn
Coon #1				Carnivore*	Carnivore	Bird insectivore
Coon #2						Bird insectivore
Little Valley #1			Herbivore, omnivore	Carnivore*		Bird insectivore
Little Valley #2			Herbivore, omnivore			Bird insectivore
Kessler #1			Herbivore, omnivore	Carnivore*	Nearly everything	Bird insectivore
Kessler #2			Herbivore, omnivore, carnivore	Carnivore*	Everything	Bird insectivore

Location	As	Cd	Cu	Pb	Se	Zn
Black Rock #1			Herbivore, omnivore	Carnivore*	Omnivore, insectivore	
Black Rock #2			Herbivore, omnivore	Carnivore*	Omnivore, insectivore	Bird insectivore
Pine #1			Omnivore	Herbivore, omnivore, carnivore*		Bird insectivore
Pine #2			Herbivore, omnivore	Herbivore, omnivore, carnivore*	Herbivore, omnivore	Bird insectivore
Pine #3			Herbivore, omnivore	Carnivore*	Herbivore	Bird insectivore

*in comparison to low end of NOAEL range.

Exceedances were common for copper, lead, selenium, and zinc. Zinc exceedances for bird insectivores and lead exceedances for carnivores were found even at unimpacted areas in Coon Canyon. However, if LOAELs are used (the level at which effects have actually been observed in the literature), all the concerns drop except for selenium in Kessler Canyon, Black Rock Canyon, and Pine Canyon. Although selenium soil concentrations are not especially high in these locations, it is thought that the presence of selenium-concentrating plants may be responsible for the potential impact noted in the calculations.

The animal and insect studies sought to determine if actual effects from the metals were occurring. With regard to population of animals, the mice population was actually highest in the areas with the highest selenium in their diet. Although this could have been more a function of habitat than metal toxicity, the higher Se concentrations in the diet do not seem to impair population growth of mice.

The success of reproduction of the mice was studied by examining females. Reproductive activity seemed to be a function of weight with 53% of the females reproductively active. The variation between sites was not a function of metal concentrations in the soils. The highest number of reproductive females was in Kessler Canyon and the highest average percentage was in Pine Canyon, both areas known to be previously damaged by smelter smoke.

Metal exposures are known to cause some changes in kidney and liver tissue of wildlife. Investigators looked for such changes in mice liver and kidneys. Although some abnormalities were found, the severity did not relate to metal

concentrations in the soil or in the mice. The abnormalities that were found were due to bacterial parasite infections.

Regarding the plant community, residual COC concentrations in the soil were not affecting plant diversity or structure in the canyons. Most impacts observed in the study were related to livestock grazing.

Regarding wildlife, the investigators concluded that only selenium might present a risk to some carnivorous and insectivorous birds and mammals in Black Rock and Kessler Canyons. Because the invertebrate and carnivore selenium diets did not relate to soil concentrations, the investigators speculated that the risk was probably related to the dominance of selenium concentrating plants, such as whitetop (an invasive, non-native forb).

EPA has concluded that soils removal in any of the upland canyon and mountain areas is not warranted. It would be unlikely to produce any long term benefits and could destroy valuable wildlife habitat in the process. It would be beneficial to avoid intentionally introducing selenium concentrating plants, such as white top, during revegetation efforts (see Section 10).

b. South Shore Wetlands

Despite the damages in the upland canyon areas, primarily damages done by sulfur gases in the smelter smoke, the open space area most severely impacted by industrial activity is the wetlands located between the smelter/refinery and the Great Salt Lake. The area received smelter smoke, plus spills which ran down from the industrial facilities, solid and hazardous wastes from use of the area as a convenient dumping ground, and ground water contaminated by the operations upgradient of the wetlands. The dumping and environmental insults to these wetlands began long before wetlands became recognized as valuable wildlife habitat. The land is still zoned M-2, for heavy industrial use. Nevertheless, the open waters attracted a whole variety of wildlife to an area not well suited for them.

The ecological studies focused on the wetlands as a separate habitat soon after the initial studies found that the plant communities and diversity were affected, and the concentrations of metals in the soils and plants were high. The initial studies found plant toxicity values were exceeded for As, Cu, Pb, and Se. Water quality criteria were exceeded for As, Cd, Cu, Se, and Pb.

There was a succession of studies in the south shore wetlands because (1) the chemical habitat kept changing as contaminated waters were discovered and rerouted; (2) the physical habitat changes with the re-routing of the railroad

infrastructure and the change of drainage patterns; and (3) a controversy developed about interpretation of biological data.

The first study (Ecological Risk Assessment, South Shore Wetlands, 1997), was similar to the studies at other habitats: a comparison of site conditions in 1994 with toxicological information from the literature (laboratory studies and field observations at other sites). This study included the Garfield wetlands, the wetlands just to the east of the Tailings Pond, the wetlands associated with the Phosphogypsum tailings pond, the Magna Tailings Pond and the restored wetlands on the north side of I-80 (the Wetlands Mitigation Area - replacement wetlands for the filling of wetlands for the North Expansion area of the Magna Tailings Pond). Two control areas were also established using similar wetlands also adjacent to the Great Salt Lake - Farmington Bay (to the northeast of the Kennecott properties) and Timpie Springs (to the west of the Kennecott properties).

Concentrations of COCs were determined in water, sediment, macroinvertebrates, fish, and bird eggs. The water concentrations of COCs were higher than the control sites, especially for copper, selenium, and cadmium. Likewise, the sediment concentrations were also higher at the site than at the control locations, especially for copper. The macroinvertebrate levels of COCs were similar at the site and the controls but the maximum concentrations always occurred at the site. Fish tissue from the C-7 ditch was particularly high in zinc. Bird eggs from the different species were not different at the site compared to controls for As, Cd, Cu, Pb, or Zn. The bird eggs at the site, especially at the Garfield wetlands and east of the Tailings Pond did have elevated selenium concentrations in comparison to the controls.

The data in this study were not useful for determination of the exposure pathway. There was no relationship found between the water and the sediment and no relation between the macroinvertebrate concentrations and either the water or sediment concentrations. There was a positive correlation between the selenium in the invertebrates (which serve as food for the birds) and the selenium in bird eggs at the site.

An attempt was made to determine if the contamination present in the Kennecott wetlands had affected the total abundance or richness of the macroinvertebrates at the site. The wide variety of habitats at the site precluded strong conclusions on this - some areas had low diversity but others were very diverse, a functionality to type of habitat rather than COCs. For this reason, it was also not particularly useful to compare the site with the control locations, because the habitats were different.

Cluster analysis did not reveal any differences between the wetlands at the site and at the control locations. Other factors potentially influencing macroinvertebrate population were examined for the wetlands. Salinity in combination with arsenic could explain up to 25% of the difference in abundance but had little effect on taxa richness. The investigators speculated that the difference in macroinvertebrates were more a function of depth and ephemerality of the water than a function of the COCs. When only those sites with the same water depth (never dried up) were compared to the controls, the invertebrate abundance and richness were similar. Because some taxa are known to be more sensitive to metals than others, i.e. mayflies, the investigators examined these separately. Mayflies were found at both the reference sites and the Kennecott wetlands and were actually more frequent at the Kennecott sites than the control locations.

The investigators also conducted bird surveys and found that the Garfield wetlands had about the same number of species as present at the bird refuge control sites (62 species vs. 63 and 62). The number of birds per acre was also similar to Timpie Springs but had less gulls than Farmington Bay control site.

Nesting success at the Kennecott site was problematic because of predation on the nests and flooding. Sheep in the wetlands to the east of the tailings pond trampled nests. The nests included stilts, avocets, red-wing and yellow-headed blackbirds and occasional nests of snowy plover, Wilson's phalarope, heron, geese, duck, Forster's tern and marsh wren. Nesting success was poor for avocets and stilts east of the Tailings Pond (due to sheep trampling of nests), but for the Garfield wetlands, the nesting success was similar to the success at the control locations. The blackbird nest success was also lower at the wetlands east of the Tailings Pond but similar between the control sites and the Garfield wetlands.

Embryos from eggs were examined for malformities. No malformities were found, but the number of observations were too low to make any statistical conclusions.

To determine potential risk of metals to birds, the investigators compared the concentration of COCs in their food source (macroinvertebrates) to literature NOAELs and LOAELs. Risk quotients were used as a measure (Table 1.16).

TABLE 1.16
RISK QUOTIENTS EXCEEDING 1.0
(Risk Quotient = actual concentration/dietary NOAEL)

Location	As	Cd	Cu	Pb	Se	Zn
Garfield wetlands			x	x	x	x
Wetlands east of tailings p.					x	x
Restored wetlands north of I-80					x	x
Control sites					x	x

A closer examination for the Garfield wetlands indicates that the risk quotient varied with each sampling. At the Garfield wetlands, there were 10 sampling sites, some sampled multiple times for a total of 18 observations (Table 1.17).

TABLE 1.17
FREQUENCY OF EXCEEDANCES OF RISK QUOTIENT IN THE GARFIELD WETLANDS

COC	Number of times out of 18 observations that the risk quotient exceeded one
Cu	3
Pb	1
Se	17
Zn	13

The highest risk quotients at the Garfield wetland were from samples collected in an area close to the smelter return canal, an area where concentrates had been dumped. Copper and lead in bird eggs did not vary across the site suggesting that the birds do not accumulate lead or copper even with high concentrations in the sediment or macroinvertebrates. Zinc toxicity appears to vary widely with

different birds and is also a function of copper concentration. The LOAEL is twice that of the NOAEL (Japanese quail) and a factor of 8 higher than the NOAEL when sufficient copper is present. Other species required 16 - 32 times more zinc than quail for signs of toxicity. Even considering the conservative toxicity values for zinc, the only site in the Garfield wetlands with potential risk due to zinc is at the smelter return canal, if the risk exists at all.

The selenium risk was present at all sites including the background and relatively uncontaminated areas of the site, such as at the Wetland Mitigation Area. Selenium bioconcentrates in the yolks of bird eggs because it can substitute for sulfur in the eggs. When the selenium is present in the eggs, it becomes toxic to the developing embryo resulting in teratogenetic effects such as skeletal and developmental malformations and embryonic death. Based on an earlier study at Kesterson, California, the teratogenetic effects start to occur when the levels in the eggs reach 8 mg/kg to 37 mg/kg selenium. A NOAEL of 8 mg/kg selenium was calculated from these data (see Table 1.18).

TABLE 1.18
BIRD EGGS WITH CONCENTRATIONS EXCEEDING LOAELS AND NOAELS

Location	Eggs/total exceeding LOAEL of 37 mg/kg selenium	Eggs/total exceeding NOAEL* of 12 mg/kg selenium
Garfield wetlands	3/23	7/23
Wetlands east of tailings pond	2/18	7/18
Restored wetlands north of I-80	0/11	0/18
Control sites	0/28	0/28
Other wetlands around the Great Salt Lake (USFWS)	0/89	0/89

Selenium in bird eggs at the Kennecott Garfield wetlands (0.8 - 69.1 mg/kg, average 16.1) was elevated over bird egg concentrations found at other Great Salt Lake wetland sites monitored by the U. S. Fish and Wildlife Service (0.90 - 7.5 mg/kg, average 3.15).

Although the egg selenium concentrations did not directly correlate with concentrations of selenium in the food of the birds (macroinvertebrates) the nests with high selenium in their eggs were in or near areas where invertebrates were

also high in selenium, suggesting that the birds may have fed there in the two weeks prior to nesting.

The fish living in the Kennecott waterways are significantly higher in selenium than at the control locations. Typically if the fish from the site canals (C-7 and West C-7 Ditches) are consumed, there would be some risk to piscivorous birds (herons, egrets, eagles, kingfishers) due to selenium. But these areas are not a good hunting ground because the fish are actually few in number due to poor habitat. The selenium values for fish are between the LOAEL and NOAEL for the birds. The investigators concluded that the occasional dose of selenium to migratory birds did not present a risk to the birds because they are just passing through and nest elsewhere.

The initial risk study concluded that the birds and other wildlife were not at risk from metals at the site, but there was a potential risk to birds from the selenium. At the time this study was conducted in 1995, the site had not been fully characterized and the cleanups had not begun. As more became known about the sediment and water concentrations and at least one of the sources of selenium in the wetlands was identified, Kennecott and agency investigators asked the biologists to study the wetlands area again to gain further insight regarding exposure pathways to the birds. Also some newer data with regard to selenium toxicity was now available which could potentially refine the risk of selenium exposure to birds living at the site.

This second study "Selenium Risk Assessment for Kennecott South Shore Wetlands (1998)" looked at new data regarding fate and transport of selenium in the wetlands and a more sophisticated approach to potential selenium toxicity. The fate and transport study was designed to help determine how the selenium was getting into the food chain. Two ponds were selected for study. At one pond, the benthic invertebrates did not take up the selenium even though the sediment concentrations were high. This observation seemed to be a function of the chemical form in the sediments which was probably selenite. At the other pond, the macroinvertebrates did accumulate the selenium. The selenium was partitioning into the biota and the organic floc near the sediments. In both cases, the sediments themselves did not appear to be a source of selenium in the biota relative to the selenium in the water. The ponds differed in oxygen distribution with the second pond a net-reducing environment. Therefore, because of the variability in aquatic chemistry and biota, one single model, maybe even two models, were not appropriate for the entire wetland environment. The study served to demonstrate the complexity of the food web at the site. The investigators could not tell if the birds were favoring one species of macroinvertebrates over another. They suggested that average invertebrate selenium might be the better indicator of bird diet selenium than any particular

species. The selenium content of each species varied widely even when collected at the same place.

In the area studied, north of the 1995 railbed, the Garfield Well #5 was the source of the selenium to the wetland. (Kessler Springs had not been re-discovered at the time of this study, but was located to the south of the railbed and was hydrologically connected to the ponds studied here.)

The investigators also used probability functions to describe the toxicity of selenium rather than the LOAEL and NOAEL with risk quotients. The data from the literature investigations were transformed into probability curves and then the Kennecott wetland situation was compared to those curves. Each species had its own curve and each toxicity endpoint also had its own curve. Based on these curves the percentage of avocets and stilts at risk due to selenium exposure could be estimated. This approach was later presented in the scientific literature as an approach useful in risk assessments (see Table 1.19).

TABLE 1.19
PROBABILITY OF IMPACTS DUE TO SELENIUM

Location	Stilts		Avocets	
Toxicity endpoint	Teratogenesis	Chick mortality	Teratogenesis	Chick mortality
All Kennecott wetlands (north and south of I-80)	3.3%	12.9%	0.29%	2.7%
Garfield wetlands	5.1%	27.0%	0.10%	0.9%
Garfield wetland and wetlands east of tailings pond	8.7%	23.9%	0.32%	3.4%

The birds, especially stilts, were at risk of poor survivability of the chicks in the Garfield wetlands due to selenium exposure. In addition, these birds also face problems with their nests due to rising and falling water levels (nest flooding) and predation, problems which also affect 50% of the nests even without the selenium exposure problems.

Based on these findings, Kennecott and the agencies agreed to (1) cut off the sources of selenium to the wetlands initially by redirecting the flow of the Garfield Well #5 to the Great Salt Lake and later into the industrial process water circuit; and (2) drain the ponds, remove the contaminated sediments, and introduce fresh water from Tooele.

After the selenium source was redirected from the wetlands and Pond A sediments had been removed, the biology investigators returned to determine if the biologic situation had improved. The selenium concentrations in the macroinvertebrates decreased in the Pond A area but not at the Garfield well wetland. The bird egg selenium concentrations did decrease in the Garfield well wetlands. The slag pond conditions had stayed the same. Still only the average concentrations of selenium in invertebrates of Pond A (the only remediated area at the time) yielded values beneath the avian diet NOAEL of 5 mg/kg. The other metals such as As, Cu, and Pb stayed the same in the sediments of the area (excavations had not yet started when this sampling was done). Water quality improvements had occurred especially for selenium near the Garfield wells wetlands.

A part of this later study was an assessment of habitat suitability. It confirmed that nests were vulnerable to drowning because the water in the wetland areas rise quickly following spring rains. The nests were vulnerable to mammalian predators, such as foxes and raccoons. Mosquito abatement crews crushed some nests and killed macroinvertebrates which are the local food source. The investigators suggested several ways to improve the bird habitat including creating islands to minimize predation, controlling water levels to minimize flooding, and eliminating or minimizing the county mosquito control program. Additional cleanups were also recommended to reduce exposures especially at the Garfield wells wetland area and the I-80 pond. Scientists suggested that the wetlands at Kessler Springs should be cleaned up or made unattractive to the birds. ("Bird Balls" were later added and used until the tainted waters could be diverted.)

Partly in response to these findings, the slag pond, the I-80 pond, and the Garfield wetlands were drained and the surface sediments removed similar to the method used at Pond A. Before the ponds were refilled with clean water, the slopes of the ponds were relaxed and islands were created to improve the habitat for the birds. The Kessler Springs Pond was equipped with bird balls to discourage bird use of the area. This area will likely be taken out of wetland service.

To this day, the goal for avian diet loads of selenium is controversial even when the same data for toxicity are used. Investigators disagree on how to interpret these data or whether these data are even applicable to this site. EPA, UDEQ, and Kennecott decided to move ahead with the removal of contaminated sediment and replacement of contaminated water sources to the extent practicable, enhancement

of the habitat for the birds to reduce the non-COC problems and live with any residual risks. Site specific data could not find any relationships between water concentrations and sediments, water concentrations and invertebrate concentrations or between invertebrate concentrations and bird egg concentrations. It is unknown if such relationships developed elsewhere are even similar to those at this site. Given the wide variety of conditions even within the site in terms of water depth, oxygen content, habitat, speciation, etc., the relationships (assuming they exist) could be variable. The extent of residual risk may always be controversial until more is known about selenium and the role of speciation and other environmental factors influencing uptake.

c. Great Salt Lake

Investigators studied the Great Salt Lake for two objectives. For the CERCLA action, remedial design requires development of a performance standard, e.g. how much selenium source treatment would be necessary to produce an effluent which would not damage the ecological system of the Great Salt Lake. At the same time, the State of Utah was interested in establishing selenium discharge limits in Kennecott's UPDES permit, which was up for renewal at that time.

Both projects needed some idea regarding how much of the different COCs were harmful to the ecological components of the Lake. Yet, because the Lake is a unique waterbody, the effects of COCs on Lake biota are relatively unknown. In this highly saline environment, the behavior of contaminants is different than freshwater and the impacts would occur at different concentrations, among other differences.

Compared to most waterbodies, the Great Salt Lake is a relatively simple ecosystem. At the bottom of the food chain are the primary producers, 7 species of green algae, 17 diatoms, 1 dinoflagellate, and 4 species of photosynthetic bacteria. These primary producers are then consumed by brine shrimp and brine flies. The brine shrimp are an important economic resource for Utah. About 10 million pounds of brine shrimp eggs are harvested each year, mainly for sale to the aquaculture industry in Japan. Both the brine flies and brine shrimp serve as a food source for resident and migratory shorebirds and gulls. Not only is there concern about damage to the brine shrimp and its food source the algae, there is concern that the brine shrimp and brine flies could bioconcentrate contaminants which could then adversely affect the birds which eat them.

The literature on toxicity of metals to brine shrimp is not extensive. A summary of the literature values is given in Table 1.20.

TABLE 1.20
TOXICITY OF METALS TO BRINE SHRIMP

COC	NOAEL	LOAEL	Chronic value	Toxicity threshold with safety factor*
Arsenic@	8 mg/l	15 mg/l	11 mg/l	-
Cadmium	0.5 mg/l	5 mg/l	1.58 mg/l	0.790 mg/l
Copper# test 1	0.025 mg/l	0.050 mg/l	0.035 mg/l	0.018 mg/l
Copper# test 2	0.3 mg/l	1.0 mg/l	0.548 mg/l	0.274 mg/l
Selenium@	3 mg/l	8 mg/l	5 mg/l	-
Zinc	0.1 mg/l	0.5 mg/l	0.224 mg/l	0.112 mg/l

* applies if laboratory studies did not evaluate reproduction, toxicity threshold = chronic/2.
@ based on bioassay tests using Great Salt Lake water conducted by Kennecott consultants.
# two studies with radically different results.

For selenium Kennecott conducted bioassays on all the components of the Great Salt Lake ecosystem. The results are given in Table 1.21 below:

TABLE 1.21
SELENIUM TOXICITY RESULTS FOR GREAT SALT LAKE BIOTA

Species	Selenate	Selenite
ACUTE TOXICITY		
Brine flies	490 mg/l	-
Brine shrimp	78 mg/l	6.8 mg/l
Green algae	32-45 mg/l	120 - 149 mg/l
CHRONIC TOXICITY		
Brine Shrimp	5 mg/l	
Green algae	14 mg/l	5.8 mg/l

When the chronic toxicity threshold for brine shrimp was compared to water quality, most of the Lake COC concentrations were well beneath the level of

concern. The one exception was the water quality of Lee Creek with regard to copper (if the lower toxicity threshold is used). Although this is interesting, Kennecott no longer discharges to Lee Creek so this result is now moot.

The hazard quotients which compare toxicity to environmental concentrations are given for the brine shrimp in the Great Salt Lake in Table 1.22.

TABLE 1.22
HAZARD QUOTIENT FOR BRINE SHRIMP
(Concentration in the Great Salt Lake/toxicity threshold)

COC	1970 studies	C-7 Ditch	Lee Creek	Farmington Bay control
As	0.009	0.008	0.006	0.001
Cd	<0.001	<0.001	<0.001	<0.001
Cu*	0.50	0.39	1.78	0.50
Pb	0.002	<0.001	<0.001	<0.001
Se	0.001	0.001	<0.001	<0.001
Zn	0.098	0.022	0.022	0.022

*conservative threshold used

The fate of the metals in the Lake is sequestration in the lake sediments. Because the bottom of the Lake in the central portion is anoxic, the metals precipitate out as insoluble sulfides. At least one study indicates that some metals are increasing in the sediments (Cd, Cu, Pb, Zn). While the sediments have potential in evaluating the pollution history of the Lake, the ecological significance is small if it exists at all.

No attempt was made to assess ecological changes due to increasing pollution loads. Part of the difficulty is that the water quality has stayed about the same over the last 30 years because the metals quickly precipitate out to the sediments and accumulate there. Only at the mixing zone are their any differences and the currents and winds quickly mix these areas into the lake. The brine shrimp harvest fluctuates from year to year and still there is enough left for the birds. It would be almost impossible to judge small changes due to pollution given the fisheries pressure and the impact of bird predation.

Although not often considered in development of water quality criteria or in UPDES permit limitations, there was a concern that the brine shrimp could

bioconcentrate the metals and therefore present a risk to the birds which feed on the shrimp. This concern was evaluated using both field and laboratory studies. None of the brine shrimp collected in the field near the Kennecott outfall by the Kennecott investigators exceeded the NOAELS for birds (with the exception of one zinc value near the C-7 Ditch).

In order to develop a water quality goal for the Great Salt Lake and then derive discharge limits for the selenium in Kennecott discharges, a relationship between selenium content in the brine shrimp and the concentration of selenium in the water was estimated. In order to achieve less than 5 ppm body burden of selenium in the shrimp (the avian dietary toxicity threshold), the selenium concentration in the water should not be greater than 27 ppb. The selenium discharge limit used in the Kennecott UPDES permit is 27 x 2 (mixing zone dilution) or 54 ppb selenium. This value is probably conservative because it assumes that 100% of the bird diet is brine shrimp near the Kennecott outfall. It is also based on toxicity results using organoselenium (selenomethionine) rather than selenate, the less toxic form actually predominant in the Kennecott discharges.

The Salt Lake office of the U. S. Fish and Wildlife Service also studied the selenium content of the brine shrimp. The concentrations ranged from 1.099 - 4.548 ppm selenium dry weight, averaging 2.33 ppm. The highest selenium concentrations were in samples northwest of Antelope Island. The shrimp samples near Kennecott's outfall were high in several metals relative to other locations (aluminum, barium, cadmium, chromium, copper, iron, mercury, molybdenum, nickel, lead, strontium, vanadium, and zinc), but not selenium.

Since these studies were performed, the selenium sources to the Garfield wetlands have been redirected to Kennecott's process water circuit. At least a fraction of selenium load is discharged to the Great Salt Lake. It is clear that selenium was a potential risk to the birds in the Kennecott Garfield wetlands. Given all the uncertainties in these calculations, it is crucial to continue to monitor the situation to ensure that there is no damage done to the Lake or its valuable aquatic life and avian resources. The UPDES permit limitation is important for both the CERCLA decisions and enforcement by the Utah Division of Water Quality.

More detail on how these findings were used for decision-making is given in the subsequent chapters.

Section 2: Magna Mills and Tailings Pond (Kennecott North Zone, OU15)

A. Site Name, Location and Description

1. Site Type and description of operable unit

The Magna Tailings Pond Operable Unit (OU 15) includes the first step of the mineral beneficiation process including the grinding of the ore and the separation of the minerals from the ground ore via gravity and flotation. It also includes the waste areas associated with the grinding and concentrating operations. It includes the major facilities, the Bonneville Crusher, the Magna Mill, the historic Arthur Mill, and the South and North Tailings Impoundments. The relationship of the milling activities to the ore beneficiation and process is shown on Figure 2.1.

2. Facilities located within OU 15

The list of facilities within Operable Unit 15 (Table 2.1) is extensive and generally includes ore milling facilities and infrastructure and waste sites associated with the milling process. Today the only operating milling facility is located in the Kennecott South Zone site, and this facility sends its wastes to the waste sites located in the Kennecott North Zone OU15.

For clarity, this Section is divided into four parts. Subpart 1 describes the facilities associated with the ore milling process at the site and minor piles of wastes. Subpart 2 describes the major waste storage facility, its infrastructure, and the wastes buried beneath the facilities. Subpart 3 describes an area, formerly in agricultural use, that was purchased for the purposes of mitigating wetland losses when the waste storage area was expanded. Subpart 4 describes the nearby power generating plants used to provide electricity to the mills (and other Kennecott facilities).

Figure 2.1: FLOW CHART OF MILLS

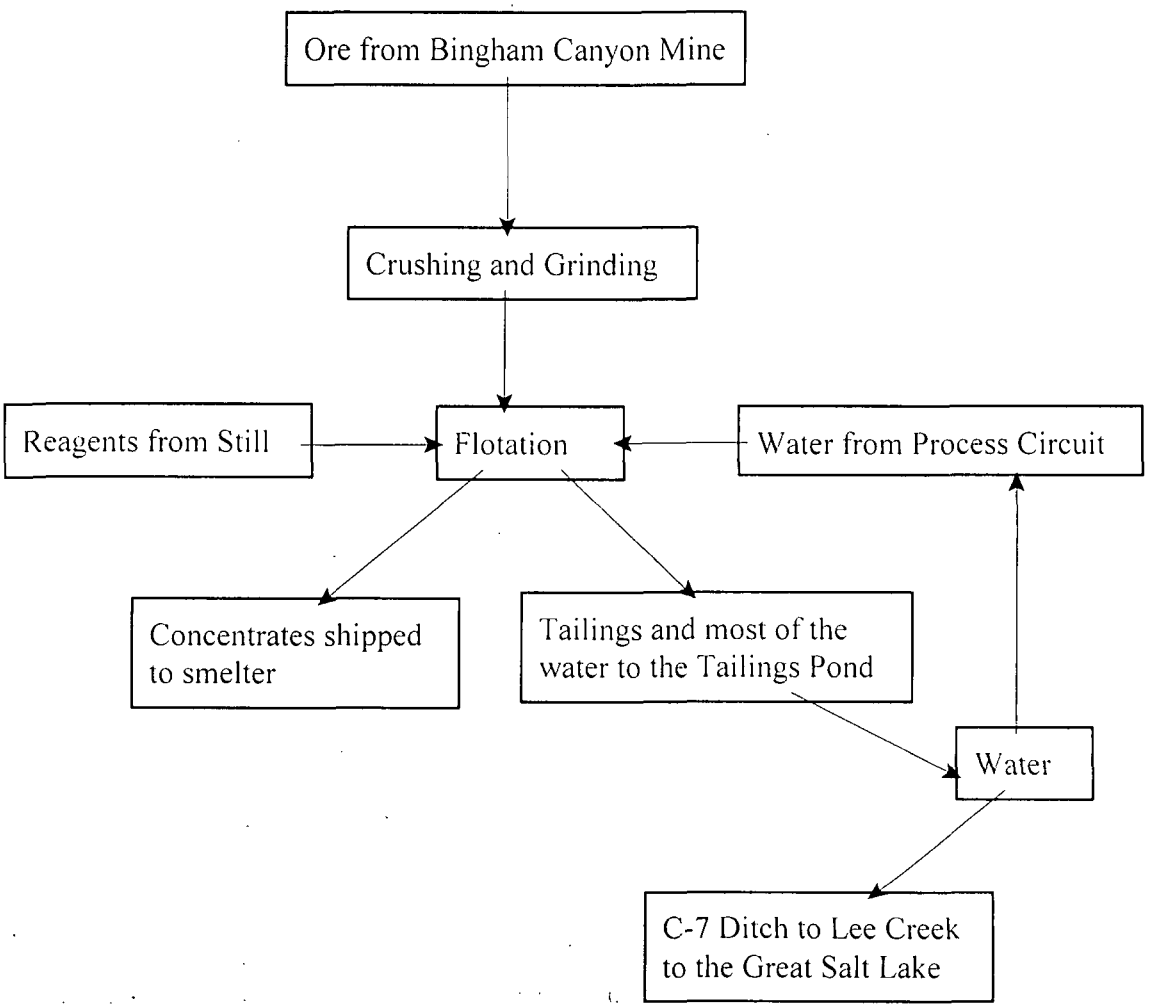


TABLE 2.1
LIST OF FACILITIES AT OU 15 AND GENERAL DESCRIPTION

FACILITY	FUNCTION	RELATION TO OU 15
SUBPART 1: ORE MILLING FACILITIES		
Magna Leaching Facility	Recover copper from oxidized ore using sulfuric acid leach	Former vats used for water storage for Magna Mill
Lime Kilns	To manufacture lime by heating limestone in kilns	Located in former Magna Leaching facility building
Lime Slacking Plant	To manufacture "milk of lime" (calcium hydroxide) from lime	Located at former Magna Leaching facility, product shipped to the mills.
Boston Consolidated Mill (Arthur Concentrator)	Grind ores and recover metal sulfides by flotation	Sent concentrates to smelter and wastes (mainly tailings) to the Magna Tailings Pond
Reagent Stills	Manufacture of reagents used in ore flotation at the Magna and Arthur Mills	Located behind Arthur Mill, reagents sent to mills via a pipeline and railcars
Foundry	Manufacture semi-steel balls used in the grinding circuits of the mills	Slag dumped on site near Arthur Mill
West Debris Site	Dump of building material and lab glass and crucibles	Near Arthur Mill
Railroad Debris Site	Pile of various wastes used as a barrier at the end of a railroad spur	Near Arthur Mill
Crucible Site	Dump of lab wastes, glass, crucibles from the Arthur Mill Assay Lab	Wastes generated by Arthur Mill Assay Lab
Arthur Second Line Ditch	Suspected contamination from railroad spillage	Near Arthur Mill
Pipeline soils	Suspected contamination from pipeline leaks	At Arthur shop building.

FACILITY	FUNCTION	RELATION TO OU 15
Bonneville Crusher	Crush and grind ores	Ground ores sent to Magna Concentrator for further processing
Scrap Yard	Former concentrate, coal, and railroad storage yard	Near Bonneville entrance gate
Bonneville Gate Hillside	Former storage area for ores for precious metals recovery	Near Bonneville entrance gate
Little Valley Settlement Ponds	Ponds for collection of ore which ran off from storm events at Bonneville Crusher	Downhill from Bonneville Crusher
North Slope Site	Piles from cleaning projects at Bonneville Crusher	On a slope next to Bonneville Crusher
North Concentrator (Magna Mill)	Flotation of ground ores produced at Bonneville, formerly a full mill with grinding and flotation circuits	Wastes (mainly tailings) sent to Magna Tailings Pond, concentrates sent to smelter
Railroad Slope Site	Slag and metal debris dump	Adjacent to Magna Concentrator
Concentrate Loading	Where concentrates are loaded onto rail cars, spillage at this site	Adjacent to Magna Concentrator
East Debris Site	Waste ore and metal debris dump	Adjacent to Magna Concentrator
SUBPART 2: SOUTH AND NORTH TAILINGS IMPOUNDMENTS, THEIR INFRASTRUCTURE AND BURIED FACILITIES		
Diving Board Tailings	Used to temporarily store tailings during upset conditions when repairs are made to Magna Tailings Pond intakes	Adjacent to Magna Tailings Pond and Magna Concentrator
Tailings Slurry Pipeline	Used to transport tailings from the Copperton Concentrator (South Zone) to North Tailings Impoundment	Ends at the Magna Tailings Pond

FACILITY	FUNCTION	RELATION TO OU 15
Concentrate Slurry Pipeline	Used to transport concentrates to the smelter	Adjacent to Tailings Slurry Line
Magna Mill Flume	Transport tailings from the Magna Mill to the South Tailings Impoundment	Ended at South Tailings Impoundment
South Tailings Impoundment	Received and permanently stored tailings (and other wastes) from the mills and concentrators	Very large facility located on the shores of the Great Salt Lake
Arthur Stepback Repository	Receives and permanently stores wastes excavated during the Superfund projects on site	Located on the side of the South Tailings Impoundment
Tailings Pond Landfill	Dump for general office, lunchroom trash and construction debris	Located on top of the South Tailings Impoundment, buried by tailings, locations change
Ragtown and Snaketown	Historic towns buried by tailings	Buried by the South Tailings Impoundment
Historic Roads	Historic roads partially buried by tailings	Includes sections of the Lincoln Highway (first transcontinental highway)
Riter	Historic railroad station buried by tailings, moved, then buried again	Buried by the South Tailings Impoundment
Historic Rail routes	Historic rail routes buried by tailings, moved then buried once again	Buried by the South and North Tailings Impoundments, vestiges still visible in wetlands
North Tailings Impoundment	Magna Tailings Pond was expanded into wetlands just to the north of the current pond	The North Tailings Impoundment buried a number of industrial facilities
Chevron Fertilizer Plant	Produced phosphate fertilizer	Buried by the North Tailings Impoundment

FACILITY	FUNCTION	RELATION TO OU 15
Morton Salt Plant	Ponds created to evaporate water from the Great Salt Lake. The salt was gathered, cleaned and sold as road salt.	Buried by the North Tailings Impoundment
SUBPART 3: RESTORED WETLANDS ASSOCIATED WITH THE NORTH TAILINGS IMPOUNDMENT CONSTRUCTION		
Wetlands Mitigation Area	Wetlands restoration area to the north and east of the North Tailings Impoundment	Used to compensate for jurisdictional wetlands buried by the North Tailings Impoundment
Morton Salt	Vacant land, unofficial debris dump	Used to compensate for jurisdictional wetlands buried by the North Tailings Impoundment
Bothwell and Swaner	Cattle grazing area	Used to compensate for jurisdictional wetlands buried by the North Tailings Impoundment
Heughs Creek Assoc.	Cattle grazing area, unofficial dump for garbage	Used to compensate for jurisdictional wetlands buried by the North Tailings Impoundment
Blackhawk Pond	Constructed by a duck-hunting club	Used to compensate for jurisdictional wetlands buried by the North Tailings Impoundment
North Pt. Con. Canal	Offshoot of Surplus Canal (excess waters from Jordan River)	Provides water for new ponds at the Wetland Mitigation Area
Goggin Drain	Offshoot of Surplus Canal (excess waters from Jordan River)	Provides water for new ponds at the Wetland Mitigation Area.
SUBPART 4: POWER PLANTS AND WASTES		

FACILITY	FUNCTION	RELATION TO OU 15
Historic Power Plant	Steam generation used to provide electricity to mills	Located near the Magna Mill, the wastes were sent to the South Tailings Impoundment
Current Power Plant	Equipped to generate electricity using coal or gas as a fuel, for Kennecott use, excess sold to Utah Power and Light Co.	Located near the Magna Mill, wastes are sent to the North Tailings Impoundment
Power Station	This was later identified as the Section 21 Pump Station	Located South and East of the South Tailings Impoundment
Rail Grave Yard	Power plant slag used as surface for rail dismantling operation	Located near Bonneville Crusher.

B. Site History and Enforcement Activities

1. Activities at the site which led to contamination

SUBPART 1: ORE MILLING FACILITIES

Following the discovery of low grade porphyry copper ores in the Bingham Canyon Mining District, two companies were formed to take advantage of this discovery. Both companies, Utah Copper and Boston Consolidated, realized that for the venture to be economical, large volumes of ore would have to be excavated and processed. But space was limited in Bingham Canyon, and there was no room for the processing facilities and the wastes they produced. Both Utah Copper and Boston Consolidated decided to locate their processing facilities near the shores of the Great Salt Lake where there was adequate space for the mills and wastes, there was a reliable water supply, and there were slopes where the local terrain facilitated gravity flow through the plants. Shortly after the two mills were constructed, Utah Copper and Boston Consolidated merged in 1910 forming one company which owned both mills. Utah Copper renamed the mills. The original Utah Copper Mill was called the Magna Mill, and the original Boston Consolidated Mill was called the Arthur Mill. After the Arthur Mill was closed, the Magna Mill was sometimes called the North Concentrator.

When first constructed, both mills used a two step process. First, the ores were

crushed and ground using rotating containers containing steel balls or rods. Second, the ground ore was separated into two fractions. The fraction containing the valuable minerals (or concentrate) was slightly heavier than the host rock fraction (or tailings); therefore, the concentrate fraction could be separated from the tailings fraction by gravity. Later on, experimentation with flotation technology demonstrated a better separation efficiency for the two fractions, and both mills were equipped with flotation circuits to replace the older gravity techniques. Flotation requires addition of a chemical mixture which attracts the mineral sulfides. The mineral sulfides are floated to the surface on air bubbles because the chemical mixture is surface active. The sulfides are then collected from the surface by skimming the froth. The tailings which do not contain economic amount of metals are drained off the bottom and are then disposed.

MAGNA LEACHING FACILITY. In order to recover copper from oxidized ore from the cap of the ore body, Utah Copper built a leaching plant just south of its mill in Magna. Ore was leached in 12 concrete vats (each 100 feet by 50 feet by 17.5 feet) using sulfuric acid. The copper extracted from the ore into the acid was recovered using scrap iron (similar to the process used at the precipitation plant at the South Zone). The leached ore was excavated from the tanks and placed on a nearby hillside. The plant was built in 1916 with a capacity of 2000 tons/day and was taken out of service in 1920. After closure, the tanks were used again for production of lime and are now in use for water storage. The current concrete vats are divided into three sections. The western two sections each measure about 100 feet x 250 feet and are filled with water. The third portion measures about 100 feet x 100 feet and only a portion of the walls remain. The water is used for emergency make-up water for the cooling towers at the power plant. These tanks are above ground.

Lime kilns. Formerly located at the smelter, the lime kilns used to produce lime for the mills were relocated to the Magna Mill site in 1929. They were installed in the building which housed the Magna leaching facility. One rotary kiln was 6 feet by 125 feet and the other was 8 feet by 125 feet. Both were fired by pulverized coal at first, then by electricity. The first kiln was used to preheat the limestone and the second was used to burn the limestone creating lime (calcium oxide). Each kiln had a steel stack partially lined with firebrick. Originally the capacity was about 120 tons/day, but in 1936 the capacity was increased to 200 tons/day.

Lime slacking plant. Also located in the building of the Magna leaching facility was a lime slacking plant, originally constructed in 1925. The calcium oxide produced by the kilns was crushed and water was added to form "milk of lime" (calcium hydroxide). The "milk of lime" was stored in a storage tank at Magna and sent by rail to Arthur. Later (1929), the lime was sent via a 4 inch pipeline to Arthur. Currently, the area where the lime kilns and lime slacking plant was

located is paved and is in use as a laydown yard - bricks, pipes, and electric transformers.

BOSTON CONSOLIDATED MILL (ARTHUR CONCENTRATOR). In 1906, the Boston Consolidated Company began construction of a large ore milling facility adjacent to the site of the ASARCO smelter (see OU 13). Located on a 810 acre site, the mill was put into operation in 1909 with a capacity of 3000 tons/day. Utah Copper, which was operating its own plant next door, bought out the Boston Consolidated Company and all its facilities in 1910, and Utah Copper ended up with two mills side by side. The former Boston Consolidated Mill, renamed the Arthur Mill, expanded in capacity to 8000 tons/day. Based on the results of flotation experiments which began in 1914, the Arthur mill was equipped with a flotation circuit by 1918 and flotation completely replaced the gravity separation technology by 1926. Flotation reagents tested at the mill included coal tar creosote, petroleum, petroleum residuum, petroleum stove oil, pine oil, reco pine oil, reco turpentine, calura (lime, sulfur and sodium hydroxide), rosin, lime, soap solution, sodium sulphide, sodium hydroxide, light oil, coal tar, phenols, sulphuric acid, alpha naphthylamine, xylidine, thiocarbanilid, ortho toluidine, and potassium ethyl zanthate. In 1924, a typical charge consisted of creosote oil, steam distilled pine oil, sodium hydroxide and sulphur. New reagents for flotation were introduced in 1925 including reco cresylic acid (a reaction product of cresylic acid and phosphorus pentasulfide) and reco alcohol (a reaction product of alcohol and phosphorus pentasulfide). The tailings and whatever reagents were used in the process were discharged to the Magna Tailings Pond (see Subpart 2, OU 15)

During the Depression, the Arthur Mill was closed between 1930 - 1936 and the mill was reconditioned at that time. The Arthur Mill then operated until 1966 when the Bonneville Crusher opened. Some ancillary activities continued until 1985. The buildings were demolished in 1988-1989. Only the Arthur Mill Administration Building and a few storage sheds remain of the original mill and its support buildings.

Reagent stills. In order to supply the flotation circuits of the mills, Utah Copper manufactured its own reagents using a variety of stills which changed in configuration and products as the needs changed. In 1924, the reagent still consisted of a 1000 gallon cylinder heated with a wood or coal fire. The cylinder was charged with creosote oil, pine oil, sodium hydroxide and sulfur with the product collected using a condenser cooled by water. In 1927, an attempt was made to make reco alcohol, but the product was corrosive and ate through the reaction vessels. Stoneware kettles were installed to contain the product but were fragile. By 1933, reco cresylic acid had proved more efficient in the flotation circuits of the mills and Utah Copper converted their stills to produce this product. Ingredients included cresylic acid, phosphorus pentasulfide and sodium

hydroxide. The two nickel-chrome stills had a capacity of 291 gallons each and were heated with electricity. The product was sodium reco cresylic acid (or sodium dicresyldithiophosphate, or reco for short) and by products were hydrogen sulfide and water. Three stills were still in operation in 1956. When investigated in 1992, the site still had nine above ground storage tanks, stills, and a reservoir. The facilities were demolished in 1993 and the site was characterized in 1995. This site occupied 6.5 acres.

Iron foundry. Utah Copper built an iron foundry at the Arthur Mill to supply both their mills with steel balls and other specialized metal products. It was in operation by 1917 at which time production was about 1.8 million pounds per month. The principal product of the foundry was semi-steel balls used in ball mill grinding. The foundry had 8 sections with 96 water cooled iron molds each with a capacity of 40 balls. The metals (steel scrap, railroad tracks, soft iron scrap, coke and lime rock) were heated in 2 cupolas fired with coke. The melted metals were transferred to the molds with 3 ton ladles. There was another circuit to cast aluminum and brass parts. This was in a separate building and had 3 blast furnaces. The by-product of the foundry circuits was a slag that was simply dumped down an adjacent hillside. This site and adjacent slag dump occupied 2.6 acres.

West Debris Site: Located west of the Arthur Administration Building was an 1.1 acre area which was a dumping ground for a variety of wastes from the mills. Included were laboratory glassware and crucibles from the Arthur Mill Assay Laboratory, metal shavings, and construction materials. Some of the materials were tainted with asbestos. The years of operation of this dump are unknown.

Railroad Debris Site: Located northeast of the Arthur Administration Building was a pile of wastes which served as an end of the line barrier for the ore haulage railroad. The wastes included metal and concrete debris and contaminated soils. The year this waste was placed is unknown. The pile is 30 feet wide and 75 feet long (0.05 acres). No removal was needed.

Crucible Site: Located northwest of the Arthur Administration Building was a 0.25 acre dumping ground of laboratory wastes from the old Arthur Mill Assay Laboratory. Wastes included fire assay debris and crucibles. The years of operation of this dump are unknown.

Arthur Second Line Ditch: Prior to digging a drainage ditch along the second line tracks location northwest of the Arthur Administration Building, soils were characterized because they were discolored. The source of the discoloration was unknown. The area involved was about 0.37 acres.

Pipeline leak: A leak in a pipeline was suspected due to yellow discoloration of soils near the Pipeline Corridor at Arthur Central Shops.

BONNEVILLE CRUSHER. In 1966, Kennecott opened the Bonneville Crusher, constructed to provide a finer grind for the ore than could be accomplished at the Arthur or Magna mills. When it was first opened, the crusher fed the flotation circuits for both the Arthur and Magna mills. Processing capacity was markedly increased from 90,000 tons/day before the opening of the crusher to 108,000 tons/day shortly after the Bonneville Crusher came on line. Since 1985, the Bonneville Crusher feeds only the Magna Concentrator.

The Bonneville Crusher is a rod mill which is more effective with harder ores than the facility in Copperton. These ores are shipped to the Bonneville Crusher from the pit via rail. After crushing, the ore slurry is sent to the Magna Concentrator for flotation. The Bonneville Crusher and the Magna Concentrator and associated were closed in 2001.

Bonneville Railroad Scrap Yard: Just to the west of the Bonneville entrance gate is an area which was used to store old railroad cars and equipment along with surplus rails and ties. It was also used as a coal storage and concentrate stockpile area. It was about 6.9 acres in size.

Bonneville Gate Hillside Site. Located immediately west of the Bonneville entrance gate was the results of a leaching experiment. Kennecott experimented with recovery of precious metals using an in-situ leaching process for oxidized minerals. The waste rock was left on this hillside after this experiment concluded. It was about 6.5 acres in size.

Little Valley Settlement Ponds. Just south of the Bonneville Crusher in the Little Valley drainage is a series of four ponds which captured runoff from the Bonneville Crusher. The ponds were created from manmade dikes installed as flood control measures in the 1930s. The silt in the ponds apparently originated from the ore stockpile associated with the crusher. There was also a layer of hydrocarbon contamination in the ponds suggesting that the ponds also collected runoff from a petroleum contaminated soil stockpile near the crusher. Little Valley is essentially open space and wildlife habitat, although occasionally parts of it have been leased to a local sheep rancher. The ponds occupied 3.9 acres.

North Slope Site: Just north of the Bonneville Crusher is a slope which has been used as a dumping ground by the crusher. It is composed of three major piles and several more smaller piles. The piles contained wastes from routine cleaning at the crusher along with other debris. The piles occupied 3 acres.

NORTH CONCENTRATOR (MAGNA CONCENTRATOR, MAGNA MILL: The Magna Mill was one of the two original mills built in the area by the two Bingham Canyon copper companies (see also Boston Consolidated Mill). After experimentation with a prototype mill in Copperton, Utah Copper Company built their Magna Mill on a hillside above the Great Salt Lake. The mill opened in 1907 and had reached a capacity of 6000 tons/day by 1908, expanding again in 1911 to 10,000 tons/day. The grinding at the mill was done with 7 foot Chilean mills. After a brief closure between 1919 - 1922, the Magna mill reopened and a froth flotation circuit was added. (Froth flotation experiments were begun in the 1914 - 1918 and by 1926, the gravity technology had been completely replaced by the flotation method.) At the Magna Mill, sodium xanthate was used as the flotation agent and a plant was added to manufacture the xanthate. But the neutralized reco cresylic acid reagent in use at the adjacent Arthur Mill proved more cost effective and the Magna Mill began using reco too in 1933. The Magna Mill remained open during most of the Depression but operated at only a fifth of its capacity. The portions of the plant not in operation were reconditioned at this time. Full scale operations resumed and the normal capacity of the mill was about 40,000 tons/day. When the Bonneville Crusher was opened in 1966, the grinding portion of the Magna mill was no longer needed and it was eventually demolished in 1991-2. However, the Bonneville Crusher continued to feed the flotation circuits of the Magna Mill and this portion was upgraded in 1975. The concentrates were flumed to rail cars and were shipped to the smelter. The tailings were sent via a flume to the Magna Tailings Pond. The Magna Mill, known also as the North Concentrator, was shut down in 2001.

Magna Administration and Safety Building: The Magna Administration building, formerly the superintendent's house was converted into an office building. The Safety Building was an old house that was converted into offices and a clinic. Although no hazardous substances were used in the buildings, the buildings contained asbestos shingles and floor tile.

Railroad Slope Site: Adjacent to the North Concentrator was a dump site located near the railroad. Located just south of the Bravo Gate and just north of the ore haulage railroad tracks, the site was a steep slope formed from the dumping of slag, tailings, stained gravels and debris. An employee parking area was located at the base of the slope and a walkway-stairs went from the parking lot to the Magna Rail Car Shops located at the top of the slope. The parking lot was moved and the walkway taken down during reclamation. The site measured about 1450 ft by 50 - 150 ft. with a surface area of about 64,400 square feet or 3.3 acres.

Concentrate Loading Area: At the northern edge of the North Concentrator is an overhead concentrate chute which loads concentrates into railcars underneath. The area was covered with spilled concentrate. The site is 1650 feet long by 15 to

150 feet wide and covers about 200,000 square feet (or 4.5 acres), including a 40,000 square feet concrete pad which was left in place. The site is a strip that trends east-west adjacent to the frontage road and consists of two sets of railroad tracks. The first set of tracks parallels the frontage road and the second set of tracks intersects with the first tracks and connects to the Magna Mill building. The main ore concentrate slurry line follows along the southern boundary of the site.

East Debris Site: Near the North Concentrator was another dump site which contained both waste ore and metal debris. It was located on the East side of the road that connects Magna and Bonneville about 100 feet east of the Magna Pump Station. The site consisted of two piles of soil, rock, and debris on the side of a steep east facing slope. Both piles had approximately 20% debris, including slag fragments, metal, wood and cement. The piles were flat-topped. Pile A was 60 ft x 90 ft and 45 feet high. Pile B was 120 ft x 530 ft and 20 to 150 feet high. The total size was 1.6 acres.

SUBPART 2: WASTE AREAS FOR MILLING OPERATIONS AND WASTE HANDLING

One of the primary reasons the location of the ore milling and processing facilities was chosen by the mining companies in the early 1900s was the large expanse of land next to the Great Salt Lake that could be used as a disposal area for the massive amounts of wastes produced by the mills. The original footprint of the tailings disposal area was expanded several times over the years, with the most recent expansion occurring about 1995. Each time an expansion occurs, the facilities already there are buried. In the early expansions, some settlements, roads and railroads were impacted. In the most recent expansion, adjacent industrial establishments were purchased and then buried by the ever increasing tailings pond. The tailings disposal area is called the South Tailings Impoundment or the Magna Tailings Impoundment with the newest expansion area called the North Tailings Impoundment (or North Expansion). The tailings get to the tailings pond by various pipelines and flumes from the mills. Mishaps are not uncommon.

Diving Board Tailings: Located just east of the NorthConcentrator is an impoundment area which has been traditionally used to impound tailings during shutdowns and upsets at the North Concentrator. The area has been used for this apparently since the North Concentrator (Magna Mill) was first constructed. It became known as the Diving Board when a cyclone was built there in the mid 1970s to separate coarse tailings for use as road base construction materials. It was last used for this to provide road base for construction of Interstates 80 and 215. The cyclone was dismantled in 1991.

Tailings Slurry Pipelines: When the Copperton Concentrator was built in 1987, a 48" diameter concrete pipeline was built to carry tailings from the new concentrator 13 miles to the South Tailings Impoundment. Later in 1993 due to pipeline failures near drop boxes near Magna, the concrete line was lined with rubber. Reportable quantities of materials have spilled from the pipeline in 1995 and again in 1999, 2000, and 2001. In those spills, the tailings escaped into Barneys Wash (South Zone). Each time, the area was cleaned up. In order to have a backup for the tailings line, a newer concrete pipeline was constructed in 1996. The newer pipeline is 60" in diameter. Due to scaling problems in the pipeline close to the Copperton Mill (see ROD for OU2, South Zone), the 60" pipeline is being expanded to an 84" diameter pipeline so that sufficient capacity would exist even in the presence of scaling.

Concentrate Slurry Pipelines: When the Copperton Concentrator was built in 1987, a concentrate slurry pipeline was built to carry the concentrates from Copperton to the smelter. The pipeline is 6" in diameter and constructed of steel pipe. Its capacity is about 2600 tons of wet concentrate per day. The pipeline was replaced in 1993 after a series of small spills in 1992. The spills occurred in 5 different locations: (1) near the former Hercules Plant; (2) near the old Garfield townsite; (3) at the Hercules Plant; (4) along eastern edge of the refinery; and (5) south of the smelter warehouse. The spills were cleaned up at the time they occurred. A concentrate slurry line was constructed in 1991-2 originally to carry excess Copperton concentrates from the filter plant at the smelter to the North Concentrator. When the filter plant was expanded sufficiently to handle the concentrates, the flow in the pipeline was reversed in 1996 to carry concentrates from the North Concentrator to the smelter.

Magna Flume: Tailings from the North Concentrator are carried via a pipeline to the South Tailings Impoundment. The pipeline crosses the railroad and the highway near the mill, the splits into two lines to different discharge points. This pipeline was broken in 1993 when a railcar backed into one of the supports holding up the pipeline as it crosses the tracks. Tailings spilled all over the road requiring the road to close for 12 hours. The spill was cleaned up.

SOUTH TAILINGS IMPOUNDMENT (MAGNA TAILINGS POND): The location of the two mills on the hillside provided sufficient elevation to allow disposal of tailings on the flat farm land below. The area was described as a meadow, fine for pasture cattle, and an irregular mass of marshes and home to large flocks of waterfowl. The original tailings pond in 1907 covered an area of 1315 acres, but was expanded shortly thereafter to include another 1460 acres. A dike was constructed on the north side to protect the railroad tracks there. By 1915, yet another expansion took place, this time requiring relocation of 9 miles of railroad tracks and a new dike 7 miles long. This expansion increased the size by another

2933 acres. Another expansion in 1918 added another 268 acres on the eastern side of the pond. A variety of construction techniques were used to raise the dikes on the pond as the area filled up with tailings. By 1982, the tailings pond covered 6259 acres and by 1995, the step back dikes had reached a total of about 223 - 253 feet high.

In general, tailings are deposited in to the pond via slurry pipelines from the mills. The tailings typically settle out near the sides and the water collects in the middle. When the water is not needed for reuse, it is discharged from the pond via a siphon to the clarification canal from whence it was then discharged to the Great Salt Lake via the C-7 Ditch to Lee Creek. Now the excess waters are discharged directly to the Great Salt Lake via Outfall 012.

There have been a number of environmental problems associated with the pond over the years beginning with its first installation and expansions in a wetland area (pre-wetlands protection legislation). In the 1980s, during a shut down of the mills, the tailings pond dried out and tailings were blown into the adjacent community of Magna (see OU9) resulting in numerous complaints. Occasionally, the water being discharged from the pond was of poor quality and it violated the state's water quality permit (UPDES permit). Of most concern to the local residents was the questionable seismic stability of the growing dikes. A dike failure during an earthquake could be complicated by liquefaction and impact the adjacent community, highways, utilities, and railroads. In fact, the tailings pond dikes had failed on several occasions already (1941, 1942, 1944, 1951, 1964, and twice in 1969). Because of the concerns about the stability of the dikes, Kennecott made plans to close this tailings pond and use an expansion area directly to the north of the pond.

Now that the adjacent new tailings pond (North Tailings Impoundment) is in use, Kennecott is drying out the former tailings pond, adding biosolids for fertilizer, and planting a mixture of pasture grasses. A portion of the pond is being used for grazing by a local rancher. The North Tailings Impoundment covers an area of 3200 acres. Dikes are constructed with coarse tailings placed on drainage blankets of slag. Construction of the first dikes were completed in 1998, and tailings were introduced shortly thereafter. Because of the newness of the pond, not all of the environmental problems have been solved. Occasionally, there are complaints about blowing tailings which drift over the nearby interstate highway, and there have been violations of the UPDES permit.

In 1990, the sources of wastes to the tailings pond included 79,000 tons/day from the Copperton Concentrator, 30,000 tons/day from the North Concentrator, 3000 tons/day from the slag concentrator, and 55 tons/day of fly ash from the power plant. At that time the South Tailings Impoundment contained about 2.1 Billion

tons of wastes.

Arthur Stepback Repository: As part of a non-time critical removal project at the North Zone, a RCRA-like repository was built in tailings on a stepback of the Magna Tailings Pond just across the highway from the refinery complex. It has a capacity of 2.3 Million cubic yards and is about half full of wastes from all over the North End of the site. Following completion of the removal action the eastern end of the repository underwent permanent closure and the western end was temporarily closed but will be used in future cleanup actions. The extra space in the repository is being reserved for wastes associated with future mine and facility closures. Associated with the repository is a staging area where wastes can be mixed and dried prior to placement in the repository.

Tailings Pond Landfill: A variety of different wastes were placed by Kennecott along the top edges of the South Tailings Impoundment. No records exist of what wastes or how much were disposed of in this way. Most of it appears to have been construction and demolition debris. Typically, the wastes were dumped and then the landfill would be completely covered with tailings as the tailings pond rose in height. Then the landfill would be relocated elsewhere along the edge of the pond and the process would start over. Known wastes included demolition wastes from the older smelter facilities (anode building, reverb building, convertor building), unused flux, construction debris, lunchroom and office trash. The landfill is permitted by the Salt Lake County Health Department to receive non-hazardous solid wastes from Kennecott facilities.

Ragtown and Snaketown: A small community of tents, dugouts, and shanties known as Ragtown developed in 1905 to house workers building the mills at Magna and Arthur. Later it developed into a town with about 60 homes. One part of Ragtown, known as Snaketown, was known for its saloons. Snaketown was later buried by tailings and Ragtown was abandoned in 1917. Most of the houses in Ragtown were moved to Magna. A small community of Japanese smelter workers developed near the Ragtown site. This community was abandoned in the 1930s. The Ragtown and Japanese town sites apparently were located in and near the current Diving Board overflow site.

Historic Roads: Two historic roads crossed the area. The first transcontinental highway, the Lincoln highway, was largely buried by State Route 201 and the railroads, but a section of the highway just west of the South Tailings Impoundment is still in use by Kennecott. Portions of the old Salt Lake to Tooele Highway were abandoned in 1917 due to one of the expansions of the tailings pond. Traces of the raised roadbed are visible in places. The Salt Lake to Tooele Highway route probably followed the stage route and the Hastings Cutoff.

Riter: Riter was a railroad station in 1905 on the San Pedro, Los Angeles and Salt Lake Railroad. It was the closest station stop to the mill construction sites. A small town developed near the station. The town site and station location were buried following the tailings pond expansion of 1918. Some of the railroad service buildings were moved northward when the railroad was relocated at that time. This newer location was again buried in the most recent tailings pond expansion in 1996. By that time, it was only a siding and there were no structures at the site.

Historic Rail Routes: Three different railroads had grades and tracks through the Magna Tailings Pond area. The original grade dates back to 1873. This route, then the Los Angeles and Salt Lake Railroad, had to be abandoned and the tracks relocated to the north in 1918 when the tailings pond was expanded. The original route is now the road next to the smelter return canal just to the west of the South Tailings Impoundment. The newer route had to be relocated again in 1997 when it too stood in the way of the construction of the North Tailings Impoundment.

The second railroad through the area was built in 1892 as the route from Salt Lake to Saltair and later to Garfield. Its route, roughly the route of Interstate 80, was not affected by the tailings pond expansions. Today, the Salt Lake, Garfield, and Western tracks extend only to 7200 W. and do not approach the Tailings Pond. The third railroad through the area was constructed in 1903 by the Western Pacific. These tracks were relocated in 1918, adjacent to the Los Angeles and Salt Lake Railroad tracks. The double tracks were relocated again in 1997.

NORTH TAILINGS IMPOUNDMENT (MAGNA TAILINGS POND NORTH EXPANSION: While the previous expansions of the Magna Tailings Pond buried some townsites, roads and railroads, the most recent Tailings Pond Expansion of 1997 buried some industrial facilities and usurped some wetlands along the Great Salt Lake. Construction materials included slag from the historic slag pile used for a drainage blanket under the dikes and coarse tailings. Slag was also used for ballast to construct new railroad facilities to the north of the expansion area. At the beginning of 2002, the North Tailings Impoundment had reached a height of 35 - 46 feet.

Chevron Fertilizer Plant: Located just north of the pre-1997 South Tailings Impoundment and mostly buried by the North Tailings Impoundment was the Chevron Fertilizer Plant and its wastes. The plant, built in 1952, was originally a joint venture of Kennecott, ASARCO, and Stauffer Chemical. The plant treated phosphate ores with sulfuric acid to produce phosphoric acid and dry phosphate fertilizer products. Annual production ranged between 10,000 and 70,000 tons/year. Wastes included 300,000 tons/year of phosphogypsum. Chevron bought the facility in 1981. They ceased production of the phosphoric and acid

and dry phosphate in 1986. Then they leased the land to FCI Agri-chem who mined the phosphogypsum tailings at the site for use as soil additives. The wastes covered about 385 acres and was thought to be about 6 million cubic yards. Kennecott bought the land in 1994 for use in the North Expansion and dismantled the plant in 1995 retaining only the administration building. There were 4 above ground fuel oil storage tanks that were removed and contamination in the footprint excavated and placed in a land farm at the site. There were also reports of the burial of Picloram at the site, but an investigation did not find any traces of this pesticide.

Morton Salt Plant: Located just north of the pre-1997 North Tailings Impoundment and buried by the North Tailings Impoundment was the Morton Salt Plant and evaporation ponds. Production of salt from the Great Salt Lake is a traditional industry of the area beginning in the earliest days of settlement. The Morton Salt operation began as the Inland Salt Company in 1887. A series of ponds adjacent to the lake were used to evaporate the salt from lake water. The first pond was used to remove suspended material. Then the water was fed to the next pond where calcium sulfate and calcium carbonate precipitated from the water. The last pond is where the sodium chloride (table salt) precipitated. The rest, called the bittern, was discharged back to the lake. The salt, 1 - 6 inches thick was harvested at first using a plow and wheelbarrows, later by tractors and scoops. Production was about 40,000 tons/year, but was as high as 180,000 tons/year in 1892. Morton Salt entered the picture in 1923, building a plant in 1923 which burned in 1927. Another mill was built in 1933 at a new location. It burned too in 1949. Yet another plant was built in 1949 and was expanded in 1965. It had a capacity of 100,000 tons/year. The process included washing in a special classifier with dewatering in a centrifuge. The product was then screened and sorted by size prior to shipment in railcars or trucks. Kennecott bought the plant with its adjacent ponds and demolished the plant (with some difficulty) in 1993. An environmental inspection at the time located a landfill on the site, a fuel storage tank, and some suspect sludges. Solvents found by the agencies in 1987 were recycled in 1990. Two PCB transformers and 6 PCB contaminated transformers were reported at the site, and were cleaned up prior to the sale of the land to Kennecott. Kennecott discovered an underground storage tank which had not been closed. Leakage from the badly corroded tank had contaminated nearby soils. One of the soil samples contained benzene higher than the UST action level, so these soils were spread out on a concrete pad to facilitate loss of volatiles and hasten biodegradation. It was theorized and now confirmed that the salt evaporation ponds themselves were permeated with salt. When Kennecott bought the land, they also acquired Morton Salt's discharge permit to the lake. The site is now buried by tailings associated with the North Tailings Impoundment.

SUBPART 3: RESTORED WETLANDS ASSOCIATED WITH THE MAGNA TAILINGS POND EXPANSION OF 1997

As a requirement of the CWA 404 permit associated with the expansion of the Magna Tailings Pond into jurisdictional wetlands, Kennecott was required to replace these wetlands at a nearby location. Several properties were purchased, all of which were close to the Kennecott facilities.

Wetlands Mitigation Area: The Wetlands Mitigation Area was former grazing and recreational land purchased by Kennecott in the 1990s to convert to wetland habitat. These wetlands were to serve as replacement wetlands to compensate for the loss of wetland associated with the 1997 expansion of the Magna Tailings Pond to the north. Water for the new wetlands came from existing canals and drains, although some water rights were purchased for this purpose. The wetlands created about 1995 have been successful as bird habitat. The site is located near the Magna Tailings Pond to the northeast. The western boundary is state land associated with the Great Salt Lake beach; the southern boundary is near I-80. Although there was no evidence of industrial activities on these lands, the Kennecott smelter stack is visible and the North Tailings Impoundment is nearby.

Morton Salt Property: In 1995, Kennecott purchased from Morton Salt four parcels of land totaling 773 acres for use as part of the Wetlands Mitigation Area. Although the land was never used for industrial or salt evaporation purposes, there was garbage, debris, and evidence of 4 wheel drive vehicular use.

Bothwell and Swaner: In 1995, Kennecott bought a 200 acre parcel of pasture land owned by the Bothwell and Swaner Company for use in Kennecott's Wetlands Mitigation Area. The land was never used for industrial purposes. There were some limited areas of garbage and debris dumps and 4-wheel drive usage.

Heughs Creek Associates: In 1995, Kennecott bought 3 parcels of land totaling 25 acres from the Heughs Creek Associates which planned to use the area as a duck hunting area. The land was previously used for cattle grazing. There was no industrial activity on site, but there was evidence of 4-wheel drives, garbage dumping and hunting.

Blackhawk Pond: Blackhawk Pond, part of Kennecott's Wetland Mitigation Area, was constructed by the Blackhawk Duck Club in the 1960s and 1970s by erection of dikes. Water came from the North Point Consolidated Canal via a ditch. The Duck Club abandoned the area in the mid-1980s when the Great Salt Lake flooded the area for several years.

North Point Consolidated Canal: The North Point Consolidated Canal receives water from the Surplus Canal (Jordan River water) and the Brighton Canal (also Jordan River water). The canal had little water due to use by upstream water rights holders until Kennecott purchased enough rights to service the Wetlands Mitigation Area.

Goggin Drain: The Goggin Drain receives water from the Surplus Canal (Jordan River) and was built mainly to reduce flows of the Jordan River through Salt Lake City. The drain sometimes floods filling depressions in the Wetlands Mitigation Area.

SUBPART 4: POWER PLANTS

Utah Copper Power Plant: Utah Copper built a steam generating plant in 1906 to provide electricity for its new mill. The site was located near the southern edge of the tailings pond. The capacity was 8,500 kilowatts. The plant was dismantled in 1912 when Utah Power and Light began to provide the needed electricity. The remaining structures were demolished in 1992-3. It is suspected that wastes from the power plant (fly ash and bottom ash) were disposed of in the adjacent Magna Tailings Pond.

Kennecott Power Plant: Kennecott built another power plant which went on line in 1944. Due to increasing power needs and lack of local capacity, the power plant was expanded in 1947 and again in 1960. The power plant is equipped to run on either coal or natural gas. Typically, coal is used in the summer and gas in the winter. The plant has two 25 megawatt units, one 50 megawatt unit, and one 75 megawatt unit. Each unit has 3 coal pulverizers, boiler, turbine, generator, electrostatic precipitator and emission stack. Wastes include silica slag, flue dust, fly ash, and occasionally sludges from boiler tube cleaning. Kennecott indicates that the silica slag is used along the railroad for drainage, the flyash goes to the Magna Tailings Pond and the bottom ash to the Tailings Pond Landfill. The fate of the sludge from boiler tube cleaning was not specified. The power plant has recently been renovated. Any power produced by the plant in excess of Kennecott's needs is sold to the western power grid.

Power Station: An inventory of potentially historic structures near the tailings ponds listed a "power station" at 2400 S 7400 W. This was later discovered to be the pump station for the Section 21 Well (drinking water). No hazardous substances were suspected at this location.

2. Investigations, cleanup activities, enforcement

Subpart 1: Mills. As part of the North Facilities Soils and Wastewater Treatment

Plant Ponds Site Removal Action (Site ID 4B), Kennecott characterized each site and conducted cleanups on those which had contaminated soils with concentrations above the Action Levels specified in the Administrative Order on Consent. After each removal, the soils after excavation were tested to determine if any wastes remained on site (post-removal sampling) and again after backfilling, grading and seeding (post reclamation sampling). In addition, there are ground water monitoring wells downgradient of most of these facilities, but a problem was found in only one well - diesel floating on the top of ground water just east of the North Concentrator. This was addressed using Corrective Action provisions of the Utah Ground Water Protection Program.

Subpart 2: Milling waste areas. There have been a wide variety of studies regarding the milling waste areas over the years, at times to study recovery efficiencies of metals using different reagents, to study the stability of the dikes surrounding the tailings pond, to determine ways to reduce blowing dusts, and to study different reclamation techniques. A summary of the investigations is given in Table 2.2.

TABLE 2.2
INVESTIGATIONS AT MAGNA MILLS AND TAILINGS POND AREA (OU 15)

Date	Activity	Performed By
Various	Routine monitoring of tailings for determining milling and flotation recovery efficiencies	Kennecott Laboratory
Various	Studies of tailings pond dike stability, usually following dike failures.	Various contractors
1979	Stauffer Chemical (Chevron Fertilizer Plant), discovery on CERCLIS, preliminary assessment	UDOH for EPA
1982	Evaluation of tailings pond discharge and need for a clarification canal before discharge	Kennecott
1990	PA/SI study for CERCLA listing: Kennecott Tailings	UDEQ for EPA
1993	Environmental Site Assessment for Morton Salt Property prior to sale to Kennecott	INTERA for Kennecott

Date	Activity	Performed By
1995	UST investigation at and removal of an underground tank left at Morton Salt	ERM-Rocky Mountain for Kennecott
1993?	Listing of permits and studies needed to obtain permits to enlarge the Magna Tailings Pond	Jacobs Engineering
1995	AST investigation at and removal of contaminated soils at the former Chevron facility	ITEX for Kennecott
1993-1995	Studies relating to the northward expansion of the Magna Tailings Pond, Environmental Impact Statement, including characterization of facilities to be demolished and buried by the expansion, and the characterization of lands to be used for wetlands restoration.	Kennecott Utah Copper Corp. Operations, with oversight by the Army Corps of Engineers and EPA
1994 - 2002	CERCLA studies, pre and post removal, for sites at former facilities and current operations	Kennecott Utah Copper, Engineering Services with oversight by EPA and UDEQ

SPILL HISTORY - The South Tailings Impoundment areas have been involved in a number of spillage incidents over the years. Table 2.3 gives the spills as reported to the Emergency Response Notification System (ERNS) from 1980 to 2001.

TABLE 2.3
SPILL INCIDENTS AT THE MAGNA TAILINGS POND AREA
REPORTABLE RELEASES (1980 - 2001)

Date	Location	Spilled Substance	Volume	Cause
6-27-90	Morton Salt plant, 3rd floor	PCBs	"Small amount"	Overload on a transformer
7-31-90	Utah and Salt Lake Canal	Process water	90,000 gallons	Leaks

Date	Location	Spilled Substance	Volume	Cause
1-19-96	Tailings line	Tailings	50 tons	Flange slipped producing gap in pipeline
11-25-97	Holding facility (Diving Board?)	Lead sulfide in tailings	500 pounds	Breach in embankment at facility
11-24-97	Temporary slurry containment	Sodium silicate solution	5000 cubic yards	Containment burst
10-7-99	Tailings splitter box	Tailings	100 tons	Excess amount of tailings coming down the line, overflowed
5-30-00	Ore slurry line from Bonneville	Ore slurry	110 tons	Leak in ore slurry line
3-1-00	Tailings line	Tailings	750 tons of tailings, 115 pounds of chromium	Spilled from Magna pump station due to equipment failure

Federal and state environmental agencies have taken a number of major enforcement actions at the Magna Tailings Pond waste areas. A summary is given in Table 2.4.

TABLE 2.4
ENFORCEMENT ACTIONS AT MAGNA TAILINGS POND AREA (OU 15)

Date	Agency/Statute	Activity, or alleged violation
5-4-87	Utah Department of Environmental Quality, Division of Air Quality, Clean Air Act	Fugitive dust from the South Tailings Impoundment
7-29-88	Utah Department of Environmental Quality, Division of Water Quality, Clean Water Act	Exceedances of UPDES permit limits for TSS, Cu, and Pb

Date	Agency/Statute	Activity, or alleged violation
3-30-89	Utah Department of Environmental Quality, Division of Water Quality, Clean Water Act	Exceedances of UPDES permit limits for TSS, Cu, and Pb
3-8-90	Utah Department of Environmental Quality, Division of Air Quality, Clean Air Act	Sulfur dioxide and visible emissions from the moly heater at the North Concentrator
7-16-90	Utah Department of Environmental Quality, Division of Air Quality, Clean Air Act	Failure to monitor dryness grid at the Magna Tailings Pond
1995	U. S. Army Corps of Engineers/ Clean Water Act, Section 404	404 Permit to fill jurisdictional wetlands as a part of the Magna Tailings Pond expansion project. The permit required certain monitoring and cleanup activities which would satisfy CERCLA concerns with regard to the Magna Tailings Pond
1978 - present	Utah Division of Oil, Gas, and Mining/reclamation permit M/035/002	The DOGM reclamation permit requires that the tailings pond be revegetated following closure of each section of the tailings pond. This permit also covers the Bonneville Crusher and the North Concentrator.
1995 - 2002	EPA/CERCLA	Non-time critical removal action
4-30-1999	Utah Dept. of Environmental Quality	133 violations of UPDES permit limitations (for metals, coliform, and TDS) especially at sewage plant, and reporting violations
7-17-2000	Utah Department of Environmental Quality, Division of Air Quality	Violations of visible emissions monitoring at crushers, North Concentrator, Fine Ore Storage Units, solvent parts washers. Still open.
7-17-2000	Utah Department of Environmental Quality, Division of Air Quality, Clean Air Act	Visible emissions and monitoring violations at the Power Plant, failure to conduct inspections. Still open.

Date	Agency/Statute	Activity, or alleged violation
11-17-2000	Utah Department of Environmental Quality, Division of Air Quality	Violation of operating permit for North Concentrator
12-19-2000	Utah Department of Environmental Quality, Division of Air Quality	Violation of operating permit for North Concentrator
2001	Mine Safety and Health Administration	Inspection only, no citations, regarding reports of fugitive dust from Arthur Repository.
3-25-2001	Utah Department of Environmental Quality, Division of Air Quality	Non-reporting of exceedance, North Concentrator and Power Plant
4-19-2001	Utah Department of Environmental Quality, Division of Air Quality	Errors on annual report, Tailings Pond
8-10-2001	Utah Department of Environmental Quality, Division of Air Quality	Fugitive dust from bulldozers at Cell 4 of the South Tailings Impoundment. Still open.

Subpart 3: Wetland Mitigation Areas. There were two investigations of the Wetlands Mitigation Area. The first occurred prior to the purchase of the lands by Kennecott. There was no sampling, just a visual inspection of the land. The second investigation occurred as a requirement of the CWA 404 permit issued by the Army Corps of Engineers in 1995. The purpose of that investigation was to assure the Corps that the Wetlands Mitigation Area was suitable for use as replacement wetlands for the wetlands to be subsumed by the Magna Tailings Pond Expansion. The waters, soils, sediments, and invertebrates were sampled and analyzed for a variety of metals. No cleanups were required by the Corps or EPA and the Wetland Mitigation Area construction proceeded. The wetlands are now operating as wetlands.

Subpart 4: Power Plants. The site of the older power plant was characterized in 2002 as a part of the Non Time-Critical Emergency Response Action. The current power plant is routinely inspected for environmental compliance by the Utah Division of Air Quality and the Utah Division of Solid and Hazardous Waste. No separate CERCLA-related studies took place at the current power plant.

C. Site Characteristics

1. Size, topography

Subpart 1: Mills. This part of the operable unit contains the buildings, facilities

and on-site wastes from three major operational areas: (1) the North Concentrator (located on a 2400 acre site); (2) the Arthur Mill (located on a 910 acre site); and (3) the Bonneville Crusher (located on a 76 acre site). The two older facilities were built on the first bench of the Oquirrh foothills overlooking the wetlands associated with the Great Salt Lake. This allowed the full use of gravity flow in the ore processing with the ore starting at the top and the concentrates and tailings coming out below. Both mills were located close to the South Magna Tailings Pond so that disposal of the tailings could be convenient and also use gravity flow. Constructed on a knoll overlooking Little Valley on one side and the mills down below on the other, the Bonneville Crusher was built on the side of the Oquirrh Mountains at an elevation above the mills. This would allow the crushed ore slurry to flow down the slope for further processing by flotation at the mills.

Subpart 2: Milling Waste Areas. The footprint of the former South Tailings Impoundment is 5727 acres in size. The North Tailings Impoundment is 4325 acres, of which 1055 acres were former jurisdictional wetlands. The area on which the tailings ponds were built is flat with an overall elevation difference of approximately 10 feet. Landforms consist of man made land (tailings or fill), lacustrine flat deposits, and minor sand and gravel bars.

Subpart 3: Wetland Mitigation Area. The Wetland Mitigation Area is about 2500 acres in size. It is relatively flat and located on the north side of I-80 and just east of the Great Salt Lake, just inland of the beach.

Subpart 4: Power Plants. The first power plant was located on the southern edge of the Magna Tailings Pond. The current power plant is located on a 28 acre site on a lake erosional bench at the north edge of the Oquirrh Mountains just to the west of the town of Magna.

2. Surface and subsurface features

Subpart 1: Mills. The surface of this site is typical of a series of large industrial complexes with buildings, storage yards, reagent tanks, water pump stations, pipelines, maintenance facilities, etc. In addition the facilities were all interconnected with a railroad system with main tracks, spurs, sidings, storage yards, and railcar and locomotive maintenance facilities. Most of the storage tanks were above ground but there were a few underground storage tanks usually associated with fueling stations for vehicles. In 1968, the North Concentrator site had 1 very large building, 11 large buildings, 10 small buildings, 2 large clarifier tanks, 4 smaller clarifier tanks, 2 ponds, 3 small storage tanks, 3 parking lots and was served by a network of roads and railroad tracks. In 1968, the Arthur Mill had 2 very large buildings, 8 large buildings 16 small buildings, 5 storage tanks on the hill behind the mill, 2 large clarifiers, 6 small clarifiers, 3 parking lots and was

also served by a network of roads and railroad tracks. In 1968, the Bonneville Crusher had 3 large buildings, 7 small buildings, several ore storage piles, and was served by a network of conveyor belts, railroad tracks and roads.

Subpart 2: Mill waste areas. The predominant surface features of the current landscape are the massive South and North Tailings Impoundments which now cover about 10,000 acres of former marsh land and valley floor. The older portion of the pond is about 250 feet high, and the newer portion is about 20 feet high. All the previous facilities which were located in the footprint of the pond have now been buried by tailings. Both the older and the newer sections of the tailings pond are underlain by the Upper Bonneville Clay sub-unit, which averages 9 feet in thickness. The Upper Bonneville Clay is underlain by the Lower Bonneville Clay which is about 6 feet in thickness and consists of lenses of sand and clay.

Subpart 3: Wetland Mitigation Areas. The Wetland Mitigation Area has three major man-made irrigation features including (1) the North Point Consolidated Canal; (2) the Goggin Drain; and (3) the Ridgeland Drain. Lower Lee Creek traverses the lower portion of the mitigation area. Before restoration the Wetland Mitigation Area consisted of 28 acres of emergent wetlands, 922 acres of saline playas, 163 acres of open water and 1407 acres of upland or man-made land.

Subpart 4: Power Plants. The power plant is a typical coal fired power plant with coal-handling, storage, and shipment facilities, boilers, turbines, cooling water condensers, smoke stacks and emissions controls. It is serviced by a railroad line.

3. Sampling strategy

Subpart 1: Mills. In general, sampling for facilities and historic facility sites was done in a grid pattern augmented with samples of opportunities in locations with discolored soils, unnatural appearance, or soils with obvious odors. Each sample was a 4- or 5-point composite. Leach tests were performed to determine the RCRA status of the wastes. The same strategy was used again for both post removal and post reclamation sampling. The objectives of the sampling events were (1) characterize soils for determination if excavation and removal was needed, where, how much and most appropriate disposal location; (2) determine if concentrations above action levels remained after excavation was completed; (3) determine existing conditions following completion of the action. The sampling events took place in the 1994 - 1999 time frame.

Subpart 2: Milling Waste Areas. The sampling strategy for this part of the site was dictated by the needs of the CWA 404 permit application and Environmental Impact Study. It was highly variable depending on the nature of the question at hand. For CERCLA purposes, the major question was whether or not burial by

tailings was sufficiently protective for any hazardous substances found on the footprint of the expansion area. An emphasis was placed on leachability, or that portion of the wastes which might be mobilized upon burial with wet tailings.

Subpart 3: Wetland Mitigation Areas. The wetlands were sampled on a screening level to determine if there were any concerns about contamination prior to establishing wetlands on the site. The sediments and water quality at each potential wetland area and all potential water sources were studied. The quantity and quality of invertebrates (bird food) was assessed. Most of this work occurred in 1995.

Subpart 4: Power Plants. The historic power plant site was characterized using the same sampling protocols as described in Subpart 1. The current power plant grounds were not sampled.

4. Known or suspected sources of contamination, nature of wastes

Subpart 1: Mills. The various facilities of the milling operations produced a wide variety of wastes with different disposal areas. A summary is given in Table 2.5.

TABLE 2.5
SOURCES OF CONTAMINATION AT MAGNA MILLS (Subpart 1, OU15)

Facility	Waste location	Years of operation	Process used	Product	Volume and nature of waste	Current status
Magna Leaching Facility	Waste rock on slope behind mill	1916-1920	Sulfuric acid leaching	Copper sludge	2000 tons per day, leached ore and waste rock, while in operation, the site itself did not need cleanup	Used for water storage, for emergency make-up water for cooling towers at the power plant

Facility	Waste location	Years of operation	Process used	Product	Volume and nature of waste	Current status
Lime kilns	Unknown	1929 - unknown	Heating of limestone	Lime rock	Unknown, 0 at site	Area paved and used as a laydown yard
Lime slacking plant	Unknown	1925 - unknown	Crush and dissolve lime in water	Milk of lime	Unknown, 0 at site	Area paved and used as a laydown yard.
Boston Consolid. Mill (Arthur Mill)	Mainly went to Magna Tailings Pond	1909 - 1985	Grind ore, separate minerals by froth flotation	Copper concen-trate	Tailings, within Magna Tailings Pond total (8000 tons/day), 237 tons of non-hazard debris, 16 tons of RCRA waste, 10 tons asbestos, 26 radio-nuclide sources. (See list, Table 12.1)	Facilities demo-lished
Reagent stills	Leaks on site	1924 - about 1985	Reaction stills and heat	Reco	2240 cu yds of unusual organics, reagents, Pb, As	Cleaned up

Facility	Waste location	Years of operation	Process used	Product	Volume and nature of waste	Current status
Iron foundry	Adjacent hillside	1917 - about 1985	Melt and pour into molds	Steel balls and other products	8824 cu yds of slag	Cleaned up
West Debris site	At site	Unknown	Dump	None	3580 cu yds, lab glassware, crucibles, debris	Cleaned up
Railroad Debris site	At site	Unknown	Dump	None	0	No action required
Crucible site	At site	Unknown	Dump	None	960 cu yds, fire assay debris, crucibles	Cleaned up
Arthur second line ditch	At site	Unknown	Dump	Done	0 (discolored soils)	No action required
Pipeline leak	At site	Unknown	Pipeline leak	None	0 (tailings)	No action required
Bonneville Crusher	At or near site	1966 - 2001	Grind ores	Ground up ore	See individual dump totals	Facility closed in 2001
Railroad Scrap Yard	At site	Unknown	Dump	None	Coal, stored concen-trates	No removal needed
Bonneville Gate Hillside	At site	Unknown	Dump	None	Ore stockpile area	Site reclaimed

Facility	Waste location	Years of operation	Process used	Product	Volume and nature of waste	Current status
Little Valley Settlement Ponds	At site	1966 - 2001	Retention basin	None	Runoff sediments from ore, hydro-carbon tainted soil stockpile	Cleaned up as part of UPDES stormwater permit
North Slope Site	At site	Unknown	Dump	None	Ore, cleaning wastes, junk metal	No action needed
North Concen-trator (Magna Mill)	Mainly to South Tailings Pond	1907 - 2001	Grind ore and recover minerals using froth flotation	Copper concen-trate	See total for Magna Tailings Pond (40,000 tons/day of tailings), 1.7 tons asbestos, 251 tons of reagents recovered (see Table 12.2)	Grinding unit gone, flotation unit idle, partial cleanup on grounds.
Moly-oxide unit	At site	Unknown	Recover moly from concen-trate	Moly-sulfide	Moly-sulfide recovered, 150 gals of PCBs	Building demo'ed, site cleaned up
Railroad Slope site	At site	Unknown	Dump	None	3500 cu.yds, slag, tailings, bricks	Cleaned up

Facility	Waste location	Years of operation	Process used	Product	Volume and nature of waste	Current status
Concen-trate loading area	At site	1907 - 1999	Spillage from loading	Copper concen-trate	7620 cu. yds., spilled concen-trate	Cleaned up
East debris site	At site	Unknown	Dump	None	710 cu yds, ore, metal debris	Cleaned up

Subpart 2: Milling Waste Areas. The sources of the wastes in the Milling Waste Areas in the vicinity of Magna are summarized in Table 2.6.

TABLE 2.6
SOURCES OF CONTAMINATION AT OU15 WASTE AREAS (Subpart 2, OU15)

Facility	Waste location	years of operation	process used	product	volume and nature of waste	current status
Diving Board Tailings	East of Magna Mill	1970 - 1991, overflow site since 1907	Cyclone, overflow settlement area	Size separated tailings	400,000 cy in 1993, 5000 cy from a spill in 1997 (tailings)	Operations area used for overflows and upsets. cleaned up
Tailings Slurry Pipeline	Along eastern front of Oquirrh Mts.	1966 - present	Slurry pipeline	Tailings (30% solids)	Spills due to overflows and line breaks (tailings)	In operation, some parts redesigned

Facility	Waste location	years of operation	process used	product	volume and nature of waste	current status
Concen-trate pipeline	Along SH 111	1966 - present	Slurry pipeline	Concen-trates in a slurry	Should be all product, spillage is waste (spilled concen-trates)	In operation
Magna Flume	Across SH 201 to tailings pond	1906 - present	Slurry pipeline	Tailings	Spills due to overflows (tailings)	Out of service since mill closed
South Tailings Impound-ment	Main tailings waste location	1906 - present	Tailings settling area	Tailings	2.1 Billion Tons, mostly tailings	Older portion being reclaimed under provisions of Utah DOGM permit
Arthur Stepback Repository and staging area	On a stepback of the Magna Tailings Pond	1995 - present	Waste repository and staging area for blending and drying	Sludges, soils	CERCLA wastes and contam-inated soil, 2,165,065 cy as of 2002.	Temporary closure
Tailings Pond Landfill	On the edges of the Magna Tailings Pond	Unknown	Solid waste landfill	Bevill wastes, trash, demo and const. debris	Unknown	Buried by tailings

Facility	Waste location	years of operation	process used	product	volume and nature of waste	current status
Ragtown and Snaketown	Adjacent to Magna Tailings Pond	1905 - 1930	Towns	Unknown	Unknown	Aban-doned and moved
Historic Roads	Under tailings pond	1905 - 1918	Roads	Unknown	Unknown	Buried by tailings
Riter	Under tailings pond	1905 - 1997	Railroad siding and station	Unknown	Unknown	Buried by tailings
Historic Rail Routes	Under tailings pond	1873 - 1995	Railroad grades and tracks	Unknown	Unknown	A portion is buried by tailings, some of railbeds still exist in wetlands
North Tailings Impound-ment	To the north of the original tailings pond	1997 - present	Tailings settling and storage	Tailings	Capacity is 1.6 billion tons, tailings and slag tailings	In operation
Chevron Fertilizer Plant	Under North Tailings Impound-ment	1952 - 1994	Phosphoric acid	Phospho-gypsum tailings	6 million cubic yards phospho-gypsum tails, 16,000 cu yds of petroleum tainted soils	Buried by tailings

Facility	Waste location	years of operation	process used	product	volume and nature of waste	current status
Morton Salt Plant	Under expanded tailings pond	1889 - 1993	Salt evaporated from Great Salt Lake	Salt	Unknown (salt residues)	Buried by tailings

Subpart 3: Wetland Mitigation Areas. There are no known direct sources of hazardous substance contamination on any of the Wetland Mitigation Area sites. None of these areas were ever used for industrial purposes. This does not mean that the land was pristine or unimpacted. The land was used primarily for grazing cattle, but saw some usage as a 4 wheel drive recreational area and dumping ground. However, the land is close to both Kennecott's Magna Tailings Ponds and Smelter. Airborne transport of wastes from these areas was possible, indeed likely to some degree. Also a potential source of contamination to these lands was the Jordan River. Both the Goggin Drain and the North Point Consolidated Canal get their waters from the Jordan River, a river with a checkered history of water pollution problems. Water quality is improving of late due to improvements in water pollution control infrastructure. A summary of possible sources of contamination to these areas is given in Table 2.7.

TABLE 2.7
SOURCES OF CONTAMINATION AT THE WETLANDS MITIGATION AREA
(Subpart 3, OU15)

Facility	Waste location	Years of operation	Process used	Product	volume and nature of waste	current status
Smelter (see OU13)	Near smelter, airborne	1907-present	smelting and converting	Copper anodes	Unknown, smelter air emissions	Air pathway abated
Magna Tailings Ponds	On site, airborne	1907-present	Settling	None	Unknown amounts, blowing tailings	Air pathway abated

Jordan River	River, canals and drains	Contam-ination began in 1847	Urban settlement	None	Unknown riverine water pollution	Continues, with some water pollution abatement

Subpart 4: Power Plants. The power plants generated wastes over the years, but most were disposed in the Magna Tailings Pond or off-site. Wastes include flyash, bottom ash, silica slag, boiler tube sludges, and atmospheric emissions. Waste management for the current facility is regulated by the state. No characterization of the wastes was performed under CERCLA authorities.

5. Routes of exposure and population.

In general, the land encompassed by OU 15 is not open to the general public and risks there are to industrial workers and maintenance workers. In some cases, after demolition of facilities, the land is converted to open space use and wildlife can be observed there (see Table 2.8).

TABLE 2.8
ROUTES OF EXPOSURE AND POPULATIONS AT MILLING FACILITIES

Category	Waste Type	Migration Potential	Exposure Pathway	Ecological populations	Human populations
Milling facilities	Tailings, concentrates, lab wastes	Erosion, groundwater	Ingestion, uptake to plants	Not currently wildlife habitat, future upland habitat, deer, elk, birds	Closed to public, occasional industrial workers only (pop = 150)
Milling waste areas	Tailings, spills	Erosion, groundwater, airborne	Ingestion, uptake to plants	Upland habitat is used by deer, elk, birds, potential impact to Great Salt Lake	Closed to public, industrial workers only (pop = 25)

Category	Waste Type	Migration Potential	Exposure Pathway	Ecological populations	Human populations
Wetland Mitigation Area	contaminants from elsewhere	airborne, waterborne	ingestion through food chain	wetland habitat, fish, inverts, birds	closed to public and workers.

D. Scope and Role of Operable Unit

Operable Unit 15 of the Kennecott North Zone Site represents the first step in the ore beneficiation process, the grinding of the ores and the separation of the copper and precious metal minerals from the host rock minerals. The main wastes produced were tailings, the ground up host rock minerals plus any unrecovered minerals. The grinding and flotation processes at these areas used large volumes of water and a small amount of reagents.

Several other environmental authorities were used in accomplishing the needed cleanups outside the CERCLA process.

E. Current and Potential Future Site and Resource Uses

The entire area of OU 15 is zoned M-2 (heavy manufacturing), with the exception of the Wetlands Mitigation Area which is designated A-20 (agriculture). As the older milling facilities are retired and demolished, the land has been converted to equipment storage areas or open space. As different areas of the Magna Tailings Pond have been retired, the surface has been reclaimed with grasses, and the land is now leased to a local rancher for livestock grazing. The Wetlands Mitigation Area is now being managed as a bird habitat wetland. In the future, the land near the mills is most likely to continue use as an industrial area because of a network of roads and railroads near the site. The tailings pond may be retired and used as agricultural or industrial property. Other land uses are possible, but may require additional cleanups.

F. Summary of Site Risks (Chemicals of Concern)

As described earlier, the human health risk assessment identified arsenic, lead, and cadmium as the most significant chemicals of concern at the site. The ecological risk assessment identified selenium as a primary chemical of concern. These chemicals were routinely monitored in the characterization and post removal studies. However, cadmium never rose to a level of health significance and is not reported in these tables. In addition to the routine arsenic, cadmium, lead, and selenium analyses, occasionally a full suite of metals was determined particularly if recycling or recovery of economic metals was anticipated. The primary chemicals of concern were arsenic, lead, and selenium. The

concentrations present at the site are given in Tables 2.9 - 2.13.

TABLE 2.9
RANGE OF LEAD, ARSENIC, and SELENIUM CONCENTRATIONS
(lightly shaded portions represent current conditions)
(concentrations in soils, mg/Kg or ppm)

Location	Arsenic Concentrations		Lead Concentrations		Selenium Concentrations	
	Max.	Mean	Max	Mean	Max	Mean
North Zone Soils Action Level (Human Health)		**100**		**2000**		**1000**
Subpart 1: Milling facilities and infrastructure						
Magna Leaching	60.4	60.4	162	162	7.9	7.9
Lime kilns						
Lime slacking (no cleanup needed)						
Boston Consolid. Mill (no additional cleanup needed)	33.1	11.9	38.8	12.0	5.2	2.8
Reagent Stills (pre-removal)	812	133.6	2700	285.8	89.4	15.8
Reagent stills (post-removal)	61	33.0	85	57.4	<9	<9

Location	Arsenic Concentrations		Lead Concentrations		Selenium Concentrations	
	Max.	Mean	Max	Mean	Max	Mean
Reagent stills (post-reclaim)	62.8	37.4	31.2	17.4	<0.5	<0.5
Foundry (pre-removal	393	62.2	8100	885	130	19
Foundry (post-removal)	82.1	37.2	1710	1238	9.1	3.7
Foundry (post-reclaim)	34.4	20.5	24.2	9.2	<0.5	<0.4
West Debris Site (pre-removal	360	146	65,000	10,032	<30	<30
West Debris Site (post-removal)	168	51.8	564	233.4	20.2	8.2
West Debris Site (post-reclaim)	54.9	46.3	295	130	5.3	2.6
Railroad Debris Site (no action)	19.3	19.3	876	876	1.2	1.2
Crucible Site (pre-removal)	210	63	37,000	6,484	<30	<30
Crucible Site (post removal)	59	34	1750	682	<6	<6

Location	Arsenic Concentrations		Lead Concentrations		Selenium Concentrations	
	Max.	Mean	Max	Mean	Max	Mean
Crucible Site (post-reclaim)	180	112	23.5	15.0	1.1	0.5
Arthur Second Line Ditch (no action)	96.8	75.5	278	238.8	8.0	2.5
Pipeline Leak (no action)	96.8		278		8.0	
Bonneville Crusher	to be characterized following demolition of the facility - see Selected Remedy					
Scrap Yard (no action)	13.6	7.97	17.8	11.67	1.15	0.66
Bonneville Gate Hillside (pre-reclaim)	35	25	47	33	2.9	1.61
Bonneville Gate Hillside (post-reclaim)	<14	<14	30.6	25.0	<13	<13
Little Valley Settlement Ponds (no removal under CERCLA, removal by NPDES)	124	78.8	96.7	42.3	<13	<13

Location	Arsenic Concentrations		Lead Concentrations		Selenium Concentrations	
	Max.	Mean	Max	Mean	Max	Mean
North Slope (no action)	44.3	27.5	65.5	34.6	<13	<13
Magna Mill-inside bldg before demolition	350	162.3	2400	598	215	52.9
North Concen-trator	to be characterized following demolition of the facility - see Selected Remedy					
Railroad Slope (pre-removal)	270	104.2	11,000	2067	15.0	11.7
Railroad Slope (post-removal)	338	104.4	5,890	1553	36	6.8
Railroad Slope (post-reclaim)	84.8	31.1	115	33.9	25.1	10.9
Concen-trate loading (pre-removal)	849	179	2270	504.1	5.1	0.4
Concen-trate loading (post-removal)	183	43.3	632	123	<0.5	<0.5

Location	Arsenic Concentrations		Lead Concentrations		Selenium Concentrations	
	Max.	Mean	Max	Mean	Max	Mean
Concen-trate loading (post-reclaim)	<0.5	<0.5	0.8	<0.6	<0.5	<0.5
East Debris (pre-removal)	990	172.5	9,900	1594	41	11.0
East Debris (post-removal)	71	42.5	460	241.5	<4	<4
East Debris (post reclaim)	33.0	26.2	162	85.2	<8	<8
Subpart 2: Mill waste ponds, piles, pipelines						
Diving Board Tailings	Concentrations of contaminants similar to tailings in Magna Tailings Pond					
Tailings Slurry Pipeline	Spilled tailings similar in concentrations to tailings in Magna Tailings Pond					
Concen-trate slurry pipeline	No data, cleanups of spills based on visual removals, concentrates are black and the underlying soils are light grey.					
Magna Mill Flume	Spilled tailings are similar in composition to tailings in Magna Tailings Pond					

Location	Arsenic Concentrations		Lead Concentrations		Selenium Concentrations	
	Max.	Mean	Max	Mean	Max	Mean
South Tailings Impound-ment (reclaim only)	130	14	63	13	5	0.65
Arthur Stepback Repository and staging area, still operational	Temporarily capped and closed.					
Tailings Pond Landfill	Landfills inaccessible - buried by tailings, not sampled.					
Ragtown and Snaketown	Historic settlements inaccessible - mostly buried by tailings. Composition would have been similar to Magna Soils (OU9) .					
Historic Roads	Historic roads now inaccessible and were not sampled					
Riter	Both old locations of Riter now buried by tailings and inaccessible. Not sampled.					
Historic rail routes (made from slag)	197	-	4280	-	38	-
North Tailings Impound-ment	Composition similar to South Tailings Impoundment					

Location	Arsenic Concentrations		Lead Concentrations		Selenium Concentrations	
	Max.	Mean	Max	Mean	Max	Mean
Chevron Fertilizer waste (now buried with tailings)	20	-	24.3	-	<2	-
Morton Salt	Metals not determined; site now buried under tailings and inaccessible.					
Subpart 3: Wetland Mitigation Area						
Ecological threshold for plants		**100**		**500**		**10**
Pond Sediment (ppm)	28.3	16.3	109	61.7	<4	<4
Canal Sediment (ppm)	2.2	2.0	16.4	15.7	<3	<3
North Point Canal Sediment (USFWS, 2001)	11.2	11.2	108	108	<1	<1
North Point Canal Sediment (EIS)	17.7	14.7	16.5	15.7	2.7	1.3
Goggin Drain Sediment (USFWS, 2000)	8.4	8.4	63.0	63.0	<1	<1

Location	Arsenic Concentrations		Lead Concentrations		Selenium Concentrations	
	Max.	Mean	Max	Mean	Max	Mean
Goggin Drain at GSL (EPA, 1995)		16		97		not analyzed
Subpart 4: Power Plants						
Old Power Plant (no removal needed)	43.5	16.1	346	132.2	10.0	6.8

TABLE 2.10
COMPOSITION OF MACROINVERTEBRATES IN WETLAND MITIGATION AREAS
(ppm, parts per million, dry weight)

	Arsenic concentrations		Lead Concentrations		Selenium Concentrations	
	max	mean	max	mean	max	mean
Avian diet NOAEL		**10**		**30**		**2**
Avian diet LOAEL		**200**		**325**		**6***
Pond inverts	10.4	4.9	36.6	14.7	6.0	4.4
Canal inverts	13.8	13.8	11.6	11.6	4.0	4.0

* action level to be used for wetlands in this action is 5 - 10 ppm Se in invertebrates.

TABLE 2.11
CONTAMINANTS IN WATER AT WETLAND MITIGATION AREAS
units are mg/L (or ppm)

	Arsenic concentrations		Lead concentrations		Selenium concentrations	
	max	mean	max	mean	max	mean
fresh-water WQ standards (corrected for hardness)		**0.048**		**0.103 - 0.284**		**0.005**
Pond water	0.100	0.031	0.012	0.006	0.036	<0.02
Canal water	0.105	0.066	0.009	0.009	<0.005	<0.005

TABLE 2.12
ORGANIC CONTAMINANTS

Location	Contaminant	Concentration
Morton Salt Underground Storage Tank Site	Benzene	1.3 mg/kg
Chevron Above Ground Storage Tank Farm site	Total petroleum hydrocarbons	957 mg/kg average, 9,370 mg/kg maximum

TABLE 2.13
RADIOACTIVITY AT ARTHUR MILL

Location	Radioactivity (before removal of sources) mR/hr	Radioactivity (after removal of sources) mR/hr
Outside Bldg 270 where radioactive sources were stored	Max. 0.32 Mean 0.15	Max 0.03 Mean 0.023
Inside Bldg 270	Not measured (one source had an activity of 25,000 mCi)	Mean 0.03

G. Removal/Remedial Action Objectives

The objectives for the operational areas of the milling areas and waste disposal areas are (1) to reduce or eliminate exposures to industrial workers at the site; (2) reduce or eliminate exposures to wildlife that might visit these areas after older structures are demolished; and (3) prevent ground water contamination by leaching of rain waters through wastes.

The main objective for the wetland mitigation area was to increase habitat suitability of the area so that it could be used to replace the jurisdictional wetlands filled in during the Magna Tailings Pond Expansion. A characterization was done to ensure the agencies that the designated replacement wetland area would be suitable habitat for birds and other wildlife.

H. The Selected Remedy

1. Remedies already completed using CERCLA Emergency Response Authorities and other environmental statutes.

Tables 2.14 and 2.15 summarize the cleanups already completed or underway using CERCLA Emergency Response Authorities and other environmental statutes.

TABLE 2.14
CLEANUP PROJECTS ALREADY COMPLETED AT MAGNA MILLING AREA
(Subpart 1: OU 15)

Location	Cleanup Method	Fate	Date Completed
North Concentrator (Magna Mill, grinding and crushing portion)	Removal of asbestos and demolition of older facilities, including warehouse, machine shop, boiler shop, carpenter shop, lumber shop, old flotation building	Asbestos to either Iron County Landfill or Salt Lake County Landfill, Flotation unit still operational until 2001.	1990

Location	Cleanup Method	Fate	Date Completed
Arthur Mill	Removal of asbestos, removal of industrial waste, removal of RCRA hazardous waste, demolition of facilities	Asbestos to Salt Lake County Landfill; industrial waste to Grandview, ID and Grassy Mountain UT; RCRA Waste to Fredonia, KS, and Baton Rouge, LA	1991
Moly-oxide unit	Removal of asbestos, PCBs, industrial waste, demolition of building	PCBs to Grassy Mountain, Moly sulfides to Washington, PA	1991
Railroad Slope	Soils removed, remaining contamination capped with 18" of clean fill, 2 terraced benches were created to reduce erosion	Arthur Stepback Repository; some wastes remain in place under 18" cap. (Could not remove all the wastes without endangering the railroad bed.)	July, 1996
Concentrate Loading Site	Soils removed except at concrete pad and a strip along southern boundary due to presence of the main copper ore slurry line, capped with 18" of clean fill.	Soils removed to Arthur Repository, except along ore slurry line, remaining soils capped with 18" of clean fill	Sept 1999
Magna East Debris	Contaminated soils removed, site regraded.	Arthur Stepback Repository	March, 1996

TABLE 2.15
REMEDIES ALREADY IMPLEMENTED MILLING WASTE AREAS
(Subpart 2: OU 15)

Location	Cleanup Method	Fate	Date
Diving Board Tailings	Spills cleaned up by excavation and removal as they occurred.	South Tailings Impoundment	Various, still operational as an area for overflows.
Tailings Slurry Pipelines	Spills cleaned up by excavation and removal as they occurred	South and North Tailings Impoundment	Various
Concentrate Slurry Pipeline	Spills cleaned up by excavation and removal as they occurred	Smelter	Several in 1992
Magna Flume	Spills cleaned up by excavation and removal as they occurred	South Tailings Impoundment	Various, 1993
South Tailings Impoundment	Water drained using wicks, biosolids added to surface in sections, revegetated	Wastes remain in place	Continuing under supervision of the Utah Division of Oil, Gas, and Mining
Arthur Stepback Repository	Used for CERCLA cleanups, temporary closure on eastern end. Full repository lined on bottom and sides with double HDPE with leak detection, Eastern half closed with triple liner, western half temporary closure with clay and soil cap	Wastes remain in place	Temporary closure 2001. Will be used again for remedial action and facility closure.

Location	Cleanup Method	Fate	Date
Tailings Pond Landfills	Buried by tailings in Magna Tailings Pond	Wastes remain in place	see Magna Tailings Impoundments
Ragtown and Snaketown	Abandoned, sites partially buried by Magna Tailings Pond	Wastes, if there are any, remain in place	see Magna Tailings Impoundments
Historic Roads	Buried by tailings in Magna Tailings Pond	Wastes, if there were any, remain in place	see Magna Tailings Impoundments
Riter	Abandoned, buried by tailings in Magna Tailings Pond	Wastes, if there were any, remain in place	see South Tailings Impoundment
North Tailings Impoundment	Still active	Still active	Still active, regulated by Utah Division of Air Quality, Utah Division of Water Quality (groundwater and surface water), Utah Division of Oil Gas and Mining.
Historic Rail Routes	Rails relocated, site buried by tailings in the tailings pond	Railbed data collected and forwarded to SHPO, potential historic site (1996)	See South and North Tailings Impoundments

Location	Cleanup Method	Fate	Date
Chevron Fertilizer Plant	Petroleum tainted soils excavated and sent to landfarm on site. Building asbestos bagged and removed, PCB transformers removed and disposed, containerized waste disposed, buildings dismantled with disposal of mercury vapor lamps, light ballasts, lead-based paint, and waste oil	Empty transformers to S.D. Myers of Tallmadge Ohio; PCB oil shipped to Aptus of Argonite, Utah. 59 capacitors shipped to Aptus. 2 bushings shipped to Aptus, soils and concrete (22,935 kg) shipped to USPCI, 2 drums of light ballasts shipped to USPCI, asbestos material shipped (115 cu yds) to Waste Control Management of Nevada, SLC. Miscellaneous chemicals used at Kennecott.	The gypstack wastes are buried in place by the North Tailings Impoundment. Also the land farm of petroleum contaminated soils and building construction debris. Cleanups performed under provision of a CWA 404 permit, Army Corps of Engineers.
Morton Salt Plant	Building demolished, UST removed, site characterized	Some of salt in the evaporation ponds dissolved in the decant waters of the North Tailings Impoundment, petroleum contaminated soils spread out to volatilize the oil, these and the rest of the wastes remain in place buried under tailings	See North Tailings Impoundment, salt ponds and former footprint of Salt Plant buried by tailings. Cleanups part of the provisions of a CWA 404 permit (Army Corps of Engineers).

At Subpart 3, the Wetlands Mitigation Area portion of OU15, the land later used for the Wetlands Mitigation Area was characterized as part of a requirement for a CWA 404 permit and was found to be suitable for bird habitat. Concentrations of hazardous substances were low and did not present a threat to wildlife. Dikes and

water management systems have now been added, and Lee Creek wetlands have been enhanced with increased flows and meanders.

At Subpart 4, the Power Plants, the current power plant was not characterized because it is already regulated by other environmental statutes.

2. Additional cleanups required as a part of this Record of Decision.

Following demolition of closed milling facilities, such as the North Concentrator, (Magna Mill) and the Bonneville Crusher, as provided in the Kennecott reclamation permit issued by the Utah Division of Oil, Gas, and Mining, the land underneath the closed facilities must be characterized and contaminated soils removed to the Arthur Stepback Repository. After removal of any contaminated soils, the site will be revegetated in accordance with the standards of the Utah Division of Oil, Gas, and Mining, unless the site is to be re-used for construction of a new industrial facility.

In the future, upon closure of the milling and milling infrastructure facilities, if these facilities are demolished, any contaminated soils or Bevill Exempt wastes uncovered by demolition of these facilities may be disposed of at the Arthur Stepback Repository and the staging area and/or covered with at least 18" of clean soil. As-generated RCRA waste must be recycled or disposed of in an approved off-site facility.

The Arthur Stepback Repository and the staging area were designated as corrective action management units (CAMUs) in 1996 as part of the Kennecott North Facility Soil/Wastewater Treatment Plant Sludge Pond (NRS/WWTP) Site Removal Action (CERCLA-VIII-95-04). The design and operating requirements for these CAMUs were set fort in the NFS/WWTP Work Plan. To facilitate implementation of the cleanups required here, this Record of Decision authorizes Kennecott to continue operation of these units as CAMUs. Given that these CAMUs were initially approved prior to April 22, 2002, they are subject to the requirements in 40 CFR § 264.551 for grandfathered CAMUs (see 40 CFR § 264.550(b)). This designation authorizing the continued use of these CAMUs is made for the same reasons, and the CAMUs will be subject to the same conditions, as specified in the 1996 Action Memorandum and as set forth in the NFS/WWTP Work Plan, as modified. At Kennecott's option, Kennecott may obtain authorization to operated these units as CAMUs from the State of Utah, at which time such State authorization will replace the authorization provided in this Record of Decision. Following CERCLA and closure of site facilities, the entire repository will be permanently closed, and the staging area cleaned up and closed.

Three maps shall be produced: (1) Map showing all known locations of wastes,

regardless of hazardous substance content, because these wastes might pose challenges during any new construction - this map shall also include areas which have not been sampled due to inaccessibility; (2) Map showing all known locations of wastes and soils which exceed typical residential land use action levels for lead and arsenic (500 ppm lead, 50 ppm arsenic), which could be used by future land use planners and developers to determine if additional cleanups might be needed should the land use change; and (3) Map showing all known locations of wastes and soils which exceed the non-residential land use standards as detailed in this Record of Decision.

Section 3: Magna Soils (Kennecott North Zone OU9)

A. Site Name, Location and Description

1. Site Type and description of operable unit

Magna is the closest community to the Kennecott ore milling, smelting, and refining facilities. Contamination of soils was suspected because the residents had complained to environmental agencies over the years about air emissions from Kennecott's nearby facilities.

2. Facilities located within OU9

Magna is a typical community in Salt Lake Valley with a downtown area, residential neighborhoods, and commercial facilities such as gas stations, convenience stores, fast-food restaurants, office buildings, and a shopping center complex. Although not in the operable unit, Magna is surrounded by industrial development including the South Tailings Impoundment to the north of town (see OU 15); the Kennecott Power Plant, North Concentrator, and Bonneville Crusher immediately to the west of town (see OU 15) and farther west the Kennecott Refinery (OU 14) and Smelter (OU 13); Hercules Rocket Fuels testing facilities (now Alliant Technologies) to the south of town; and the Salt Lake Valley metropolitan area to the east of town.

B. Site History and Enforcement Activities

1. Activities at the site which led to contamination

Originally known as Pleasant Green, Magna became a growing community beginning in 1905 when the adjacent Arthur and Magna Mills were being constructed (see OU 15). At first, in addition to a few scattered ranch houses, the communities were tents, dugouts, and shanties to house the construction crews. When the mills became operational, workers and their families built permanent structures. Magna grew as the mills expanded and hired more workers. It has been known, at least informally, as one of the most ethnically diverse communities in Utah because of the different immigrants that came to work in the mills. They brought their languages, their churches, and their culture with them. The community is still known for its diversity.

This history of the community of Magna and the companies of Utah Copper (later Kennecott Utah Copper) have been linked. The community still has a large number of Kennecott employees, vendors and retirees and, until recently, was home to Kennecott's corporate offices. Kennecott contributed land for civic

purposes such as the golf course, the Webster School, and the recreation center and has supported these facilities with donations. On the other hand, Kennecott's environmental problems have indirectly affected Magna. In the 1930s, there was a flash flood which came roaring down Little Valley flooding downtown Magna. Kennecott smelter emissions had killed most of the vegetation in Little Valley and Kessler Canyon. The soils were subject to severe erosion and could not retain moisture. The Magna flood waters were very muddy with soils from Little Valley. The citizens of Magna launched a flood control project building dikes across Little Valley to hold back the waters, and then planted grasses and trees in an effort to prevent flood and mudflow recurrences.

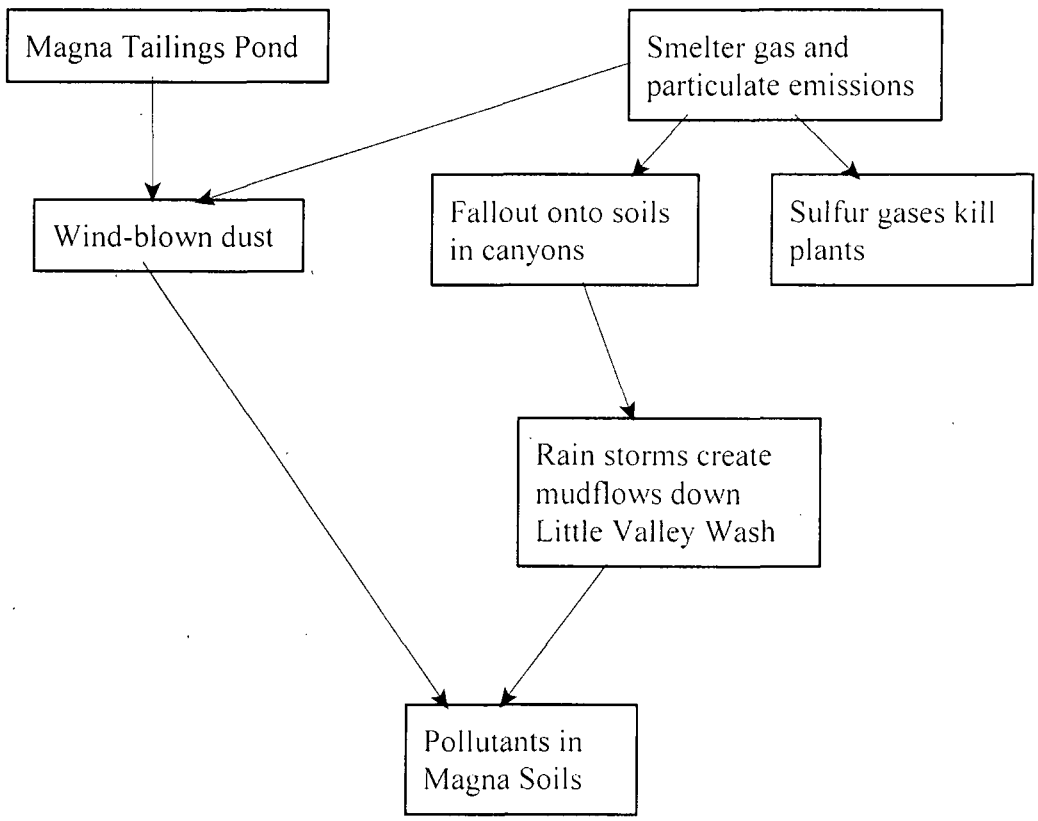
Magna is also close to a number of Kennecott facilities which have air emissions out of their stacks and fugitive emissions. The smelter is 4.6 miles away, the Kennecott power plant is about 1 mile away, and the South Tailings Impoundment is 0.5 miles away. Magna citizens have often complained that smelter causes unpleasant odors in town, but, at least lately, this is more likely odors from the nearby Great Salt Lake marshes.

The Magna Tailings Pond has often been, at very least, a major nuisance in Magna. If the surface of the operational tailings pond is not kept wet, winds can kick up the tailings creating quite a dust storm. The dust content of the air is so high that it cuts visibility on the nearby Interstate Highway 80 and SH 201. When the mills were shut down temporarily in the mid-1980s, the tailings pond surface dried out and dust storms over Magna were so intense, the dust had to be swept up off porches and off cars. Complaints went to state offices and the state legislature. A state enforcement action required Kennecott to keep at least 95% of unreclaimed tailings wet to prevent the dust clouds.

The community of Magna is still unincorporated, but has recently been given township status by Salt Lake County which allows the local residents to have more influence over planning and zoning decisions. There are two "town" councils: (1) Magna Area Community Council which is officially recognized by Salt Lake County for their opinions on land use and growth issues; and (2) Magna Community Council which is largely a group of Magna businessmen. The population of Magna is about 22,770 [2000 Census].

Citizens and scientists thought that the soils of Magna might be contaminated from (1) the emissions of Kennecott's smelter; (2) tailings blown off the Kennecott tailings pond; and (3) contaminated mud brought into town by flood waters in the 1930s. Other sources of contamination were also possible including lead paint in older homes and fallout of urban air pollution particulates. It was not a surprise to anyone in town when EPA expressed an interest in Magna's problems.

Figure 3.1: POTENTIAL SOURCES OF CONTAMINATION IN MAGNA SOILS



2. Investigations, cleanup activities, enforcement

There were four different sampling events in Magna, each with a different objective. In 1990, UDOH conducted a PA/SI sampling for the Kennecott Tailings site, then under consideration for listing on the NPL. The objective was to determine if the metals in the soils were above background concentrations. A total of 42 samples were analyzed collected from 13 locations. The concentrations of lead, arsenic, and copper were above background concentrations. There was no consistent trend of concentrations as a function of depth down to 12 inches. UDOH indicated that there was a slight downward trend in metal concentrations from the northwest part of town (closest to Kennecott facilities) to the southeast.

The second sampling event occurred in 1994 as part of a removal assessment by EPA. The objective of the study was to determine if an emergency response action was needed in Magna. Approximately 240 surface soil samples were collected by BOR with emphasis on the northwest part of town (the older sections) and the land just east of the South Tailing Impoundment. Lead was the primary concern in Magna, but arsenic and copper concentrations were also determined, mainly to aid in source identification (arsenic as a tracer of smelter smoke and copper as a tracer of tailings. There were only two samples which exceeded 500 ppm lead (an action level previously used at the Sharon Steel Superfund Site in Midvale for windblown tailings) at 560 and 540 ppm lead. Although above background, the values did not rise to a significant health threat. This was later confirmed by ATSDR in a Public Health Assessment.

The third and fourth sampling events were actually a study of the uptake of lead and arsenic into garden vegetables. For the first phase, investigators collected samples of soils from as many gardens in Magna as could be found. The objective was to locate gardens covering a wide range of lead concentrations for a later study of the vegetables. In Phase 1, soils from 37 gardens were collected and analyzed. Based on these results, for Phase 2, the investigators returned to 14 gardens and took another 45 soil samples which were co-located with the roots of vegetables (carrots, tomatoes, beet greens and zucchini). The highest lead concentration was 1420 ppm next to a zucchini plant in one garden. However, concentrations of lead next to other plants in this same garden averaged 273 ppm. (In the first phase of this project, this garden had soil concentrations of 311 ppm lead.) The one high concentration was determined to be an outlier and not representative of gardens in Magna. The results of this garden vegetable study indicated that the concentrations of lead and arsenic in the vegetables were too low to include as a major pathway in exposure calculations for either Magna or Bingham Creek.

In Magna, the bioconcentration factor (vegetable concentration/soil concentration) was calculated for lead and arsenic for a variety of vegetables. For lead, the carrot bioconcentration factor was 4.6E-03; the tomato bioconcentration factor was 5.9E-04; the zucchini biocoentration factor was 8.9E-05.

As a result of these investigations, EPA determined that no removal action was needed in Magna, and no enforcement action was taken.

In 1995, Kennecott funded the University of Cincinnati and the Salt Lake City/County Health Department to conduct a blood lead study of Magna children. Although a final report of this study was never published, Kennecott indicated to ATSDR that 6.2% of the children studied (162) had blood lead levels exceeding 10 ug/dL. The average blood lead was 4.1 ug/dL with a range of 1.6 to 11.2 ug/dL. The investigators did not explain where the 10 children with high blood leads were exposed since the soil lead levels were low. Neither ATSDR nor EPA has had access to this study, so any causality could not be determined by the agencies. A final report was never issued; Kennecott (who funded the study) could not get further details despite repeated requests.

Later in 1996, the Agency for Toxic Substances and Disease Registry conducted a public health assessment for the Magna area, among other areas. After examination of air quality measurements in Magna, the ATSDR concluded that the "air exposure situations pose no apparent public health hazard". Based on the TRI, they suggested that organic contaminants from the Hercules facilities to the south of town be evaluated. (These facilities are not a part of the Kennecott site.) After examination of EPA soils data, ATSDR concluded at the "soil exposure situation poses no apparent public health hazard" and did not identify any issues warranting recommendations.

C. Site Characteristics

1. Size, topography

The Town of Magna, about 6.5 square miles in size, is generally flat, with slopes that average about 5%. The lowest point in town is in the northeastern corner (4,220 feet above sea level) and the highest point is in the southwestern corner (4,600 feet above sea level).

The only major natural stream is Coon Creek, which originates in Coon Canyon to the southwest of town. There are several irrigation or water supply canals including the Utah and Salt Lake Canal which cuts across the southwest corner of town en route to the Great Salt Lake. The Riter Canal cuts across the northern part of town.

Because of its low elevation, Magna has several wetland areas, mostly in the northern part of town. The wetlands are created by a high water table in that area. Groundwater flow is toward the southeast, except in the immediate vicinity of the Magna Tailings Pond which creates a mound of groundwater flowing outward in all directions.

2. Surface and subsurface features

The Town of Magna is located in the valley of the Great Salt Lake on former lake sediments and soils washed off the Oquirrh Mountains. Because of its proximity to the Great Salt Lake, the soils and the groundwater are both salty. The soils, especially in the north of town, have a high potential for liquefaction during an earthquake.

In addition to the natural features, Magna has a wide variety of structures typical of residential and commercial development including subsurface infrastructure such as pipelines, underground storage tanks, and utilities. The most prominent features are actually outside the town. Just to the north of town is the Magna Tailings Pond which exceeds the size of the town and is 130 feet high. Just to the west of town are several other Kennecott facilities.

3. Sampling strategy

The sampling strategy of the four different sampling events varied because the objectives of each event were different. The first sampling (UDOH) included a preliminary survey of 13 locations apparently chosen at random. The emphasis of the sampling was on the portions of Magna which were closest to Kennecott facilities. The objective of this study was to gather information for use in evaluation of the site for listing on the NPL.

The second study (EPA-BOR-Sverdrup) included two sections of town. The south portion was located south of the tailings pond bounded by 2100 S and the tracks, Kennecott property to 7200W. One composite sample was collected in each grid cell which measured 800 feet by 800 feet. The east portion was located immediately east of the tailings pond. Grid sizes there were 1000 feet by 1000 feet. About 240 locations were sampled. The objective of this study was a removal assessment to determine if an emergency action was needed in Magna and, if so, where.

The third sampling was a survey of residential gardens in Magna to determine the ranges of contaminants present in the gardens and the types of vegetables grown in each garden. Samples were collected from all gardens which could be found. The objective of this study was to design another sampling program which could

look at uptake of lead and arsenic in various vegetables over a range of soil concentrations. Soils from 37 gardens were tested in this event. Based on these results, a fourth sampling program was designed.

In the final sampling, 14 gardens were selected for further study and an additional 45 soil samples were collected. The soils in this study were collected near the roots of plants which were collected at the same time. For example, one garden yielded 4 samples, 2 of which were associated with zucchini samples and 2 of which were associated with tomato plants.

4. Known or suspected sources of contamination

The lead and arsenic in the soils of Magna are suspected to have originated from several sources. Fallout of atmospheric particulates originating from the South Tailings Impoundment was the most obvious source. There is anecdotal evidence of heavy dust fall from the Tailings Pond relayed by local residents who indicated that the dust fall was so heavy they had to sweep the tailings off their porches and cars. Because of odors, several residents concluded that smelter emissions could be detected in Magna, largely sulfur dioxide. Fallout of atmospheric particulates originating at the smelter is, therefore, also a suspected source. Indirectly, flood waters originating in Little Valley during the 1930s may have also carried soils that were tainted with atmospheric fallout from the smelter. It is known that the flood waters were very muddy and that much of the vegetation in Little Valley had been devastated by smelter emissions during the early days of smelter operations. Another nearby industrial facility, the coal-fired power plant operated by Kennecott, also produces airborne emissions and dusts. Finally, because of Magna's location in Salt Lake Valley, automotive emissions particularly in the days of leaded gasoline use could have also contributed some lead to Magna Soils.

5. Types of contamination, quantities

The quantities of lead and other contaminants which reached Magna via airborne emissions can be roughly estimated comparing concentrations in Magna with background concentrations. Lead concentrations were used to estimate smelter fallout because lead is present in high concentrations in historic smelter flue dust, but very low in the tailings. The excess lead in Magna is 749 tons which is equivalent to 6420 tons of smelter fallout. Copper concentrations were used to estimate fallout from the South Tailings Impoundment. There were about 1900 tons of excess copper in the soils of Magna which equate to about 1.3 million tons of tailings.

A more direct study of atmospheric fallout rates is available. Kennecott conducted a few dust jar experiments (1969 - 1980) to determine the fallout rate in

Magna and other locations. Although the fallout rates, as suspected, varied widely, the average pre 1972 fallout rate at the Magna station was about 21 mg $Pb/m^2/mo$. After 1972, the dustfall rate decreased to average about 5 mg $Pb/m^2/mo$. Over the 4600 acres sampled in the EPA-BOR study, this would amount to 353 tons of lead. This method of estimation agreed within a factor of 2.1 with the inventory of lead found in the soils of Herriman.

In addition, there were slightly higher concentrations of lead in the area of Magna prone to flooding. The excess lead in this area was about 29.4 tons of lead which equates to about 245 tons of smelter fallout. In terms of wastes, fallout from tailings dust clouds represent the largest contribution, followed by smelter fallout, and then floods. However, smelter fallout is more significant in terms of contributions to lead contamination. Note that although these atmospheric fallout tonnages would seem large, these values are spread over a large area and are not high enough to pose a health threat.

6. Location of contamination, exposures

Studies of lead and arsenic in the soils of Magna did not find concentrations high enough to pose a health threat to Magna residents.

D. Scope and Role of Operable Unit

The Magna Soils Operable Unit (OU 9) was the area where the most significant impacts to local citizens were suspected. Unlike most of the other operable units which are on Kennecott land and frequented only by industrial workers, the Magna Soils OU 9 could have been the place where all the industrial activity had health significance to the public. It was this operable unit which was the most important project in the entire Kennecott North Zone site.

E. Current and potential Future Site and Resource Uses

Magna, originally a multi-ethic community of miners, smeltermen, and mill operators, has an older section with a downtown and older modest homes. Recently, however, Magna has started to grow as it becomes attractive as a suburb to Salt Lake City. The growth is toward the east into former agricultural lands. Kennecott has not begun to sell any of their land holdings in this area yet.

As of 1989 when the Salt Lake County Public Works Department published the Magna Community Master Plan, the land use of Magna was distributed as given in Table 3.1.

TABLE 3.1
MAGNA LAND USE (1989)

Land Use	Acres	Percentage
TOTAL	4200 acres	100%
Vacant or Agricultural	2146 acres	51%
Agricultural	1399 acres	34.53%
Vacant	675 acres	16.66%
Residential	974 acres	24%
Institutional and park lands	276 acres	6.8%
Institutional	122 acres	3.01%
Parks and Recreation	154 acres	3.80%
Commercial	78 acres	1.93%
Industrial	51 acres	1.26%
Transportation	530 acres	13.1%
Utility	68 acres	3.01%

The drinking water needs of Magna are served by the Magna Water Company and the source of the water is wells. The Magna Water and Sewer District, founded in 1961, operates several wells located east of Magna in West Valley City, and several other additional well sites to accommodate future growth. None of the wells are in the pathway of any Kennecott-related contamination. Kennecott's water needs come from their own wells. Additional water supplies can be obtained from both the Central Utah Water Conservancy District and the Jordan Vally Water Conservancy District. The Magna Water Company does not anticipate needing additional waters from any wells near Kennecott.

F. Summary of Site Risks

1. Chemicals of Concern.

The soils of Magna were determined in four separate studies in the area, as described previously. The concentrations of the chemicals of concern found in these studies are summarized in Table 3.2.

TABLE 3.2
CONCENTRATIONS OF METALS IN THE SOILS OF MAGNA (mg/Kg, ppm)

Location	Arsenic Concentrations		Copper Concentrations		Lead Concentrations	
	Max.	Mean	Max.	Mean	Max.	Mean
Typical residential action levels		50 - 100				400 - 1200
Magna (UDOH, 1990)	189 J	27	716 J	182	265 J	81.2
Magna (BOR-EPA, 1994)	40-58*	9.5 - 15.2*	600	208	540-560*	113 - 119*
Magna Gardens, Phase 1 (Sverdrup/ EPA, 1994)	31	<20	461	177	775	158
Magna Gardens Phase 2	23.2	12.2	-	-	1420@	183
Magna (Univ. of Cincinnati) 1995, outdoor dust	not measured		not measured		1920	253
Magna (Univ. of Cincinnati) indoor dust	not measured		not measured		1047	207

J = estimated
* Two different analytical techniques were used in this study. Results from both techniques are presented here.
@ Later determined to be an outlier.

G. Removal/Remedial Action Objectives

The objective of the potential removal project in the town of Magna was to reduce or eliminate unacceptably high exposures of lead and arsenic to the residents of Magna. This objective was not applied in this case because no unacceptably high exposures were found in the assessment studies.

H. The Selected Remedy

No action is needed. The levels of contaminants present in the soils of Magna were not high enough to present a risk to Magna residents.

In addition, the potential sources of lead and arsenic contamination in Magna soils have been abated over the last several years. First, the smelter emissions have been reduced dramatically with the construction of the new smelter which has improved gas handling technology. Smelter emissions are monitored by Kennecott under the provisions of an air quality permit administered by the Utah Division of Air Quality.

Second, the problem of tailings blowing into the town of Magna has also become less frequent in the past several years, because the older sections of the South Tailings Impoundment, which were adjacent to the town, have been retired from service and are now being reclaimed with vegetation. The active portion of the tailings pond, the North Tailings Impoundment, is farther away from town. The closure and revegetation efforts are being conducted by Kennecott under the provisions of a permit issued by the Utah Division of Oil, Gas, and Mining.

Section 4: Smelter and Acid Plants (OU 13)

A. Site Name, Location and Description

1. Site Type and description of operable unit

Operable Unit 13 of the Kennecott North Zone is comprised of the Garfield Smelter and associated facilities and is located just south of State Highway 201 near the western boundary of Salt Lake County at the mouth of Kessler Canyon. The smelter is designed to process concentrates produced by the mills (see OU15). The concentrates are melted in a high temperature process to burn off the sulfur and further separate metals from non-economic minerals. The products produced are copper anodes (which also contain precious metals) and sulfuric acid (from the off-gases in the furnaces). The wastes produced by the smelter include slag, flue dusts, stack gases, fugitive air emissions, spills of process waters, and others. The waste handling protocols of today are much improved over operations of the past. There is ground water contamination in the smelter area, but that is included as a part of another operable unit (see OU23).

Figure 4.1 demonstrates the interrelationship between the smelter operations and other operable units.

2. Facilities located within OU 13

The list of facilities within Operable Unit 13 (Table 4.1) generally includes the smelters, acid plants, associated infrastructure, and waste areas associated with smelting activities at KUCC over the years. For clarity, this Section is divided into three parts. Subpart 1 describes the facilities associated with the smelters, acid plants and materials handling facilities. Subpart 2 describes the infrastructure such as pipelines, transportation corridors, and water management facilities associated with smelter operations. Subpart 3 describes the waste dumps, landfills, and catchments associated with the smelters.

Figure 4.1: FLOW CHART AT SMELTER AND ACID PLANT

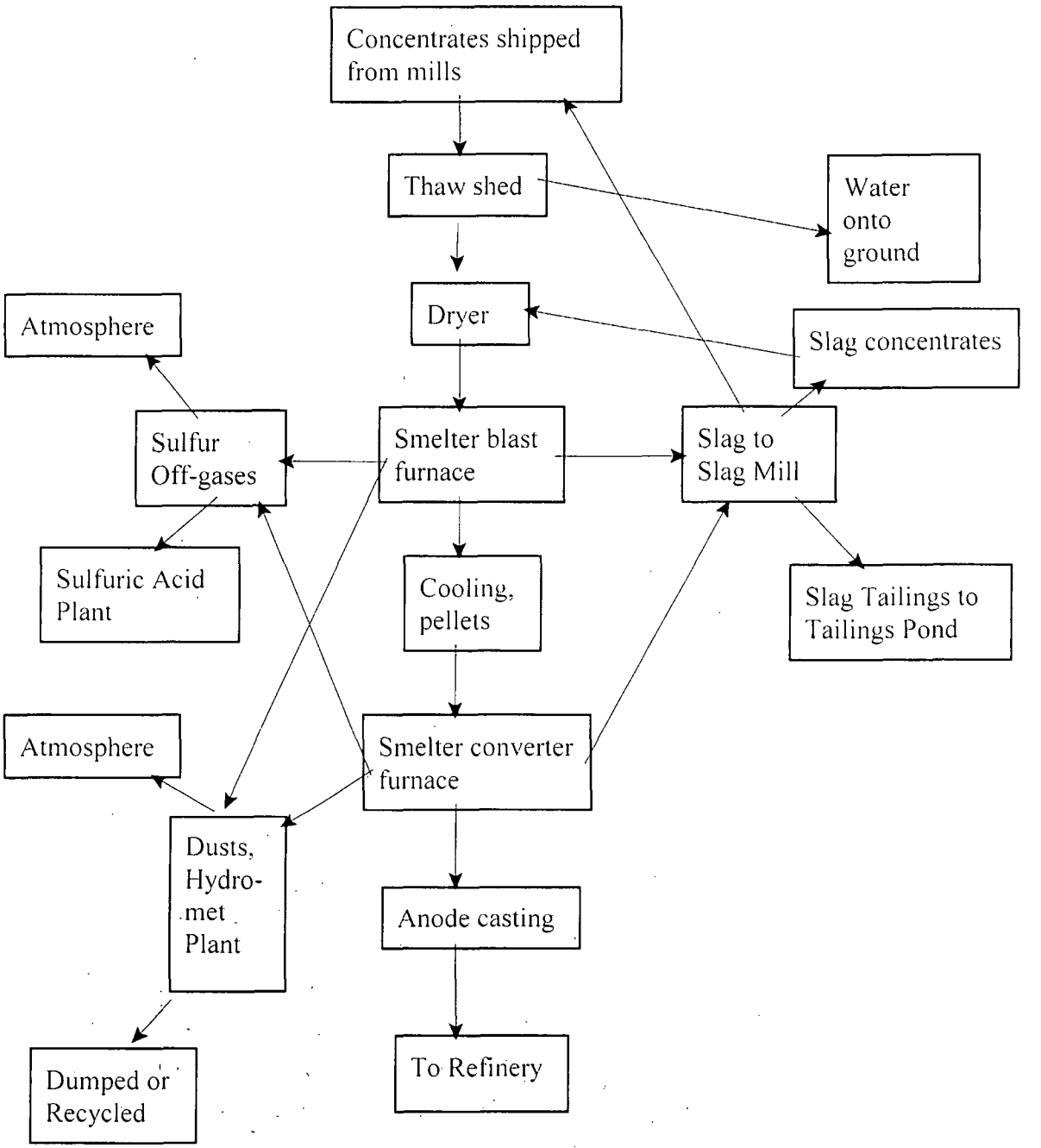


TABLE 4.1
LIST OF FACILITIES AT OU 13 AND GENERAL DESCRIPTION

FACILITY	FUNCTION	RELATION TO OU 13
SUBPART I: SMELTERS, ACID PLANTS AND MATERIALS HANDLING		
SMELTERS	drive off sulfur and float off other elements from the concentrate to form a copper plate containing some impurities	Three smelters on-site at various time periods each with its own wastes
Reverberatory Smelter	drive off sulfur and float off other elements from the concentrate to form a copper plate	The smelter in use from 1906 - 1978. The new smelter was built mainly on the footprint of this original smelter
Smelter power house	Provided electric power to the older smelters	Located adjacent to the Noranda smelter hot metals building
Reverb mixing chamber	Off gasses from the smelter were mixed with air prior to going to the stack	These series of vaults were under the reverb smelter and a number of roads around the new smelter were built on top.
Converter Annex Building	Located north of the converter aisle of the Reverberatory Smelter. The building was used as a support maintenance facility	Located on the footprint of the new Materials Handling portion of the Outokumpu Smelter. It was demolished prior to construction of the current smelter
Egg Crate Building	A.K.A. Reverberatory Material Handling and Storage Building. It was used to blend concentrate and flux for furnace feed.	Located on the current footprint of the Matte Dome. Demolished during construction of the current smelter.
Uphill Stacks	Three stacks discharging gasses produced in smelting.	Located behind the smelter, connected to the smelter by flues which were above ground except at the railroad yard.

FACILITY	FUNCTION	RELATION TO OU 13
Reverb Bypass Flue	Bypass of mixing chamber	Close to the reverb mixing chamber
Railroad flues	Flues underneath railroad tracks carried smelter off gasses to the stacks	Flues from the reverb smelter went from the smelter, underneath the railroad tracks to the stacks on the hillside behind the smelter.
Noranda Smelter	Drive off sulfur and float off other elements from the concentrate to form a copper plate	The smelter in use from 1978 - 1996. Demolished in 1998.
Overhead flues	Flues above the ground carried off-gasses from the smelter to the stack	Overhead steel flues carried off-gasses from the Noranda smelter to gas handling
Cooling towers	Smelters had cooling jackets which used water as a coolant. The towers were used to cool the waters after use	Near the Noranda smelter
Shot coolers	Each furnace had its own initial cooler to cool the gases before they went to gas handling.	Next to the Noranda smelter
Misc.smelter buildings	Small buildings which performed special maintenance and administrative functions	Located on smelter grounds
Old Smelter Soils	Soils underneath the Noranda Smelter and infrastructure after the buildings were demolished	Wastes which were spilled within buildings and collected in the soils underneath the buildings
Outokumpu Smelter (current smelter)	Drive off sulfur and float off other elements from the concentrate to form a copper plate	Built on footprint of the Reverberatory Smelter. The current smelter went into operation in 1996.

FACILITY	FUNCTION	RELATION TO OU 13
New Smelter Soils	Before the new smelter was built, the soils in the footprint were characterized to determine fate of these soils	Soils which had to be excavated before the new smelter was built
ACID PLANTS	There were at least 8 different historical acid plants used to make sulfuric acid from the gaseous sulfur gases emitted by the smelter. The Outokumpu smelter has a double contact acid plant.	The historical acid plants were located adjacent to the hot metals buildings to treat off gasses. The plants were demolished.
Hydromet(allurgical) plant	With the Outokumpu smelter, the hydromet plant recovers metals from smelter off-gasses.	Associated with the new smelter to recover metals from furnace off-gasses, the hydromet plant is located just west of the new smelter.
Acid Tank Farm	Used to store sulfuric acid prior to shipment and sale	Located near the smelter on the railroad
MATERIALS HANDLING	Equipment and buildings used to stage materials used in the smelting or for temporary storage	Located in close proximity to the smelters
Standby fuel station	Supplied #6 fuel oil and waste oil to reverb smelter during winter (1923-1973)	Footprint now underneath new smelter
Slag crushing	Because the slag waste contains more copper than the ore, it is crushed and recycled back to the smelter	Just west of the Noranda Smelter footprint
Slag Mill Thickener	Part of the Slag Concentrator operation	Near the Slag Crushing Mill
Praxair	Supplies oxygen and other gases to the smelter	The gas plant is adjacent to the smelter. The land is leased from Kennecott but is not a part of the CERCLA action.

FACILITY	FUNCTION	RELATION TO OU 13
Thaw shed	Railroad cars full of concentrate (and snow and ice) were allowed to thaw out in this area before used in smelting	Immediately behind the Materials Handling Bldg.
Slag Pot Cooling	Slag pots full of molten slag from the smelter are hauled to this area to cool before crushing in the slag mill	Near the Slag Crushing Mill
Materials Handling Bldgs	Copper concentrates from the mills were mixed with flux for smelting	Dryer building was west of new concentrate building. Hopper building was east of the stack
Cherry Bowl	Formerly used to store excess concentrates	Behind and just east of new smelter, paved and now used as a materials storage area
Concentrate storage pad	An outdoor pad used to store excess concentrates	On footprint of the former acid plant #8 just behind the footprint of the Noranda Smelter
Roundhouse	Formerly a locomotive roundhouse, at the time of demolition it was being used as a slag pot repair shop	Located just to the north of Acid Plant 7 on the slag bluff before it was demolished.
Row 5 Screening	A part of the Slag Mill which was no longer in use and demolished	Near the Slag Mill
SUBPART 2: INFRASTRUCTURE		
TRANSPORTATION	Materials are transported via rail, truck, and pipelines	Connects one part of the process with another
Railroads	Railroads surround the smelter and are used to transport copper anodes to the refinery, concentrate for sale, and sulfuric acid for sale	Railroad tracks surround the smelter facility - the tracks are a spur from the main line UP tracks to Salt Lake, Los Angeles, and San Francisco

FACILITY	FUNCTION	RELATION TO OU 13
East Yard	Wide spot next to the railroad tracks used to store off-spec concentrates	Near RR tracks just to the east of the smelter (nearly opposite the Cherry Bowl)
RR Yard Soils	Loading and off-loading area for concentrates being prepared for shipment off-site, largely for sale	On RR spur behind smelter building
Pipelines	Pipelines transport slurries of tailings, concentrates, and process waters	Pipelines come and go from the smelter to other destinations
Slag tails pipeline	Pipeline from smelter to Magna Tailings Pond to carry slag tailings for disposal	Currently in operation transporting tails from the slag mill
Section 17 Pump Station	Provides water to the smelter	Located adjacent to the Hazelton pump station
Process water pipeline	Process water goes from smelter to Pump Station 4 to be reused in milling process	The older process water pipeline was prone to failure and was retired. The new pipeline is double walled and was formerly used to transport waste water to the former WWTP.
Weak acid pipeline	Transported waste water from the Lift station to the treatment plant	Now in use for process water
Weak acid lift station	The main pump station for the smelter waste water.	Formerly pumped waste water to the treatment plant
Water management	Water management infrastructure moves water from storage areas to operational areas and waste ponds	Water management systems are a part of the infrastructure of the smelter and acid plants
Section 21 RO Plant	Treated process intake waters	Formerly treated water for cooling towers and the powerhouse

FACILITY	FUNCTION	RELATION TO OU 13
Pump Stations	Move process waters and waste waters to a variety of locations	Currently transport process and makeup waters to various facilities
East and West Process Water Ponds	Lined storage ponds for process waters	The east pond is between the former Acid Tank Farm and Praxair. The west pond is adjacent to the smelter entrance road. The west process pond liner was torn and repaired.
Japanese Springs	Not used in smelting	Adjacent to smelter road entrance, it feeds a small wetland
Springs 3 - 5	Not used in smelting	From slag bluff adjacent to smelter entrance road.
Wooden Flume	Carry overflow waters from check dam in lower Kessler Canyon to a culvert via a wooden flume	Stormwater management of smelter grounds via Kessler Creek to the wetlands
SUBPART 3: WASTE AREAS		
Black Rock Tailings Pond	Slag tailings disposal area	One mile west of smelter
Smelter Slag	Slag disposal area on both sides of SH 201.	Historic slag now being used in construction projects
Last Chance Pond	Stormwater retention pond	Formerly located where West Process Water Pond is today
East Stormwater Pond	Overflow from Process Pond and stormwater retention basin for acid tank farm and the new smelter	Overflows go to the wetlands
West Stormwater Pond	Overflow from Process Pond and stormwater retention basin for the slag concentrator and office area	Overflows go to the wetlands

FACILITY	FUNCTION	RELATION TO OU 13
RR crossing spill	Location of a train-truck collision which spilled wastes being hauled via truck	Just behind smelter
Smelter land fills	Two landfills behind the smelter	Used for construction debris, garbage and office trash
Smelter Parking Lot	Location of a spill from an overflow of the slag concentrate thickener	Workers alleged that the spill damaged their cars

B. Site History and Enforcement Activities

1. Activities at the site which led to contamination

SUBPART 1: SMELTERS, ACID PLANTS, AND MATERIALS HANDLING

Subpart 1 facilities include historic smelter and acid plant operations. There were three different smelters and eight acid plants each using different technologies over the years. In addition, each of these facilities in turn required different materials handling support facilities. In some cases, newer facilities were built on land previously occupied by former facilities. The following is a description of the operations which occurred at the site.

SMELTERS

Reverberatory Smelter: ASARCO began construction of the first smelter at the site in 1905. The design was similar to the Washoe Reduction Works at Anaconda, Montana. Operations began in 1906 using concentrates generated by Utah Copper and Boston Consolidated, both of which were mining in Bingham Canyon. The smelter was originally designed as a copper smelting and converting plant with a capacity of 500 tons of concentrates per day. The main building was 804 feet long by 305.5 feet wide by 92 feet high. There were 24 buildings in the industrial complex. In 1909, the facility employed 1200 men. The original plant consisted of two reverberatory furnaces, two blast furnaces, six acid-lined converters and eight roasters. The reverberatories were originally heated by hand-fired coal grates. By 1911, the furnaces were heated with oil, in 1915 by powdered coal, and in 1930 by natural gas. In general, molten copper matte from the primary smelting furnace was transferred to the converter furnaces where silica flux and compressed air was added to the molten material. After removing the slag, additional air or oxygen was blown in to oxidize the remaining sulfur and

convert copper sulfide to blister copper. The sulfur was removed in the form of sulfur dioxide gas that was delivered to adjacent acid plants. The smelter off-gasses were "treated" with Cottrell plants, one for the reverberatory furnaces and one for the converter furnaces. Smoke and dusts were captured by hoods above the furnaces and blown by fans into the Cottrell treaters - essentially electrostatic precipitators. Flue dusts and Cottrell dusts were recycled back to the smelter. Kennecott bought the smelter from ASARCO in 1959 for about $20 Million, modernized it to have a capacity of 2600 tons of concentrate per day, and then replaced the smelter with newer technology in 1978. The older facilities were mostly demolished at that time. The wastes from the old smelter included smoke stack emissions (which were apparently very high in the early days of operation), slag, and waste water from the acid plants.

Smelter Powerhouse: A large building (just east of the site of the Noranda Smelter) housed an electricity generating plant. It was originally built in 1905 but was expanded and modified over the years as power needs increased. The equipment included three generators, two electric turbines, four steam turbines, and five screw compressors. The steam generators used coal, fuel oil, and natural gas during different time periods. Its full capacity was 15 Megawatts, sufficient power for the smelter. The power plant was used during the reverberatory smelter period and the Noranda smelter period, but became surplus when the Noranda smelter was retired in 1995. The powerhouse was demolished in 1997. Wastes from this operation included flyash and fugitive dusts. After demolition, underlying soils were removed down to 5 feet, but some arsenic remained. The remaining contamination was capped with clean fill. Its footprint was 1.3 acres.

Reverberatory smelter mixing chamber: Directly behind the newest smelter is one of the structures from the old smelter that still remains. There are a series of concrete vaults which were used to mix gases prior to entry to the stacks. Constructed in 1905, the vaults are now nearly 100 years old and are no longer watertight. The walls are multicolored. This structure, now nicknamed the "catacombs", serves as a retaining wall for a road associated with the new smelter and is crisscrossed with new smelter infrastructure. Some high level flue dust wastes remain in the chambers.

Converter Annex Building: This building was located north of the converter aisle of the Reverberatory Smelter and was used as a support maintenance facility. The building was demolished in 1990-1. The former site is now located under the materials handling portion of the new Outokumpu Smelter.

Egg Crate Building: Formerly located immediately east of the "A" frame building, the Egg Crate building was also referred to as the Reverberatory Material Handling and Storage Building. This structural steel exterior building

consisted of concrete bins used to blend flux, concentrate and feed materials for the smelting furnaces of the Reverberatory Smelter.

Uphill (short) stacks and flues: Constructed in the 1930s, a series of three short stacks were located in Kessler Canyon just behind the reverberatory smelter. The stacks were connected to the smelter via flues that were largely above ground (except where the flues went under the railroad tracks). The stacks and flues were demolished in the early 1990s and associated dusts hauled to Grassy Mountain.

Reverb Bypass Flues: A bypass of the baghouses, these flues are a part of the mixing chamber, now known as the catacombs.

Railroad Flue Dust: Flues, constructed in 1905 out of bricks, carried gasses (and dusts) from the reverberatory smelter to two 300 foot smokestacks on the hill behind the smelter. A portion of these flues went underneath the railroad tracks behind the smelter. Some of the dusts escaping removal by the electrostatic precipitators at the smelter settled out in that section. The section under the tracks is 15 feet by 20 feet by 180 feet long and contained about 5 to 6 feet of accumulated flue dusts. In 1993, the accessible material was cleaned out, but the entire vault is structurally unsafe. To protect the integrity of the railroad structures above the vault, the entire vault was filled with backfill to prevent collapse and both ends were sealed. The vault was in use from 1905 to 1978. The remainder of the flues leading from the reverberatory smelter to the old 300 foot smoke stacks was above ground and was removed in 1979. The older smoke stacks were demolished in 1987 - 8.

Noranda Smelter: A new Hot Metals Building was constructed in 1977 to house a new process. The older Reverberatory Smelter was retired at the same time. Originally, this new smelter consisted of three Noranda reactors which produced a high grade matte and four conventional converters followed by an anode casting unit. Oxygen enriched air was used to increase the smelting rate, lower the fuel requirements and reduce the volume of gases. Additional acid plants to make sulfuric acid from the sulfur burned from the concentrates were constructed at this time also. The new building also had flues at the top to collect fugitive emissions. Although the new process improved the collection of emissions, the slag produced by the process was high in copper content. To solve this problem, the slag was crushed, concentrated, and recycled back into the smelter. Slag disposal ceased - slag was now too valuable. The slag mill and concentrator produced a slag concentrate and slag tailings. The slag tailings were disposed of in the Magna Tailings Pond. At the same time as the switch in process, a new 1,200 foot smelter stack was built to replace one of the earlier short stacks. It is built of concrete and has an inspection elevator inside. Flues supporting gas handling of the Noranda Smelter measured about 2 ½ miles in length. Wastes from the

Noranda Smelter included flue dusts, stack emissions, slag tails, and spills of various products. The Noranda Smelter building and associated conveyors, flues, acid plants and equipment became surplus when the Outokumpu smelter became operational in 1996. Demolition began in 1997 and was completed by 1999. The 1,200 foot smelter stack is still in use by the new smelter. The Noranda footprint was 3.6 acres.

Overhead flues: The flues from the Noranda smelter to the gas handling facilities were high above the ground mounted on supports. Constructed of stainless steel, the flues were 6 feet in diameter and sometimes contained deposits of flue dusts a foot thick inside. Demolition of these overhead flues was an engineering feat.

Cooling towers: There were five cooling towers associated with the Noranda Smelter. Used to cool different process waters, the towers were constructed of steel with a covering of asbestos.

Shot coolers: Each furnace in the Noranda smelter had a cooler to cool off gases before they entered the gas handling systems. This was a collecting place for flue dusts and the dusts were cleaned from the coolers and packaged up here. Spills of the dusts here are suspected. Immediately downgradient from this area, groundwater is very high in arsenic and the shot coolers are the suspected source of the arsenic.

Miscellaneous Smelter Buildings: There were about 40 buildings, tanks, conveyor systems, flue systems, pump houses; etc. associated with the Noranda smelter operations. Although some of the older structures are still in use by the new smelter, most have been demolished now. Asbestos was a common problem for these.

Noranda Smelter Soils: Because of various spillage that occurred over the years of operation of the Noranda smelter and its associated acid plants, the soils underneath a number of the buildings were contaminated. In some cases, the contaminated soils might have been associated with pre-Noranda operations.

Outokumpu Smelter: Kennecott began construction of a new smelter in 1993 which became operational in 1996. In general, the new smelter was constructed in the original location of the first 1906 smelter, the reverberatory smelter. The newest smelter relies on new technology whereby no hot metals are transported with overhead cranes as was the case in the two older smelters. Briefly, copper concentrates are dried and then injected with oxygen into a modern flash smelting furnace, designed by Outokumpu. The mixture burns providing most of the heat necessary to keep the furnace at the proper temperature. Most of the iron is oxidized and forms a slag which is skimmed from the surface of the melt. The

sulfur off-gasses go to a double contact sulfuric acid plant designed by Monsanto. The copper produced in the smelting step is molten copper sulfide called matte. The matte is tapped from the furnace and quenched in a water spray to form a solid with the consistency of sand. The matte is then dried and ground to a fine powder which can be injected into a second flash furnace. The powdered matte burns in the second furnace producing copper metal and liberating the sulfur. The sulfur gases then go to the acid plant, and the molten copper metal is tapped into one of two refining furnaces. The copper from the refining furnaces is tapped into an anode casting wheel. The copper anodes are then shipped to the refinery via rail for further refining and recovery of precious metals. As is the case with most new technologies, there were several accidents during the initial years of operations, some of them rather spectacular. There were several modifications in design to prevent recurrence of these events.

Outokumpu smelter footprint soils: Because the new smelter was to be built on the footprint of the older reverberatory smelter, Kennecott characterized the soils excavated for the new smelter basement at the site to determine the fate of the potentially tainted soils. Some of the soils were found to contain economically significant amounts of copper, silver and gold. The wastes appeared to have originated from the reverberatory smelter and had the composition of concentrates, flue dusts, roaster wastes, and mixing chamber soils. There were still some high concentrations (especially arsenic) remaining even after the basement was excavated. These wastes were left in place under the building.

ACID PLANTS

Acid plants: First installed in 1916, acid plants were designed to remove sulfur gases from the smelter off-gasses and make sulfuric acid in the process. The original owner was The Garfield Chemical and Manufacturing Corporation, which was organized by Utah Copper (the predecessor of Kennecott) and the Garfield Smelting Company (ASARCO and Utah Copper). The first acid plant had a capacity of 75 tons of 50 degree sulfuric acid per day. The acid plants were numbered chronologically as new plants were installed and old ones demolished. The plants were all single contact in design. Acid Plant #1, installed in 1937, had a capacity of 100 tons/day. Acid Plant #2, installed in 1944, had a capacity of 150 tons/day. Acid Plant #3, installed in 1950, had a capacity of 250 tons per day. Acid Plant #4, installed in 1953, had a capacity of 250 tons per day. Acid Plant #5, installed in 1956, had a capacity of 250 tons/day and was demolished in 1989. Acid Plant #6, installed in 1967 had a capacity of 500 tons/day. Acid Plant #7, installed in 1970, had a capacity of 500 tons/day. Acid Plant #8, installed in 1977, was not rated for capacity of acid, but for gas flow treatment rate. The most recent plants, Acid Plant #7 and Acid Plant #8, became obsolete when the new smelter went on-line in 1995. Acid Plant #7 was located just to the northeast of the

Noranda smelter and Acid Plant #8 was located adjacent to the Noranda Smelter on the south. Acid Plants were complex. Acid Plant #8 alone was composed of 25 structures. Contamination at the Acid Plant #7 exceeded 14 feet in places. Soils beneath Acid Plant #7 were excavated down 3 - 14 feet at the eastern part of the site and from 1.5 - 3 feet on the western part of the site. Remaining contamination was capped under clean fill. Acid Plant #8 occupied about 6.8 acres; Acid Plant #7 occupied about 3 acres.

New Acid Plant: A new acid plant to work with the new smelter was constructed at the same time as the Outokumpu smelter. Unlike the older acid plants, this current acid plant is double-contact and removes sulfur from the off-gasses more effectively. Located just to the west of the new smelter, the new acid plant, designed by Monsanto, has a capacity of 1 million tons/year of high purity sulfuric acid. There is a heat exchanger associated with the new gas handling system which allows recovery of heat as steam which is then used to co-generate electric power.

Hydrometallurgical plant: A newly designed hydrometallurgical plant was built just west of the new acid plant as part of the new smelter complex. The plant uses waste acidic waters to recover metals (copper and precious metals) from the flash smelter electrostatic precipitator dusts and other dusts in the off-gasses. The metals are separated and recovered in a series of acid-base reactions. Because this plant treats both the acid and the metals in the waters which were formerly waste, the need for a separate industrial waste water treatment plant was eliminated.

Acid Tank Farm: Kennecott operated a sulfuric acid tank farm between 1976 and 1994. The tank farm, composed of 4 large tanks, was originally built to store fuel oil. Beginning in the mid 1980's, Kennecott used the tanks to store sulfuric acid prior to sale and shipment. The tanks have been the scene of several leaks resulting in acidic ground water under and downgradient of the tanks. There is an on-going RCRA Corrective Action to deal with the cleanup of this area. The original tank farm was demolished in 1993-4, and a new tank farm has been constructed just south of the former facility. There have been no reported spills from the new facility.

MATERIALS HANDLING

Praxair: Kennecott leases land to the Praxair Oxygen Plant located just to the north of the former acid tank farm and just east of the new smelter. The oxygen plant supplies the new smelter with the oxygen used in the smelting process. Because of its location, the groundwater under the plant was contaminated from leaks at Kennecott's former acid tank farm. Wastewater generated by the plant, cooling water and plant wash down water, is routed to Kennecott's East Process

Water Pond.

Thaw Shed: Located behind Materials Handling was the former Thaw Shed where railcars full of concentrate could be heated to melt off accumulated snow and ice. The melt waters with associated contaminants just soaked into the ground, leaving a residue of contaminants that leached from the concentrate. The area was cleaned up and paved. It is in use today as a concentrate loading and unloading area. Railcars are loaded with excess concentrate which is sold and shipped to other smelters.

Cherry Bowl: Located on an erosional bench adjacent to the railroad tracks southeast of the new smelter was an area which was used as an unpaved storage place for excess concentrates. It was recently retired when the new concentrate storage pad was constructed and the accumulated contamination was cleaned up. After cleanup and paving, it found use again as a storage area for intermediate products. Today it stores blister copper, matte, copper contaminated soils, cross contaminated soils and debris. It is a part of the operational area for the smelter.

Concentrate Storage Pad: Located on the footprint of the former Acid Plant #8, Kennecott constructed a storage pad in 1999 for concentrates awaiting smelting. The storage pad was constructed of impermeable asphalt and has run-on and run-off controls. The new storage pad was built to eliminate the practice of storing concentrates on the ground in Kessler Canyon. This practice resulted in washing concentrates from the canyon down into the wetlands. The new concentrate storage pad also prevents re-contamination of the cleaned and restored wetlands.

Materials Handling: Associated with the Noranda smelter (1978 - 1995) were two materials handling buildings and an overhead conveyor belt system. The purpose of the buildings was to dry the concentrates and then blend them with flux before sending them to the Noranda smelter by conveyor belt. The Dryer Building, located immediately west of the A-Frame Concentrate Storage building, was demolished in 1997. The soils were contaminated by a layer of spilled concentrate, but the copper was not high enough for recycling. The Hopper building, located east of the main stack, was also contaminated with copper concentrate, some of which was recycled. The soils underneath the concentrate were also contaminated. The materials handling functions were also supported by several thousand feet of conveyors and belt feeders ranging from 24 to 48 inches wide. Galleries supported the conveyors. Spilled concentrates were sometime found underneath the conveyor belts. This part of the smelter operation was about 22 acres in size. The building footprint was 1.2 acres.

Slag Pot Cooling: Because the slag produced by both the Noranda Smelter and the current Outokumpu smelter contain substantial values of copper, the slag is not

disposed of, but rather is recycled. The first step of the slag recycling process is the skimming of the slag into slag pots, each holding about 48 Tons of slag. The slag pots are then hauled to a cooling pad where they are cooled using water spray with a total flow of about 300 gpm. The cooling pad is located just to the northwest of the former Noranda Smelter. Slag is cooled for about 24 - 30 hours. The solid slag is then dumped from the pots and broken up with a trackhoe equipped with a pneumatic hammer. There have been accidents when the pots were dumped prematurely and hot slag poured out into the area. Runoff from the slag cooling spray is collected and goes to the west process pond.

Roundhouse: In a former roundhouse used to turn locomotives around, there was a slag pot repair facility. The facility was demolished in 1997 after removal of asbestos. Some of the soil samples from underneath this building were contaminated with arsenic. The area was paved and is now in use as a maintenance equipment laydown yard. It was about 0.42 acres.

Slag crushing mill: In 1977, Kennecott constructed a slag mill and concentrator which could recover the high copper values present in the slag from the Noranda smelter. It operated similarly to the other mills, except instead of crushing, grinding, and flotating ore, the slag mill used slag as a feedstock. The slag concentrates produced by the mill were added to the regular concentrates as they went to the smelter. Like the other mills, the waste product of the mill was tailings, called slag tailings. Between 1977 and 1984, the slag tailings were disposed near the slag mill (see Black Rock Tailings Pond, OU 13, Subpart 3). Later Kennecott began sending the slag tailings to the Magna Tailings Pond via a slurry pipeline. The slag tailings are mixed with tailings from the hydromet plant and the mixture goes to the Magna splitter box where they are then mixed with tailings from Copperton for transport to the Tailings Pond.

Row 5 screening plant: A part of the slag mill, this facility was used to remove big chucks of slag before the slag went to the crushing facility. Chunks larger than 10" were removed here. It was located outside in the slag pot cooling area along the 5th Row of slag pots. The plant was demolished in 1998 and the footprint is in current use as part of the slag pot cooling area.

Slag mill concentrate thickener: There was a thickener tank and filter plant building associated with the slag mill before the concentration functions were eliminated in 1995. Here, the water was removed from the slag concentrate prior to recycling back to the Noranda smelter. The concentrate thickener and filter building was demolished in 1996 and the soils under the facility were found to be contaminated with arsenic. It was about 1.2 acres.

Standby fuel station: The standby fuel station, also known as the oil pump house,

was located to the east of the old reverberatory smelter now in the new Outokumpu smelter footprint. It supplied the fuel for the reverberatory smelter in the winter months between 1923 - 1973. The fuel station supplied No. 6 fuel oil sometimes blended with waste oil. There were two above ground storage tanks each holding 3000 gallons. The fuel station was demolished in 1990. The soils near the station suggested that there were some overflows of oil from the facility. The oil-stained soils were excavated - some were used for mixing with asphalt in road paving, others were sent to ECDC. Later it was also discovered that the fuel station had contaminated a local perched aquifer.

SUBPART 2: SMELTER INFRASTRUCTURE

Associated with smelters is a network of infrastructure which, though not related directly to the smelting process, is necessary for transportation of products and wastes and management of the water requirements for the smelter. Such is the case with the Kennecott smelters. Anytime wastes or products are moved from place to place, spillage and accidents are possible.

TRANSPORTATION

East Yard Soils: The railroad tracks in this area were built on waste, leading to railbed slopes which are discolored. In addition, there is evidence that spent electrolyte slimes were dumped from railcars next to the tracks. Prior to 1999, the area was used for concentrate storage.

RR Yard Soils: This is an area where concentrates are loaded, off-loaded, weighed and sampled prior to shipment for sale to other smelters. It is still in operation. Loading is done with front end loaders and spillage is routine. The railroad yard is about 7.1 acres.

PIPELINES

Slag tails pipeline: The slag tailings pipeline is a 6 inch pipeline that transports slag tailings from the smelter to the Magna Tailings Impoundment. Currently, it is also in use to transport hydromet tails to the tailings pond. The slag tails are first mixed with the hydromet tails and then sent via this pipeline to the Magna splitter box where the slag/hydromet tails mixture is added to the Copperton tailings just prior to discharge to the Magna Tailings Pond. The corridor is about 3.1 acres. The corridor is located along north side of State Highway 201.

Section 17 Pump station: A section of this pumphouse was demolished to provide better access to the pipes, but no soils were exposed. No wastes, if any, were exposed. (See also Pump Stations, OU 13, Subpart 3)

Process water pipeline: This pipeline was a 16 inch HDPE pipeline which carries smelter process water from the smelter to the No. 4 Pump Station. Because it sprung a series of leaks in 1998 and 1999, it was taken out of service. It has been estimated that 100 million gallons of process water with high arsenic levels spilled before the 1999 leak was discovered. It is theorized that the failure was due to excess pressure. The process water is now going through an adjacent pipeline that conveyed waste water from the smelter to the former Waste Water Treatment Plant and was then converted for use to convey decontamination water from the smelter cleanup decontamination area (just west of the Noranda smelter footprint) to the No 4 Pump Station. The new process water line is double walled. The older pipeline has been abandoned.

Weak acid pipeline: The weak acid pipeline carried weak acids and waste process waters from the smelter via the Weak Acid Lift Station to the Waste Water Treatment Plant. It was not needed after the new smelter was constructed and was used for a time as the conveyance for the decontamination waters from the smelter demolition projects. Later, when the current process water pipeline failed, it was reactivated for use as the process water pipeline. The corridor is about 4.7 acres.

Weak acid lift station: This was the main pump station which sent the weak acid water and excess process waters from the smelter to the Waste Water Treatment Plant. It has been demolished and nearby contaminated soils removed.

West weak acid lift station: This is a different name for the same facility as above.

WATER MANAGEMENT

Section 21 Reverse Osmosis Plant: The Section 21 pump station is equipped with a reverse osmosis plant to treat incoming waters going to the smelter. The effluent from the plant can be used for process waters at the mills or be discharged out the new 012 outfall to the Great Salt Lake. The building was demolished in 1996, but the concrete foundation was saved to be used as a decon pad.

Pump stations: Kennecott operates 4 pump stations at the North End to handle process water intakes and outflows. In summary, the Section 17 Pump Station takes incoming water from wetland areas and the Tooele Canal and pumps it to the smelter or wetlands. Pump Station 1 pumps water from the Adamson Springs, the Magna Tailings Pond Clarification Canal, and the Riter Canal to the Magna Reservoir and the North Concentrator (Magna Mill). Pump Station 4 pumps water from the Smelter Return Canal, the smelter, Praxair, and the new sewage treatment plant to the Magna Reservoir. Pump Station 3 pumps the process water from the Magna Reservoir to the Bonneville Reservoir or to the Copperton Reservoir.

East and West Process Water Ponds: Both contact and non-contact waters used by the smelter are stored for reuse by the smelter in the East and West Process Water Ponds. Contact waters include granulation and casting cooling waters. Water is used by the smelter or directed to Pump Station 4 for use at the mills. If Pump Station 4 is out of service or there is a problem with the pipeline, the water can be directed to Magna Tailings Pond. In addition, the East Process Water Pond receives waters from Praxair and from an interceptor trench used to collect acid waters which spilled from Kennecott's Acid Tank Farm. The West Process Water Pond was constructed in 1992 at the former location of Last Chance Pond (see OU 13, Subpart 3). It has experienced 2 leaks, (1993, 1995), perhaps more. It was repaired again in 1997. Ground water monitoring suggests that the leaks did not impact groundwater perhaps because the clay liner underneath the pond remained intact though the HDPE liners tore. The sediment buildup in this pond is heavy and removal of the sediments is challenging if the liners are to be protected.

Japanese Springs (1 and 2): Located downgradient of the smelter adjacent to the smelter entrance, Japanese Springs has a flow of 100 gpm and feeds a small wetland area just to the south of SH 201. It is also a water source for smelter process water. Water quality is not pristine.

Japanese Springs (3 - 5): Springs 3, 4, and 5, are located in lower Kessler Canyon along the slag bluff just to the south of SH 201. The water is not pristine. The water drains into the wetlands on the north side of SH 202 via a culvert.

Wooden flume: At the end of Kessler Canyon is a check dam designed to trap sediments coming down the canyon. The overflow of the dam was sent via a 200 foot wooden flume to a pipe which then sent the waters to the wetlands. The basin behind the dam and the wooden flume filled up with sediments and contaminated the soils underneath the flume. The system has been either cleaned or replaced, as appropriate. The area was about 0.75 acres.

SUBPART 3: SMELTER WASTES

The areas described in this subpart are known waste areas associated with the smelter. Please note that some smelter wastes (e. g. slag tailings and hydromet tailings) are/were disposed of in the Magna Tailings Pond which is a part of another operable unit (OU 15). Other smelter wastes found their way to the Waste Water Treatment Plant Sludge Ponds that are also another operable unit (OU8). Air emissions are also another separate operable unit (OU 19). The areas in this subpart are waste locations near the smelter itself, not remote locations.

Black Rock Tailings Pond: Located about 1 mile west of the smelter is a tailings impoundment at the mouth of Black Rock Canyon. The impoundment was used

between 1977 and 1984 for the disposal of slag tailings. Before introduction of the Noranda process, slag was considered waste and was simply dumped near the smelter. After the Noranda process was installed, Kennecott discovered that the slag had more copper than the ore did. A slag mill was built to grind and separate the economic minerals from the slag. The slag mill produced slag concentrates which were sent back to the smelter and slag tailings, a waste product. After 1984, the Black Rock Tailings Pond was retired, capped and revegetated. Slag tailings are now being disposed in the main Magna Tailings Pond with the other tailings. Kennecott estimates that there are about 434,000 cubic yards of slag tailings at the Black Rock Tailings Pond.

Smelter Slag: Slag, composed mainly of iron and silica, is the major waste product of the smelting process. Kennecott's smelter disposed of their slag in a variety of locations near the smelter until 1977. After 1977, Kennecott began recycling their slag because it contained economically valuable concentrations of copper when the Noranda process was used. Even with the new Outockumpu smelter, Kennecott continues to recycle their slag. There were two main disposal areas used by the smeltermen in the old days (prior to 1977). The earliest slag deposit originating from Kennecott just dumping their hot slag in an area just to the north of the smelter complex. Eventually, this created a large flat area with a bluff on the down hill side. The slag is all melted together and the large flat area on top is now used as a laydown yard for equipment. Eventually the slag bluff got close to the highway in front of the smelter (SH201) and Kennecott starting dumping the slag on the north side of the road opposite the smelter. In 1967, Kennecott developed a process that granulated or prilled the slag so that the slag could be slurried to the slag disposal area. It is known that other wastes were sometimes dumped on top of the slag heap as well, including flue dust and storm water sediments. Dumping of the slag stopped in 1977 when the slag mill was put into operation. In 1991, one source estimated that there was 20 million tons of slag still on the site. Because of the physical and chemical characteristics of Kennecott's slag, Union Pacific leased the entire slag pile in 1991 and planned to transport all of it off-site for use as rail ballast. They had a crushing and screening operation on site. In 1995, Kennecott canceled the lease with Union Pacific. Kennecott found that they themselves needed the slag material too for use in construction of the new Tailings Pond Expansion and for construction of new rail lines around the pond. Since the slag passed leach tests, Kennecott used it as a drainage blanket underneath the dikes of the new pond. What is left of the slag pile on the north side of SH 202 is likely to be gone by 2004. The status of slag bluff on the south side of SH 202 is in doubt. It too may be needed in construction projects.

Last Chance Pond: This pond, located just north of the Noranda smelter, was installed originally to contain spills at the smelter, and runoff from the smelter

area. In actual practice, it filled up with sediments which originated from the slag mill nearby. The sediments in the pond were mainly slag concentrates containing 21% copper. The concentrates which had washed into the pond were excavated and reprocessed in the smelter. On the footprint of this old pond, Kennecott built a new facility originally called the Smelter Interim Process Water Pond and later the West Process Water Pond (see West Process Water Pond, OU 13, Subpart 2). It was lined with clay and 2 layers of HDPE including leak detection.

Flue Dust Disposal Area: An area just to the south of the main stack was used as a disposal ground for flue dust between 1970 and 1990. The flue dusts were RCRA characteristic wastes and were excavated and disposed of at a RCRA facility. Additional cleanups were needed for the soils underlying the wastes.

East Stormwater Pond: The East Stormwater Pond has a capacity of 6.5 million gallons and collects runoff from a 90 acre area of the smelter including the acid tank farm, the smelter landfills, the repair and machine shop, and the new smelter. The water can be pumped into the Process Water Ponds after the storm is over, or back to the concentrators. When the pond overflows, the water goes to the wetlands and then the Great Salt Lake. The Pond can also be used to contain any process water overflows from the East Process Water Pond.

West Stormwater Pond: The West Stormwater Pond has a capacity of 3.5 million gallons and collects runoff from a 50 acre portion of the smelter grounds including the slag concentrator, filter plant, patio, west parking and office area, and the slag pot cooling area. The water can be pumped into the Process Water Ponds after the storm is over, or back to the concentrators. When the pond overflows, the water goes to the wetlands and then the Great Salt Lake. The Pond can also be used to contain any process water overflows from the West Process Water Pond.

Railroad Crossing Spill: In 2000, a load of contaminated soils were dumped at the railroad crossing of the road between the smelter and Kessler Canyon when a dump truck and pup trailer struck an oncoming mine train hauling sulfuric acid cars. This spill was immediately cleaned up.

Smelter Landfills: There are two landfills in Lower Kessler Canyon just to the south of the smelter complex. One landfill (lower landfill) was used for trash and the other (upper) was used for construction debris. The landfills have been in use for a long time and it is unknown what other materials might be in there. Pockets of concentrates and flue dust were found in the lower landfill along with a rainbow of colors in the soils. Now the landfills are permitted by the County, with the lower landfill designated for construction debris, and the upper landfill for concrete and rebar.

Smelter parking lot: Employees have reported that wastes sometimes wash down into their parking lot at the smelter. Kennecott indicates that this might have been overflow from the slag concentrate thickener. During the early days of demolition at the Noranda Smelter, employees also complained that their cars were dusted with fallout from the demolition blasts. Air monitoring proved that this was not the case.

2. Investigations, cleanup activities, enforcement

Investigations at the smelter area:

There were a number of investigations conducted by Kennecott at the smelter over the years. Table 4.2 gives a listing of the more recent investigations in the area.

TABLE 4.2
ENVIRONMENTAL INVESTIGATIONS AT THE SMELTER AREA

Date	Subject	Objective
1991	Sulfuric Acid Tank Farm, Sergent, Hauskins, and Bechwith for Kennecott	Determine the integrity of tank foundations and the extent of subsurface contamination from the spills in March, 1991.
1991	Uphill Stacks and Acid Plant #5 Stack, Custodis for Kennecott	Determine if the construction materials associated with the older stacks were hazardous.
1992	New Smelter Footprint, Kennecott	Determine fate of soils to be excavated during construction of new smelter and determine if wastes underneath the building would contribute to groundwater contamination
1992	Sulfuric Acid Tank Farm, Montgomery for Kennecott	Site characterization following spills
1994	Sulfuric Acid Tank Farm, Montgomery-Watson for Kennecott	Site Remediation Plan for RCRA Consent Order 9212006

Date	Subject	Objective
1993	Standby Fuel Station	Determine extent of petroleum contamination in footprint of new smelter
1994	Smelter	Remedial Investigation.
1995 - 2002	Smelter soils	Characterization and post removal sampling associated with the North Facilities Soils Removal Action

Spill History:

The smelter and acid plants have been involved in a number of spillage incidents over the years. Table 4.3 gives the spills as reported to the Emergency Response Notification System (ERNS) from 1980 to 2001.

TABLE 4.3
SPILL INCIDENTS AT THE SMELTER AND ACID PLANTS (SUBPART 1)
REPORTABLE RELEASES (1980 - 2001)

Date	Location	Spilled substance	Volume	Cause
5-7-75	Not specified	Lube oil	40 gallons	Not given
7-23-75	Not specified	No. 2 fuel oil	300 gallons	Not given
9-10-80	Smelter, acid plant #7	Sulfuric acid	1 pound, a later report indicates up to 55,800 gals of acidic water escaped to the GSL	Incorrect valve handling
4-28-81	Acid tank farm	Sulfuric acid	12,000 gallons	Tank rupture
12-10-81*	Not specified, SLC	Sulfuric acid	1 gallon	RR tank car, valve failure
12-6-82	Smelter	Sulfuric acid	500,000 lbs	Derailment

Date	Location	Spilled substance	Volume	Cause
9-17-88*	Not specified, SLC	Sulfuric acid	1 gallon	RR tank car, valve failure
3-15-90	Smelter area	Sulfuric acid	1000 gallons	Pipeline leak
8-30-90*	Not specified, SLC	Sulfuric acid	2 gallons	Top closure on RR tank car failed
9-4-90*	Not specified, SLC	Sulfuric acid	2 gallons	Closure on top of RR tank car burst
9-4-90*	Not specified, SLC	Sulfuric acid	2 gallons	Closure on top of RR tank car burst
11-11-90	Smelter	Sulfur dioxide	Unknown	Malfunction of pollution control equipment
3-15-91	Acid tank farm	Sulfuric acid	Unknown (at least 30,000 gallons)	Weld began leaking
3-19-91	Smelter area	Sulfur dioxide	20 pounds	Pipeline ruptured by backhoe
3-20-91	Smelter area	Sulfuric acid	Unknown	Pipeline leak
7-1-91	Acid plant?	Sulfuric acid	2200 pounds	Process line break
9-20-91	Acid plant	Sulfuric acid	950 gallons	Flange failure on drying tower
10-3-91	Smelter	Flue dust	5 pounds	Collection bin dumped on floor
10-26-91	Smelter area	Sulfuric acid	100 gallons	Transfer line struck during excavation

Date	Location	Spilled substance	Volume	Cause
10-27-91	Smelter area	Sater and sulfuric acid	400 gallons	Leak in underground pipeline
11-16-91	Acid tank farm	Sulfuric acid	500 pounds	Leaking valve
11-20-91	Acid plant #7	Sulfur dioxide	2 pounds	Pump failure
12-10-91	Smelter	Weak acid blowdown	200 gallons	Mechanical seal
1-8-92	Smelter	Weak acid blowdown	Unknown	Scrubber developed a leak
1-16-92	Smelter area	Acid plant blowdown	Unknown	Underground pipeline
1-28-92	Smelter area	Sulfuric acid	100 gallons	Joint in pipeline leaked
2-4-92	Smelter	Weak acid blowdown	100 gallons	Cooling vessel pressure gauge broke off
2-6-92	Smelter	Sulfuric acid	Unknown	Pipe flange from drying tank failed
2-14-92	oadside ditch	Acid solution	Unknown	Pipeline failed, check valve
2-21-92	Smelter	Acid blowdown	500 gallons	Cooler, broken pressure gauge
2-26-92	Acid plant?	Sulfuric acid	3000 gallons	Flange on pipeline from surge tank
3-19-92	Acid pump station	Acid blowdown	Unknown	Pump failure
3-30-92	Smelter	Sulfuric acid	200 gallons	Discharge flue corroded

Date	Location	Spilled substance	Volume	Cause
4-5-92	Acid plant #7	Sulfuric acid	5000 gallons	Carbate cooler, failure of pressure release valve
4-20-92	Smelter area	Weak acid blowdown	6000 gallons	Restriction in elbow of pipeline
5-27-92	Smelter return canal	Sulfuric acid	Unknown	Supply line leak
6-5-92*	Not specified, SLC	Sulfuric acid	1 gallon	Top closure on RR tank car burst
8-13-92	Smelter	D004, D006, D008 waste	88 pounds	Trash bin dumped into landfill
9-22-92	Smelter	Arsenic in liquid	20 gallons	Rolloff container leaking seal
10-22-92	Smelter	PCBs	1 gallon	Seal failure
10-29-92	Smelter	Sulfur dioxide	Unknown	Smelter air emissions
12-3-92	Smelter area	Sulfuric acid	10,000 gallons	Pipeline flange broke
12-23-92	Acid plant	Sulfuric acid	2000 gallons	Acid plant overflowed
4-1-93*	Not specified, SLC	Sulfuric acid	3 gallons	Top closure on RR tank car burst
4-1-93*	Not specified, SLC	Sulfuric acid	3 gallons	Top closure on RR tank car burst

Date	Location	Spilled substance	Volume	Cause
4-13-93	Smelter area	Sulfuric acid	100 gallons	From abandoned large pipeline, spilled during removal of residuals.
7-14-93*	Not specified, SLC	Sulfuric acid	2 gallons	Valve on top of RR tank car burst
7-28-93	Acid plant #8	Sulfuric acid	unknown	Broken pipe
7-31-93*	Not specified, SLC	Sulfuric acid	3 gallons	Valve on top of RR tank car burst
8-3-93*	Not specified, SLC	Sulfuric acid	3 gallons	Valve on top of RR tank car burst
8-25-93*	Not specified, SLC	Sulfuric acid	3 gallons	Valve on top of RR tank car burst
8-30-93*	Not specified, SLC	Sulfuric acid	3 gallons	Valve on top of RR tank car burst
9-9-93*	Not specified, SLC	Sulfuric acid	0.05 gallons	RR tank car burst at top due to corrosion
9-18-93*	Not specified, SLC	Sulfuric acid	2 gallons	Valve on top of RR tank car burst
2-14-94	Pump station	Sulfuric acid	Unknown	Overflow tank overfilled due to cracked water line
5-3-94	Acid tank farm	Sulfuric acid	Unknown	Broken pipe at tank farm

Date	Location	Spilled substance	Volume	Cause
5-27-94	Acid plant #7	Sulfuric acid	800 gallons	Above-ground tank had a level control malfunction
7-10-94	Smelter	Sulfuric acid	13,700 pounds	Cooling tower had leak in line
1-25-95	Smelter	Sulfuric acid	600 gallons	Acid product pipeline ruptured due to construction work
6-16-95	Smelter	Waste water with sulfuric acid	150,000 gallons	Smelter holding tank pump failure
8-22-95	Acid plant	Sulfuric acid	70 gallons	Heat recovery system failure
9-12-95	Smelter	Sulfuric acid	100 gallons	Containment system overflowed
9-19-95	Smelter	Sulfuric acid	500 gallons	Vacuum truck rear hatch opened
12-19-95	Acid tank farm	Sulfuric acid	10,000 gallons	Breach in line from acid storage to WWTP
12-19-95	Acid tank farm	Sulfuric acid	1000 gallons	Acid line broke (may be same incident as above)
3-14-96	Smelter	Sulfuric acid	2000 gallons	Furnace scrubber communications system failure

Date	Location	Spilled substance	Volume	Cause
8-26-96	Acid loading facility	Sulfuric acid	904,800 gallons	Interlock system failure
9-6-96	Smelter granulation unit	Process water	1000 gallons	Overflow of containment
4-30-97	West process water pond	Process water	Not given	Both top and bottom liners in pond damaged during cleaning
6-6-97	Acid plant	Acid	Not given	Leak in line
6-9-97	Smelter grounds	Acidic water	750 gallons	Small hole in pipeline sprayed water on asphalt
7-28-97	Loading dock	Oils, diesel	Unknown	Pipeline from containment basin sump
9-21-97	Smelter grounds	Contaminated ground water	400 gallons	Groundwater pump test ruptured line
10-12-97	Acid plant	Sulfur dioxide	10,000 pounds	Acid plant converter had high temperature causing release of tail gas
11-6-97	Gas absorption plant	Sulfuric acid	186 gallons	Hose split during transfer to final absorption plant storage bin
1-29-98	Hydromet plant	Sulfuric acid	100 gallons	Crack in containment wall
3-27-98	Acid plant?	Sulfuric acid	200 gallons	Flange failure

Date	Location	Spilled substance	Volume	Cause
4-23-98	Acid plant?	Sulfuric acid	200 gallons	Separated flange on product line
9-5-98	Smelter return canal	Arsenic	Unknown	Spill into canal, reason unknown
10-5-98	East process water pond	Process water	100,000 gallons	Power outage
1-7-99	Not specified	Boiler dust	Not given	Sack of boiler dust ruptured spilling dust down 300 yards of roadway.
6-5-99	Slag mill #8	Slag tailings	200 gallons	Above ground pipe failure
7-15-99	Smelter	Sulfuric acid	1000 gallons	Acid line leaked at a flange
8-7-99	Old smelter	Arsenic	1 pound	Demolition of building, dust
8-15-99	Old smelter	Lead and arsenic	Unknown	Demolition of building, dust
10-1-99	Process water pipeline	Process water	Unknown	Break in line
10-23-99	Old smelter	Dust	Unknown	Demolition of building, dust
6-15-00	Smelter area	Process water	65,000 gallons	Leaked from a dumpster
8-1-00	Acid tank farm	Sulfuric acid	1535 pounds	Flange failure on acid transfer line from storage tanks
9-13-00	slag mill	dusts	unknown	fugitive dusts from operations

Date	Location	Spilled substance	Volume	Cause
10-11-00	rail crossing in Kessler Canyon	contaminated soils	12,000 pounds	haul truck ran into train.
11-29-01	smelter	sulfuric acid	200 gallons	heat recovery system, failed coupling on sampling pipeline

* US Department of Transportation incident reports.

Enforcement Actions:

Because the smelter is an operational facility, compliance with a number of environmental statutes is verified through state and federal non-CERCLA authorities. Table 4.4 gives a summary of enforcement actions taken by state and federal environmental agencies. (CERCLA actions are given elsewhere; see Section 1)

TABLE 4.4
ENFORCEMENT ACTIONS AT THE SMELTER (NON-CERCLA)

Date	Location	Statute	Nature of alleged violation
1981-1989	Section 21	SDWA	Warning letters, regarding monitoring violation total coliform rule
5-25-84	Smelter	CAA	UDEQ, visible emissions violation
9-6-84	Smelter	CAA	UDEQ, visible emissions violation
9-14-84	Not given	CAA	UDEQ, visible emissions violation
7-24-90	Acid plant 8	CAA	UDEQ, sulfur dioxide, visible emissions

Date	Location	Statute	Nature of alleged violation
8-3-90	Smelter	CAA	UDEQ, monitoring not done
8-24-90	Smelter	CAA	UDEQ, monitoring not done
9-13-90	Acid plant 8	CAA	UDEQ, late monitoring report
10-31-90	Smelter	CAA	UDEQ, burning of dump
1991	Section 21	SDWA	formal state NOV, coliform rule
1-17-91	Acid plant 7	CAA	UDEQ, sulfur dioxide bypasses acid plant
3-3-91	Smelter	CAA	UDEQ, poor recovery rate
4-10-91	Smelter	CAA	UDEQ, leak between heat exchanger and catalyst
12-19-91	Smelter	TSCA	PCB
12-19-91	Acid plant	EPCRA	inadequate containment under acid plants.
1-24-92	Slag crusher	CAA	UDEQ, water scrubber not working
1-25-93	Slag crusher	CAA	UDEQ, visible fugitive emissions
6-30-92	Smelter	RCRA	Spill treatment without permit, improper container
1999	Not given	SDWA	Formal state NOV, monitoring violation

Date	Location	Statute	Nature of alleged violation
8-16-1999	Smelter	CAA	State administrative order, failure to test anode stack
4-29-1999	Smelter	RCRA	3008a order from state, leaking containers, open containers
9-4-99	Process water pipeline	CWA, NPDES	Single time discharge without permit, pipeline break.

C. Site Characteristics

1. Size, topography.

The smelter was built on a 160 acre industrial site located at the mouth of Kessler Canyon near the shore of the Great Salt Lake. The smelter was built on a former Lake Bonneville shoreline sloping terrace at an elevation of 4227 - 4407 feet above sea level. The Great Salt Lake is about 4203 feet above sea level. The smelter is built on a partially eroded alluvial fan coming from Kessler Canyon. The canyon is a relatively large south-north trending canyon at the north end of the Oquirrh Mountains.

2. Surface and subsurface features.

The site is an industrial complex which includes the main smelter building, a hydrometallurgical plant to clean and recover flue dusts and gases, a variety of materials handling buildings which prepare the concentrates for smelting, a slag pot cooling area and outdoor slag mill, with a variety of support buildings for administrative and environmental staffs. As the new smelter went into operation at least 41 older buildings were demolished. Accompanying the surface buildings are a number of pipelines for water handling. Most of the pipes used in the processing and gas handling are now above-ground for easier detection of leaks. Some of the new buildings were built on facilities used in former smelter operations.

The buildings sit upon a top layer of 15 to 20 feet of interbedded lacustrine clay and silt with local thin layers of quartz silty sand and oolitic beach sands.

Underlying these lacustrine deposits is a sequence of northward-trending deposits that appear to have been transported down the canyon by mud flows. This gravel sequence ranges from 30 to 100 feet in thickness. The bedrock underneath the sediments is folded and thrust-faulted Paleozoic sedimentary rocks intruded by Tertiary rocks.

3. Sampling strategy

The objective of the initial sampling was characterization of the site. This included determining if the soils under demolished facilities exceeded the action levels for the removal action and if the soils contained metals which could leach into ground water. Wastes with leachable metals (e. g. flue dusts) were sent to off-site RCRA landfills. Occasionally, if the soils exhibited visual and chemical evidence that the material was economically valuable, further testing was done to determine if the material could be recycled to recover the metals. Sampling used a 50 foot grid with a 5 point composite located 5 feet apart.

Following clean-up, another sampling event took place to determine if metals above the action level were still present after excavation. At the smelter, the depth of the excavation could be roughly determined visually (change in color). Again a sampling grid of 50 feet with 5 point composites was used. Depending on the results, there was more excavation or a cap was designed if the remaining soils exhibited leaching characteristics.

The final sampling event collected surface soils after the fill was placed in the excavation and graded. In some cases, the fill was analyzed before placement. Only a few grab samples were collected at this stage.

Note that this describes only the sampling associated with the North Facilities Soils Removal Project. Other sampling programs are required by other statutes including, for example, stack emissions, surface water quality, ground water quality and personal air quality monitors for compliance with safety statutes.

4. Known or suspected sources of contamination, types and quantities

The sources of contamination are numerous and varied according to the specific process step involved in the operation of the smelters, acid plants, and associated infrastructure. A summary of the known waste producing sources is given in Table 4.5. Additional information regarding the volumes of flue dusts removed during the Emergency Response Action is given in Table 12.2.

TABLE 4.5
SOURCES OF CONTAMINATION AT THE SMELTER (OU 13)

Facility	Waste Location	Years of operation	Process used	Product	Type and volume of waste	Current status
SMELTERS						
Reverber-atory smelter (First smelter)	Scattered on hillsides behind smelter, buried at site, slag piles.	1906 - 1978	Smelting and converting	Blister copper, copper anodes	See other entries (total could be as high as 42 million tons)	Demolished in 1978, soils cleaned in 1992 - 8.
Smelter Power-house	At building site	1905 - 1995	Steam driven turbines	Electricity	3677 cu yds, remainder capped	Demolished in 1997, soils cleaned in 1998
Reverber-atory smelter mixing chambers	At building site	1906-1978	Mixture of gases	Stack effluent	Unknown volume of flue dust	Capped in place
Converter Annex Building	In building	1906-1978	Maintenance	none	80.4 tons asbestos; 19 tons transite	Asbestos removed, building demolished
Egg Crate Building	In building	1906-1978	Blending of feed material	smelter feed	327 PCB capacitors, other PCB contaminated items (a splashed pickup truck), 374 tons of lead and As soils.	PCB spill during demolition cleaned up
Uphill stacks	Inside lining of stacks, dusts	1930s -1979	Conveyance	Smelter emissions	12771 tons flue dusts	Flue dust to Grassy Mtn, washed concrete to smelter landfill.

Facility	Waste Location	Years of operation	Process used	Product	Type and volume of waste	Current status
Reverb Bypass Flue	Inside flues	1906 - 1979	Conveyance	Smelter emissions	3.2 tons asbestos, 23.5 tons asbestos	3.2 t asbestos to Iron County LF, 23.5 t asbestos to Mackey LF
Railroad flue dust	Under railroad behind smelter site	1906 - 1978	Transport gases from smelter to smoke-stacks	Stack effluent	11,463 tons of flue dust	Flue dust removed to Grassy Mtn. flue filled in and ends capped
Noranda Smelter (second smelter)	Just west of current smelter	1978 - 1996	Copper smelter and converter	Copper anodes	24,332 cy contaminated soils, 504,060 pounds of copper nuggets	Demolished in 1997, soils cleaned up
Overhead flues	Just east of Noranda Smelter above truck road	1978 - 1996	Transport gas from smelter to gas handling	Stack effluent	1036 tons	Flues dis-assembled and sent to Grassy Mtn.
Cooling towers	Near acid plants	1978-1996	Cool process waters	None	Asbestos, volumes not calc.	Demolished
Shot coolers	Near Noranda smelter	1978-1995	Cool gases before gas handling	Gases to sulfur recovery	Included in soils total	Removed
Old Smelter Soils	See Noranda smelter					
Outokumpu Smelter		1995 - present	Smelting and converting	Copper anodes	Regulated by other statutes	In operation
Outokumpu Smelter Soils	From basement excavation for new smelter	Excavated in 1992	Construction	New building	73,240 cubic yards, total	Remaining waste underneath building
ACID PLANTS						

Facility	Waste Location	Years of operation	Process used	Product	Type and volume of waste	Current status
Acid Plants	Adjacent to smelters	1916 - 1995	Reaction of sulfur gases with water	Sulfuric acid	53,000 cubic yards (16,924 cy from AP#7, 36,796 cy from AP#8) plus 2010 tons of flue dust). Remainder of contam-ination (deeper than 5 feet) capped or paved.	Site now used for equipment storage and concentrate storage
Acid Plant #5	Located east of smelter	1956-1989	Reaction of sulfur gases with water	Sulfuric acid	34.5 tons transite, 48.3 tons asbestos	Demolished in 1989
New Acid Plant	Between Outokumpu smelter and stack	1995 - present	reaction of sulfur gases with water	sulfuric acid	No spills reported (yet)	In operation
Hydromet plant	Just west of Outokumpu smelter	1995 - present	Recovers metals from off-gases with a variety of reactions	Copper and other metals	No spills reported (yet)	In operation
Acid Tank Farm	On a hillside east of the smelter	1976 - 1994	Storage of sulfuric acid	Sulfuric acid	17,000 cy soils plus 11 MG of acid ground water (RCRA Corrective Action)	Original pads used to store treated wastes, new tanks located nearby
MATERIALS HANDLING						
Praxair	Just east of smelter along SH201	1977 - present	Separation of gases from the air	Oxygen and other gases	Sent to Kennecott	In operation

Facility	Waste Location	Years of operation	Process used	Product	Type and volume of waste	Current status
Thaw shed	Just south of new smelter materials handling buildings	1906 - present	Railroad cars full of concentrate allowed to thaw out	Concentrate minus snow and ice	See Kessler Canyon total	Paved and used for loading excess concentrate onto rail cars
Cherry Bowl	On a bench just east of new smelter	1989 - present	Used to store excess concen-trate and other smelter materials	Storage only	See Kessler Canyon total	Cleaned up except for materials underneath railroad
Concentrate storage pad	On foot-print of former acid plant #8	1999 - present	Used to store excess concen-trate (replaces Cherry bowl)	Storage only	New facility built to replace former on-ground storage sites	Paved, with run-on and run-off controls.
Materials Handling Bldg	2 buildings and conveyors next to Noranda smelter	1978-1995	Dry, blend with flux concen-trates and send to smelter	Concentrates prepared for smelting	2234 cu yds	Demolished in 1997, soils removed or recycled
Round-house	Locomotive repair, then slag pot repair	Demolished 1997	Used to repair slag pots	Slag pots	Underlying soils are slag, no removal	Demolished in 1997, area paved with asphalt
Slag Pot Cooling	Flat area NW of the Noranda footprint	1977 - present	Used to cool slag prior to milling and recycling	Cooled slag	Built on slag, no removal	In operation
Slag crushing	West of slag pot cooling pad, wastes (slag tails) to Magna Tailings Pond	1977 - present	Crush and grind slag so that it can be recycled	Ground slag	Slag tails to Magna Tailings Pond	In operation

Facility	Waste Location	Years of operation	Process used	Product	Type and volume of waste	Current status
Row 5 screening	Part of the slag mill	1977- 1998	Screen out very large chunks of slag prior to crushing in slag mill	Boulder-less slag	Built on slag, no wastes	Demolished in 1998
Slag mill thickener	Part of the slag mill	1977- 1996	Remove water from slag concentrate	Slag con.	2700 cy, backfilled and asphalt covered	Demolished in 1996, in use now as part of the Kress haul road
Standby fuel station	Footprint under new smelter	1923-1973	Store and pump fuel oil during winter	No. 6 fuel oil and waste oil blend	25,000 cubic yards petroleum tainted soils	Demolished in 1990, now under smelter
TRANSPORTATION BY RAIL						
East Yard	Railyard east of smelter	Railroad still in use	Dumping ground	Stockpiles of products	See smelter landfill total, approx 56,500 cy	Cleaned up or capped
RR yard soils	Railyard behind smelter	Railroad still in use	Loading and off loading of concentrates	Concentrates	No remvoal, spilled concentrates under an operational facility	Operational
PIPELINES						
Slag tails pipeline	From slag mill to Magna splitter	1977 - present	Transport slag tails to Magna Tailings Pond	Slag tails	Character-ized - no removal needed	Operational
Section 17 pump	From freshwater source to smelter	? - present	Supplies smelter with water	Water	No removal needed	Operational

Facility	Waste Location	Years of operation	Process used	Product	Type and volume of waste	Current status
Process water pipeline	Water leaks typically went to the wetlands	? - present	Conveyance of water to mill	Industrial waters	No removal needed	Older pipeline abandoned, new one is former weak acid pipeline
Weak acid pipeline	Acid leaks typically went to the wetlands	? - present	Conveyance of waste water to treatment plant	Waste water	No removal needed	Now in use for process waters
Weak acid lift station	Leaks typically to nearby wetlands	? - 1998	Pumping of wastes	Waste water	9171 tons (8245 cy)	Demolished
WATER MANAGEMENT						
Section 21 RO Plant	Leaks to underlying soils, wastes to process water line	? - 1995	Treatment of smelter intake waters	Intake water	See total from Material Handling	Demolished, then used as a smelter decon pad, now in use as a ready line for materials handling.
East and West Process water ponds	Leaks to underlying clay liners, overflows to stormwater ponds	1995 - present	Storage and settling basin for smelter process water	Process water	Mucked out occasionally	In operation
Japanese Springs	Potential point of discharge of contaminated ground water	-	Springs and seeps feed a small wetland area	Water	-	Still flows
Springs 3 - 5	Potential point of discharge of contaminated ground water	-	Intermittent flow to Garfield wetlands	Water	-	Intermittent flows

Facility	Waste Location	Years of operation	Process used	Product	Type and volume of waste	Current status
Wooden flume	Used to convey flows from Kessler Creek to culvert	?	Flume, clogged with sediments	Sediments	3194 cy sediments	Cleaned up, sediments to Arthur Repository
SMELTER WASTE AREAS						
Black Rock Tailings Pond	1 mile west of smelter	1977 - 1984	Tailings impound-ment	slag tailings	434,000 cy	Capped
Smelter Slag	Just north of smelter on both sides of SH201	1905 - 1979	Slag heap	Slag	20 million tons	Stored in place and used in construction activities
Last Chance Pond	North of smelter along entrance road	? - 1993	Retention basin	Slag concentrate spills	Not recorded	New pond built on the site
Flue Dust Disposal area	Just south of stack	1970 - 1990	Dump	4 piles of flue dust	Included in smelter landfill total, see also Table 12.3 for RCRA wastes	Cleaned up
East Storm-water Pond	Down-gradient of smelter on east side	1995 - present	Retention basin	Stormwater and upset waters	6.5 million gallons capacity	In use
West Storm-water Pond	Down-gradient of smelter on west side	1995 - present	Retention basin	Stormwater and upset waters	3.5 million gallons capacity	In use
RR Crossing Spill	East of smelter along tracks	2000	Accidental spill	Contaminate d soils	6 tons	Cleaned up
Smelter landfills	South behind smelter	1959 - 1991 (lower), 1991 - present (upper)	Landfills	Concentrates, flue dusts, unknowns	352,956 tons (161,098 cy)	Mostly excavated, remainder capped.

Facility	Waste Location	Years of operation	Process used	Product	Type and volume of waste	Current status
Smelter parking lot	To west of new smelter	? - present	Fallout, runoff	Demolition dust, overflows from slag mill	Slag concentrate, volumes not recorded	Parking lot cleaned after each incident, slag concentrates recycled.

5. Location of contamination, exposures

The contamination was scattered throughout the operable unit. It was usually associated with the footprint of former buildings, underneath overhead flues and conveyors, at former storage places where intermediate products were stored on the ground, near railroad tracks, along pipeline corridors, in drainage canals, and in former impoundments. The exposures to humans were primarily to industrial and construction workers at the site (see Section 1). Although this area is not prime wildlife habitat because of the presence of heavy industrial usage, it is upgradient of the Garfield and smelter wetlands which provide habitat for a variety of wildlife, especially birds. Ecological risk studies revealed that the element of most concern for bird exposure was selenium. Selenium in the water is taken up by aquatic invertebrates which are a food source for insectivorous birds (see Section 1).

D. Scope and Role of Operable Unit

The smelter and acid plant operable unit (OU13) concerns the solid wastes (both hazardous and non-hazardous) and contaminated soils in the vicinity of the smelter and former smelters. These surface wastes have been implicated in contamination of the groundwater in the vicinity of the smelter (OU23) and have washed down into the wetlands and the Great Salt Lake (OU22) just downgradient of the site. During operations of the smelters, airborne emissions have been implicated as a source of contamination to the Magna Soils (OU9) and Kessler Canyon (OU 19). Waste water from the smelter was the source of the metals in the treatment sludges in the wetlands (OU 8). Slag tailings are disposed at the Magna Tailings Pond (OU15). Wastes from the smelter have migrated to a variety of locations. OU 13 concerns only those wastes which have stayed at the site.

E. Current and potential Future Site and Resource Uses

The land on which the smelter is located is zoned M-2 (manufacturing, heavy

industrial) by Salt Lake County. Due to an excellent transportation infrastructure including nearby highways and rail service, the site is likely to remain an industrial site. The smelter itself may continue operations as a custom smelter even following closure of other mining facilities. The future of the site will depend on economic conditions at the time of mine closure. Other land uses are possible.

F. Summary of Site Risks

1. Chemicals of Concern

Human health risk assessment calculations revealed that the chemicals likely to be of highest concern at the smelter were lead, arsenic, and cadmium. The ecological risk assessment suggested that selenium would be a concern at the smelter also, mainly because it could wash down into wetlands adjacent to the smelter complex. Tables 4.6, 4.7 and 4.8 give a summary of concentrations of lead, arsenic and selenium at the smelter, smelter infrastructure, and smelter waste sites. (Cadmium is not included because the concentrations rarely exceeded industrial land use action levels).

TABLE 4.6
RANGE OF LEAD, ARSENIC, AND SELENIUM CONCENTRATIONS AT SMELTERS

Site	Arsenic concentrations (mg/Kg)		Lead concentrations (mg/Kg)		Selenium concentrations (mg/Kg)	
	Max	Mean	Max	Mean	Max	Mean
Reverb. smelter						
Smelter power house (pre-removal)	565	132	1140	241	58	4.2
Smelter power house (post removal)	255	149.1	824	394.2	24.3	10.2

Site	Arsenic concentrations (mg/Kg)		Lead concentrations (mg/Kg)		Selenium concentrations (mg/Kg)	
	Max	Mean	Max	Mean	Max	Mean
Smelter power house (post reclaim)	28.4	11.0	48.4	12.5	<0.5	<0.5
Smelter power house cooling tower (post demo)	73	38.3	201	92.7	<4	<4
Reverb. mixing chamber (pre-capping)	12,400	3562	18,100	4051	780	120.9
RR flue dust (pre-removal, soils)	66970	60870	120,600	71,066	1014	612
RR flue dust (pre-removal, bricks)	3506	1654	75.6	69.4	89.1	66.8
RR flue dust (back-fill)	39.0	11.7	23.4	38.0	<0.5	<0.5
Noranda Smelter						
Overhead flues (feed gas, pre-removal)	131,000	131,000	41,100	41,000	324	324

Site	Arsenic concentrations (mg/Kg)		Lead concentrations (mg/Kg)		Selenium concentrations (mg/Kg)	
	Max.	Mean	Max	Mean	Max	Mean
Overhead flues (tail gas, pre removal)	169	169 (failed TCLP)	107	107	20	20
Lower Ecodyne cooling tower post-demolition	83.4	83.4	93.8	93.8	<5	<5
Upper Ecodyne cooling tower post-demolition	28	28	115	115	<4	<4
Shot coolers	see Hot Metals characterization and post removal data					
Misc. smelter bldgs						
Noranda Hot Metals footprint (pre-removal)	924	88	4390	279.5	136	6.0
Noranda Hot Metals footprint (post-removal)	2100	1428	1940	1215	225	97
Noranda Hot Metals footprint (post-reclaim)	35.6	24.5	17.9	12.0	5.8	4.5

Site	Arsenic concentrations (mg/Kg)		Lead concentrations (mg/Kg)		Selenium concentrations (mg/Kg)	
	Max.	Mean	Max	Mean	Max	Mean
Under conveyors to Noranda (post-removal)	390	78.5	356	110	<0.5	<0.5
New Smelter						
Outo-kumpu smelter soils (pre-removal)	7250	815	28,500	1744	3611	98.7
Outo-kumpu smelter soils (post-removal	141	46.5	1240	108.4	38.2	0.7
Smelter soils (excavated from basement area)	2946	455	3003	602	370	35.8
Acid plants						
Acid plant #7 (soils, pre-removal)	8680	760.3	31,600	2718	2740	161.6
Acid plant #7 (soils, post-removal), now under asphalt	2130	412.3	8630	1046	416	47.5

Site	Arsenic concentrations (mg/Kg)		Lead concentrations (mg/Kg)		Selenium concentrations (mg/Kg)	
	Max	Mean	Max	Mean	Max	Mean
Acid Plant #8 and gas handling (pre-removal)	7250	856	28500	2234	3611	170.9
Acid plant #8 and gas handling (post removal), now under asphalt	2240	208	10700	540.3	320	8.5
Acid tank farm	Remediation via a RCRA corrective action permit					
Materials Handling						
Praxair	operational, not characterized					
Thaw shed (pre-removal)	11,200	1313	13,300	1865	23.9	5.9
Thaw shed (post-removal), now under asphalt	1220	254.3	4810	905.5	59.5	7.6
Cherry bowl (pre-removal)	6600	1200	3060	557	52.2	7.3
Cherry bowl (post-removal)	1000	428.9	1910	606.7	13.9	5.3

Site	Arsenic concentrations (mg/Kg)		Lead concentrations (mg/Kg)		Selenium concentrations (mg/Kg)	
	Max.	Mean	Max	Mean	Max	Mean
Cherry bowl (post-reclaim)	9.7	8.1	4.1	2.9	<0.5	<0.5
Materials Handling buildings (post-demo, pre-removal)	1200	421	3890	761	169	49
Materials Handling (post removal)	167	48.4	213	82	<0.5	<0.5
Materials Handling (post-reclaim)	35.2	35.2	1.6	1.6	<0.5	<0.5
Slag Pot Cooling	operational, surface paved with slag					
Round-house (pre-reclaim)	1160	398	1080	673	13.5	4.0
Round-house (post-reclaim)	20.9	17.7	<0.5	<0.5	1.1	0.7
Row 5 screening	Surface covered with slag, not characterized					
Slag mill thickener (pre-removal)	1850	364	2610	541	218	25.3

Site	Arsenic concentrations (mg/Kg)		Lead concentrations (mg/Kg)		Selenium concentrations (mg/Kg)	
	Max.	Mean	Max	Mean	Max	Mean
Slag mill thickener (post removal) now under asphalt	94.2	52.7	129	76.9	3.9	0.9
Standby fuel station*	366.7	61.6	1302	69.3	<0.5	<0.5

*The concern at this site was petroleum contamination

TABLE 4.7
RANGE OF LEAD, ARSENIC, AND SELENIUM CONCENTRATIONS IN SOILS AT SMELTER INFRASTRUCTURE SITES (ppm, unless otherwise noted)

Location	Arsenic concentrations		Lead Concentrations		Selenium Concentrations	
	max	mean	max	mean	max	mean
Transportation						
East Yard (pre-removal)	2140	544	4650	1287	837	71.3
East Yard (post-removal)	224	59	470	125	9.0	2.0
East Yard (post-reclaim)	168	49.9	466	102	9.0	2.1

Location	Arsenic concentrations		Lead Concentrations		Selenium Concentrations	
	max	mean	max	mean	max	mean
RR yard soils (active, not cleaned up)	10900	1617	14000	2300	156	66.6
Pipelines						
Slag tails pipeline (no removal)	348	40.4	961	77.7	12.5	1.8
Slag slurry line (no action)	23.3	10.4	13.7	3.7	No data	No data
Section 17 pump	34 µg/L in water	7.7 µg/L in water	15 µg/L in water	4.3 µg/L in water	13 µg/L in water	3 µg/L in water
Process water pipeline	348	108	961	208	No data	No data
Weak acid pipeline (NE branch) (No action)	125	29.5	179	77.3	12.5	1.2
Weak acid pipeline (no action)	348	108	961	208	12.5	1.8
weak acid lift station (pre-removal)	4370	741	1300	636	81.4	29.1
Weak acid lift station (post-removal)	3000	367	835	219	9.2	5.3

Location	Arsenic concentrations		Lead Concentrations		Selenium Concentrations	
	max	mean	max	mean	max	mean
Weak acid lift station (post-reclaim)	155	80.1	228	108	8.4	3.9
Water management						
Section 21 RO plant	Portion still covered with concrete, rest of data under powerhouse project.					
East and West process water ponds	9510	7055	8040	4530	154	80.8
Japanese Springs 1-2	<5 ug/L in water	<5 ug/L in water	<5 ug/L in water	<5 ug/L in water	5 µg/L in water	5 µg/L in water
Japanese Springs 3 - 5	141 ug/L in water	141 ug/L in water	<5 ug/L in water	<5 ug/L in water	47 µg/L in water	25 µg/L in water
Wooden flume (pre-removal)	5150	641.3	3490	662	564	49.9
Wooden flume (post removal)	316	137	2500	578	<0.5	<0.5
Wooden flume (post reclaim)	38.7	25.5	22.1	13.4	8.3	6.1

TABLE 4.8
RANGE OF LEAD, ARSENIC, AND SELENIUM CONCENTRATIONS
AT SMELTER WASTE PILES

Location	Arsenic Concentrations		Lead Concentrations		Selenium Concentrations	
	max	mean	max	mean	max	mean
Black Rock Tailings Pond	2900	1081	6200	2247	300	<70
Smelter Slag (Utah)	523	489	4000	1952	14.3j	6.5j
Last Chance Pond	Former footprint underneath current West Stormwater Pond					
Flue Dust Disposal Area	see Smelter landfills in Kessler Canyon					
E. Storm-water pond	lined ponds still operational					
W. Storm-water pond						
RR crossing spill (post removal)	80.1	80.1	103	103	7.8	7.8
Smelter, Kessler Canyon dumps (1995, pre removal)	31,100	1967.4	35,600	2048.9	244	28.8

Location	Arsenic Concentrations		Lead Concentrations		Selenium Concentrations	
	max	mean	max	mean	max	mean
Smelter, Kessler Canyon dumps (2000, pre removal)	69,800	1491	135,000	1757	1788	14.2
Smelter, Kessler Canyon dumps (post-removal)	2830	171.7	9190	343.5	577	8.2
Smelter, Kessler Canyon dumps (post reclaim)	194	68.1	340	43.8	44.8	2.1
Smelter parking lot	155	155	309	309	6.1	6.1

G. Removal/Remedial Action Objectives

1. Reduce or eliminate exposure of industrial workers to soils with unacceptable concentrations of hazardous contaminants;

2. Prevent contamination of ground water by eliminating sources of ground water contamination or containing contamination so that it does not continue to leach into the ground water;

3. Eliminate or contain contaminated materials which might wash down into sensitive wetland habitats;

4. Notify local governmental agencies of any wastes remaining on site which could pose a threat to future occupants of the land following facility closure.

H. The Selected Remedy

1. Previous Cleanups

Over the past decade, the smelter has been the focus of numerous cleanups associated with a CERCLA Emergency Response Action. Some of the cleanups were conducted in conjunction with the construction of new facilities. A summary of the cleanups is given in Table 4.9.

TABLE 4.9
SMELTER CLEANUP ACTIVITIES

Location	Action Taken	Date Completed
SMELTING FACILITIES		
Reverberatory Smelter	Smelter building demolished. Underlying contaminated soils partially removed and stored at Cherry Bowl. Remainder of waste is under new smelter building or capped with asphalt.	1978 - demolition 1992 - soils removed, new smelter constructed on top of remaining contamination
Smelter Powerhouse	Asbestos removed, equipment salvaged and cleaned, and building demolished. The concrete foundation was removed. Underlying contaminated soils removed down to 5 feet, remainder was capped with clean fill.	1998
Mixing Chamber	Accessible flue dust removed, remaining dust capped. Demolition was not done because a wall holds up an active road.	Run-on control Fall, 2002, remainder of work pending
RR flue dust	Accessible flue dust removed, rest sealed in place by capping both ends of the flues (under an active railroad)	1993

Location	Action Taken	Date Completed
Noranda Smelter	Building demolished using explosives. Steel decon'ed before sold for scrap. Some equipment was sold. Copper found under the building was recycled. The anode bay foundation (concrete) was saved. Surface soils were removed and the remainder of the contamination capped.	1997
Overhead Flues	Flues were cut into sections then lowered to the ground. The flue sections were capped at both ends and were transported to a RCRA landfill with the wastes still inside the stainless steel piping.	1997
Cooling towers, including: Ecodyne Cooling Tower Upper Ecodyne Cooling Tower Lilly Hoffman Cooling Tower Trombone Cooling Tower	Asbestos was removed before demolition.	1996
Shot cooler	Contaminated soils were removed as part of the Noranda smelter cleanup.	1997
Old smelter soils	Contaminated soils were removed. Large copper nuggets were cut up and removed. The area was then revegetated.	1997 (see Noranda smelter)

Location	Action Taken	Date Completed
New smelter soils	Most of the contaminated soils were removed in the process of preparing the ground for the basement and foundations of the new smelter. Remaining contamination is underneath the new building.	1993
Acid Plants	Acid plants 5, 6, 7, and 8 were demolished. Contaminated soils underneath the plants were removed. The area is now paved and most is in use as a concentrate storage pad.	1998
Acid Plant 7	Asbestos insulation removed, sludges from tanks removed, tanks washed, then dismantled, concrete under plant removed, contaminated soils removed down to 3 - 14 on eastern end, and 1.5 - 3 feet on western end; remaining contamination was capped with clean fill.	1997
Acid Tank Farm	Tanks were demolished, some impacted soils from spills were removed. A trench to collect sulfuric acid was dug downgradient. Collected major part of 1991 spills. Earlier spills not addressed.	ongoing under RCRA Corrective Action
Thaw Shed	Wastes removed or recycled. Area paved and is used to load concentrates for sale. Some wastes remain in place underneath the railroad	2001

Location	Action Taken	Date Completed
Cherry bowl	Various intermediate products sorted, recycled, reprocessed, wastes removed. Some wastes remain in place underneath the railroad	2001
Materials Handling Bldg	Galbestos removed, Structures demolished, construction debris decontaminated by washing, contaminated soils removed	1997
Roundhouse	Asbestos was removed, then the structure demolished	1997
Row 5 Screening	Structure demolished, underlying soils were slag	1998
Slag Mill Thickener	Structure demolished, arsenic tainted soils underneath the facility removed	1996
Standby fuel station	Demolished, soils contaminated with petroleum hydrocarbons were removed. Site now underneath new smelter.	1990
SMELTER INFRASTRUCTURE		
East Yard	Contaminated soils removed to the Arthur Stepback Repository.	2001
RR Yard Soils	No cleanup - this area is still operational	-
Slag Tails Pipeline	No cleanup, nothing found - this area is still operational	-
Section 17 Pump	A section of this pump house was removed to provide better access, but no wastes were exposed.	-

Location	Action Taken	Date Completed
Process water pipeline	Abandoned due to failure	1999
Weak Acid pipeline	Southern branch now used as process water pipeline. No corridor contamination found.	-
Weak Acid Lift Station	A portion of the station was demolished, soils removed to the Arthur Stepback Repository and the remainder capped.	2001
Section 21 RO Plant	The building was demolished, but the concrete foundation was saved for use as a decon pad	1996
East and West Process Water Ponds	West Process Water Pond was constructed on the footprint of the former Last Chance Pond. The HDPE liner has been repaired several times due to tears	1997
Japanese Springs 1 - 2	No action	-
Japanese Springs 3 - 5	No action	-
Wooden flume	Sediments behind check dam and in and under a wooden flume removed to the Arthur Stepback Repository	2000
SMELTER WASTE AREAS		
Black Rock Tailings Pond	Wastes capped in place with topsoil and revegetated	1984

Location	Action Taken	Date Completed
Smelter Slag	Slag used as railroad ballast by Union Pacific and as a drainage blanket in the construction of the North Expansion of the Magna Tailings Pond by Kennecott. It was also used as fill at various locations. Some washed into the adjacent Slag Lagoon. Although high in arsenic, the slag is not leachable.	Kennecott continues to use the slag in construction projects.
Last Chance Pond	Sediments removed and recycled. A new lined pond was built at the site of this older facility	1994
Flue Dust Disposal Area	Flue dusts removed and sent to RCRA landfill	1998
RR crossing spill	Wastes excavated and removed to Arthur Stepback Repository	2000
Smelter Landfills in Kessler Canyon	Most of lower landfill wastes removed to Arthur Stepbak Repository with remainder capped. The upper landfill (concrete monofill wastes) was left in place, non-hazardous	2001
Smelter Parking Lot	Spilled concentrate picked up and recycled. Routine sweeping for fugitive dusts.	-

2. Additional cleanups required as a part of this Record of Decision.

Following facility closure and demolition of any smelting facilities, the land underneath each closed facility must be characterized and soils removed to the Arthur Stepback Repository and the staging area. As-generated RCRA wastes must be recycled or removed to approved off-site facility. After removal of any

contaminated soils, the site will be capped with at least 18" of clean fill (if unexcavated wastes remain), regraded and revegetated, unless the site is to be re-used for construction of a new industrial facility.

Three maps shall be produced: (1) Map showing all known locations of wastes, regardless of hazardous substance content, because these wastes might pose challenges during any new construction - this map shall also include areas which have not been sampled due to inaccessibility; (2) Map showing all known locations of wastes and soils which exceed typical residential land use action levels for lead and arsenic (500 ppm lead, 50 ppm arsenic), which could be used by future land use planners and developers to determine if additional cleanups might be needed should the land use change; and (3) Map showing all known locations of wastes and soils which exceed the non-residential land use standards as detailed in this Record of Decision.

Remedial action may be required at the site of the former Acid Tank Farm, currently being addressed through a RCRA Corrective Action. Pumping at a collection trench designed to trap sulfuric acid and sulfuric acid reaction products has recently been turned off because the trench is no longer collecting significant quantities of materials. The reason for this observation is not clear, but could be related to dry conditions at the site. Because this site is close in proximity to the wetlands, a sensitive habitat, further action under CERCLA authorities may be necessary at this location. Contingency remedial designs shall be developed to prevent migration of sulfuric acid and sulfuric acid residues into the adjacent wetlands.

Section 5: Refinery (Kennecott North Zone OU 14)

A. Site Name, Location and Description

1. Site Type and description of operable unit

The refinery operable unit of the Kennecott North Zone (OU14) comprises facilities which perform the final ore processing step and actually produces the metals for shipment and sale. The copper is purified in electrolytic tanks which produce wastes similar to electroplating shops. The sludges from the electrolytic refining are then processed to recover the precious metals. Prior to 1995, this process relied on high temperature furnaces and reactions, similar to smelters. After 1995, the process was changed to sequential precipitation and dissolution to separate out the various metals. A simplified flow chart is given in Figure 5.1. Liquid wastes were discharged on site at first, then later to the WWTP where the metallic wastes ended up in the sludge ponds (OU 8). There is a ground water plume associated with the pre-1995 precious metals operations, but that issue is covered in a different operable unit (OU 23).

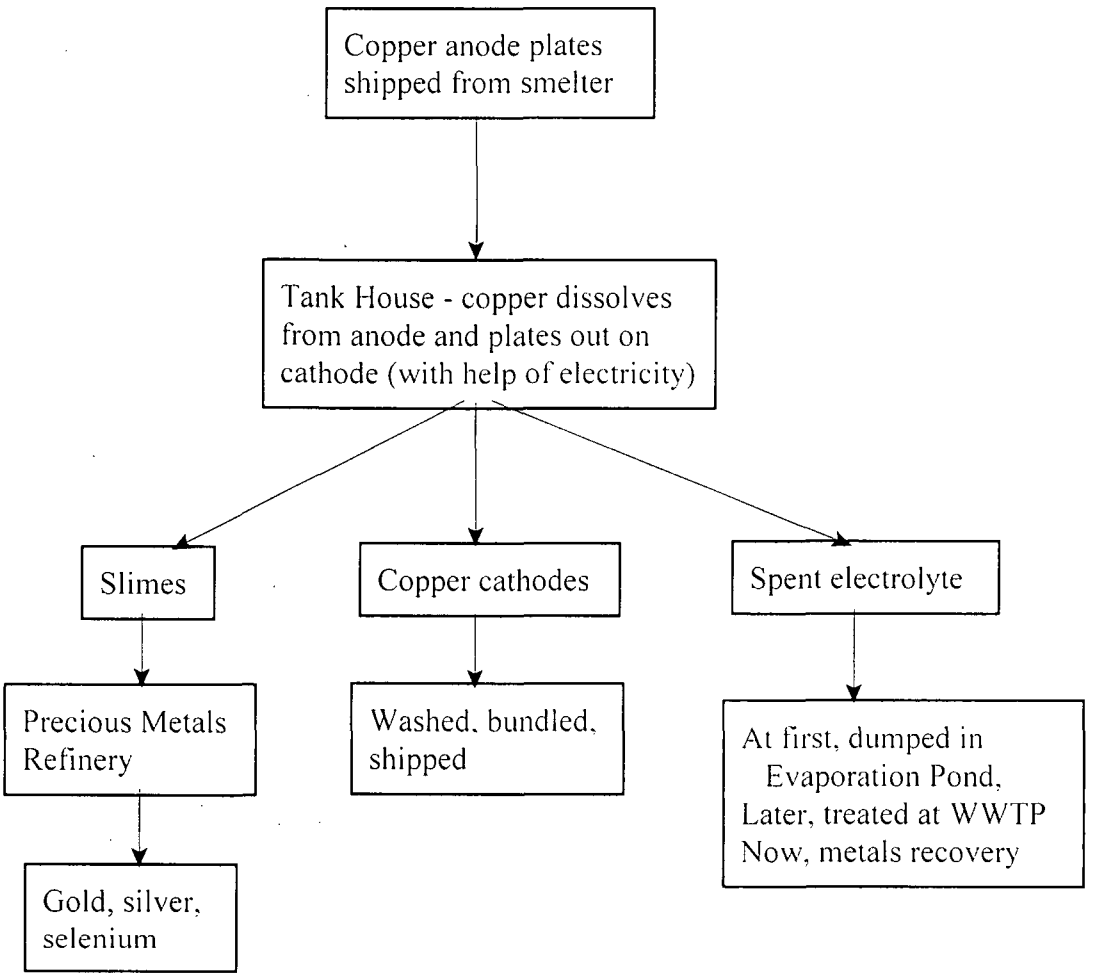
2. Facilities located within OU14

A list of individual facilities and waste sites at the refinery complex is given in Table 5.1.

TABLE 5.1
LIST OF FACILITIES AT OU 14 AND GENERAL DESCRIPTION

FACILITY	FUNCTION	RELATION TO OU14
FACILITIES ASSOCIATED WITH OPERATIONS		
Old Refinery	Copper was refined electrolytically in the tank house. The tankhouse still performs this function. The old precious metals refinery separated and purified precious metals from the slimes formed during the electrolytic refining of copper. Pyrometallurgical techniques were used.	The Tankhouse has been modernized and is still in use. The old precious metals building was located just to the west of the Refinery tankhouse.

Figure 5.1: FLOW CHART AT REFINERY



FACILITY	FUNCTION	RELATION TO OU14
Old Precious Metals footprint	The ground underneath the old refinery precious metals building.	Wastes were found under the building after it was demolished. These wastes are the suspected source of a selenium-tainted ground water plume.
New Refinery	New precious metals building which performs the same function as the old refinery, but uses sequential leaching and precipitation techniques to recover the gold and silver.	Located to the west of the former precious metals refinery.
New Precious Metals footprint	The ground on which the new building was constructed.	The land had formerly been used as a stockpile area and needed to be cleaned up before it could serve as a building site.
Electrolyte Purification Bldg	This former building was used to recover metals dissolved in the electrolyte before reuse or disposal	The concrete contained precious metals and the ground under the building was contaminated.
Lead Shop	This building was used to fabricate the lead tank liners formerly used in the tankhouse.	This footprint was studied, but not contaminated
Oil Storage	Containment berms around oil tanks.	Near tankhouse.
Boiler Bldg	Boiler building studied due to high lead content in air	Near tankhouse, the lead came from lead paint.
Assay Lab	Chemical and physical lab associated with refinery. Ducts were filled with dust	Adjacent to the refinery. The lab function was moved to the new laboratory at Arthur.
Bridge Crane	Used to hoist anodes and cathodes inside the tankhouse. This was removed from the building	The crane has been sold. No contamination was associated with this removal

FACILITY	FUNCTION	RELATION TO OU14
WASTE LOCATIONS ASSOCIATED WITH THE REFINERY		
Refinery Evaporation Ponds	Used to "evaporate" wastes from the refineries and the electrolyte purification process.	The pond was located behind the refinery complex. The waste percolated into the ground creating a ground water plume.
East Railyard	A dump near the railroad used for flyash, slag and metal debris	The railroad is still operational. The dump has been retired.
Electrolyte pipeline	A pipeline carrying electrolyte from the refinery to the WWTP.	No longer in use.
West Laydown Yard	A historic dump for metal debris and construction materials	Cleaned up, not reused.
Kessler Spring Dump	A historic dump of contaminated soils probably from the refinery - contained high concentrations of silver.	Located near Kessler Springs across the highway from the refinery
RI-R2 Containment	Near two above ground diesel storage tanks. Soils were tainted with petroleum.	Area paved over for use as anode storage area.
Bosh Pond	Water storage tank for cooling water for the anode remelting furnaces at the old refinery	Concrete lined, and cleaned out occasionally.
Santa Fe Basin	A dumping ground behind the fuel tanks	Not in service
Stormwater Canal	A former drainage converted into stormwater canal. Also drained off spills from sumps	Stormwater drain for most of OU 14
TOWN SITE		

FACILITY	FUNCTION	RELATION TO OU14
Garfield Townsite	A company town located just downhill from the refinery site	Kennecott sold the town to a developer and the people moved away. The houses were moved or demolished and the developer then sold the land back to Kennecott. Air quality in the town was not good. The town was located just to the north of the refinery.

B. Site History and Enforcement Activities

1. Activities at the site which led to contamination

The next step of the copper recovery process is refining of the copper anodes produced by the smelter. The copper anodes are 99.6% pure copper with impurities including gold, silver, platinum, and other precious metals. The refining step seeks to purify the copper and to recover the precious metal by-products. The refinery at Kennecott purifies the copper using an electrolytic method by which electrical current causes copper to migrate from the anode plate and then plate out on a stainless steel starter cathode plate. Non-copper elements precipitate and fall to the bottom of the electrolyte cells and are known by the general term "slimes". The slimes are then sent to a precious metals recovery operation. The copper produced by the refinery is 99.96% pure (cathodic copper). It is the refinery that produces the final product and most of the by-products of the ore processing, smelting, and refining operations. A description of the facilities associated with the refinery is given in the following.

FACILITIES ASSOCIATED WITH OPERATIONS

Old Refinery: In 1950, Kennecott completed construction of an electrolytic refinery located about 1.5 miles east of the smelter. By 1963, the refinery had been expanded and the capacity was 16,000 tons of refined copper per month (192,000 tons/year). In 1988, the owners reported the capacity at 240,000 tons of refined copper per year. The refinery operated in two steps. First, the copper anodes produced by the smelter were placed in tanks with electrolyte containing mainly sulfuric acid. Starter plates of copper were placed between the anodes in the tank. Second, low voltage direct current was sent through the anodes, electrolyte and cathodes. Copper dissolved from the anode plates, migrated to the cathode, and there deposited on the cathodes. After about 28 days, the cathodes

were removed from the tanks, the electrolyte drained (for reuse) and the slimes at the bottom of the tanks were collected. The copper cathodes were washed and packaged for shipment and sale.

The slimes from the bottom of the tanks were sent to the Precious Metals Building, also known as the Silver Refinery Building, also known as the slime Treatment Plant. The process there included leaching, filtering, fusing, and then smelting the slimes to create a gold/silver alloy called dore. The dore was electrolytically refined to separate the gold from the silver. The silver was collected on cathodes and the gold precipitated to the bottom of the cell. The gold mud is recovered and electrolytically refined again. This time the gold plated out on the cathode and the platinum and palladium stayed in the electrolyte. These by-products were also recovered. In 1988, Kennecott reported that the capacity of this operation was 295,000 ounces of gold per year and 2,250,000 ounces of silver per year. This process took about 45 days.

Selenium was also a by-product of the Precious Metals recovery process. Before the initial smelting step which produced dore, the slimes were heated to volatilize the selenium. Sulfur dioxide was added to convert the selenates and selenites to elemental selenium. The selenium was recovered from the off-gases, filtered, and then purified in a retort. The production rate was about 220,000 pounds of 99% pure selenium per year.

There was a wide variety of wastes produced by the old refinery. From 1950 to 1979, wastes generated during the purification of the electrolyte solutions at the Electrolyte Purification Building were disposed of in an "evaporation" pond behind the refinery (see Refinery Evaporation Pond). After 1979, these wastes were sent to the WWTP (see OU8). Spills of slimes on the concrete floors of the building created precious concrete indeed. Upon later demolition of the building, the concrete was recycled to recover these lost metals. Kennecott discovered that several of the pipes and sumps under the building had leaked over the years. Significant concentrations of gold, silver and selenium were found under the building when the building was demolished. Other deposits of slimes originating from the refinery were found in dumps near the refinery. The reasons for this dumping are unknown. A dore slag was also produced, but it was typically recycled. Some of the diesel fuel used in the boiler house also leaked out and was found when the structures were demolished. The leaks of selenium process circuit waters are the suspected primary source of the selenium ground water contamination in the refinery area (see OU 23). The old precious metals building was 1.7 acres.

The old refinery was modernized in 1995 (see new refinery), and several of the older buildings were demolished or converted to other uses (see new refinery, lead

shop, electrolyte purification building, boiler house)

New refinery: In 1995, Kennecott modernized their refinery to increase the capacity to match the capacity of the new smelter and reduce labor costs. The tankhouse was kept but the process for the electrolytic operation was updated: (1) the lead lined electrolysis tanks were replaced with acid resistant polymer concrete; (2) the substructures and floors of the tankhouse were replaced with acid resistant concrete; (3) all the piping was replaced and sumps and drains constructed as part of a closed loop containment system; (4) the electrolysis system began to use the Falconbridge-Kidd process which used stainless steel cathode starter sheets rather than copper; (5) more cells were added; (6) new rectifiers were installed to increase the electric current to the cells; (7) cathodes were moved to the packaging area of the tankhouse using Automated Guided Vehicles rather than overhead cranes; (8) cathodes were corrugated for easier shipping; (9) the electrolyte purification process was improved to allow more recovery of slimes and electrolyte for recycling; (10) all wastes go to the hydromet plant for recovery of metals. The copper processing rate is now about 310,000 tons of purified copper per year.

An entirely new process is used for precious metals recovery. Slimes from the tankhouse are still delivered to the new precious metals building but the new process involves a series of sequential leaching and precipitation steps rather than high temperature smelting operations. Gold is removed from solutions of precious metal chlorides by solvent extraction. Selenium is removed by reduction with sulfur dioxide. Rhodium, platinum, and palladium are recovered from the leach solution. The insoluble chloride slimes contain the silver which is further leached, re-precipitated, and reduced to metallic form. High temperatures are used only for casting purposes. Production rates now are about 500,000 ounces of gold each year, and 4,000,000 ounces of silver each year. The new precious metals refinery was built on ground that had been used formerly as a stockpile for demolition materials and soils from the old precious metals building. The site required some cleanup before the new building was constructed.

Electrolyte Purification Building: This building, part of the old refinery, housed a purification plant for electrolyte. The purpose was to remove impurities from the electrolyte and recycle it back to the tankhouse of the refinery. It maintained the electrolyte solution, controlled copper content and soluble impurities such as arsenic, antimony, and bismuth, and controlled organics by electrowinning in cells containing insoluble lead anodes. It had 48 lead lined concrete cells. Wastes from this process were disposed of behind the building at the refinery evaporation pond between 1950 and 1979. Then the wastes were sent to the WWTP (see OU 8). The Electrolyte Purification building was demolished in 1996, and contaminated soils under the building removed. Some of the demolition debris

was contaminated with gold and silver and these materials were recycled. The space was used as a staging area for demolition of the adjacent old Precious Metals building. It was 0.55 acres.

Lead Shop: The lead shop was used to manufacture lead linings for the electrolytic cells in the tankhouse. The lead shop building was demolished in 1997. Soils under the building did not contain hazardous substances above action levels. It was 0.11 acres.

Oil Storage: There was an oil storage tank on the refinery site equipped with a berm surrounding it to contain spills. A pipe goes through the berm. Petroleum contamination is suspected. It was 1.1 acres.

Boiler building: This building was a 100 feet x 100 feet building which housed boilers serving the refinery complex. Because of high lead in some atmospheric samples, the site was characterized. The lead came from lead paint used in the building. The building was demolished in 1995. The soils under the building were not contaminated. It was 0.25 acres.

Assay Lab: The Assay Lab building was 100 feet x 100 feet and housed the laboratory facilities at the old refinery. This function was transferred to the new consolidated laboratory near the Arthur Administration Building. Contamination was found in the hood duct work. The duct work was cleaned out before the building was demolished in 1995. The soils underneath the building were not contaminated. It was 0.25 acres.

Bridge Crane: The bridge crane originally located in the materials handling portion of the refinery tankhouse was no longer needed when the refinery was modernized. It was removed from the building and sold. Removal of the crane did not produce any wastes.

WASTE LOCATIONS ASSOCIATED WITH THE REFINERY

Refinery Evaporation Pond: Between 1950 and 1974, a depression behind the refinery was used as a waste disposal pond for spent electrolyte and other refinery wastes. The pond was 6 - 14 feet in depth. The wastes contained very high selenium and arsenic and flowed into the pond at a rate of about 100 gpm. Although the area was called an "evaporation" pond, it is clear that the main method of disposal of these waste waters was percolation into the underlying gravels. Reports vary as to whether or not the pond was lined with clay. This seems unlikely since the metals associated with the electrolyte could be found under the pond at depths down to 55 feet or more. The pond measured 200 feet by 600 feet, or about 2.75 acres. The pond has undergone several attempts at

cleaning. In 1972, the pond was drained and 830 tons of sediment were removed. The sediments were so high in copper, silver and gold, the sediments were sent to the smelter for recycling. In 1982, sediments/soils were again excavated and recycled to the smelter. In 1997, another 3 feet of soils were removed, backfill added, and the area capped. There is contamination left in place under the cap. Contamination of selenium and arsenic in the vadose zone persists all the way to groundwater at a depth of 45 feet. The pond is a suspected secondary source of selenium contamination in the refinery groundwater plume (see OU23).

East Rail Yard Site: The East Rail Yard Site is a bench area along the railroad corridor near the refinery which was also a dumping ground for flyash, slag, and other metal debris. It was 4.8 acres.

Electrolyte Pipeline Corridor: This was a pipeline that carried spent electrolyte and other wastes from the refinery to the WWTP. It was 0.6 acres.

West Laydown Yard: Located in trenches next to the railroad near the refinery was a historic dump of demolition debris, refinery wastes, laboratory wastes, and fill soils. The area was 75 feet x 350 feet at a depth of 2 - 12 feet deep. It was cleaned up in 1997. It was 1.3 acres.

Kessler Spring Dump: Immediately adjacent to the Kessler Spring was a dump of refinery wastes containing high values of copper, arsenic and silver. It was cleaned up in 1998.

R1-R2 Containment Area: This 50' x 65' area, close to the Anode storage area and two above ground diesel storage tanks, was contaminated with petroleum. As an interim measure, it was capped with asphalt and used to extend the storage area. It was 0.07 acres.

Bosh Pond: The Bosh Pond was a water storage area for the anode remelting furnaces at the old refinery. It was concrete lined and was mucked out occasionally. The area is currently capped with asphalt.

Santa Fe Basin: Located behind the oil tanks was an area used as a dumping ground for concrete, scrap metal, and tainted soils.

Refinery Stormwater Canal: There is a canal, formerly used for stormwater and for containing leaks in the selenium circuit, which goes from the northern most part of the refinery west and northwestward to a culvert underneath SH201. The culvert is at the same location as Kessler Springs. The sediments in the canal (no longer active) contained elevated selenium and arsenic. It was apparently mucked out occasionally because contaminated sediments were found on the banks as

well.

TOWNSITE

Garfield Townsite: The first settler in the Garfield area came in 1857, but the town of Garfield was founded in 1905 to house construction crews at the mills and smelters. The town was a company town owned by the Garfield Improvement Company, a subsidiary of ASARCO and Kennecott. By the 1950's Garfield had a population of 2000 and had a school, swimming pool, library, post office, and businesses. In 1955, Kennecott and ASARCO decided to close the town. The people could buy their own houses, if they moved them elsewhere. There were 394 houses in Garfield. By 1957, all the residents had left. The reasons for the abandonment of the town varied. One frequent observation was the air of the town was not healthful, due to its proximity to the refinery, smelter, and fertilizer plant. Because an atmospheric pathway was reported, the soils of the townsite were characterized. If the land were to be used for residential purposes the soils are above typical action residential actions levels, but are suitable for industrial use. The townsite (42 acres) is used to stockpile materials, serves as a parking lot for refinery workers, and the rest has been reclaimed with native grasses and trees. Certainly it shows little evidence of the vibrant town life that was once there.

2. Investigations, cleanup activities, enforcement

A summary of the various environmental investigations at the refinery is given in Table 5.2.

TABLE 5.2
ENVIRONMENTAL INVESTIGATIONS AT THE REFINERY

Date	Location	Organization	Objective
1972	Electrolyte Evaporation Pond	Kennecott	Characterize sediments, recover sediments for recycling
1985	Tankhouse	RB&G	Determine cause of soil heaving underneath tankhouse building

Date	Location	Organization	Objective
1989	Electrolyte Purification Bldg, and Precious Metals Bldg.	Kennecott	Characterize brick and concrete waste piles and recover valuable precious metals
1992	Tankhouse	SHB Agra	Characterize concrete from foundations to determine toxicity.
1992	Concrete slab near Precious Metals Building	Kennecott	Characterize concrete, recycle concrete to recover precious metals
1992	East Rail Yard	Kennecott	Characterize site, determine if site contained valuable metals
1998	Refinery and EP pond	Shepherd Miller	Part of RI/FS, geochemical characterization of selenium and leaching experiments
2000	Ground water underneath refinery	Kennecott	RI/FS completed

The refinery has been involved in a number of spillage incidents over the years. Table 5.3 gives the spills as reported to the Emergency Response Notification System (ERNS) from 1980 to 2001.

TABLE 5.3
SPILL INCIDENTS AT THE REFINERY
REPORTABLE RELEASES (1980 - 2001)

Date	Location	Spilled Substance	Volume	Cause
2-20-92	Loading dock at refinery	Sludge with acid, lead, arsenic	100 gallons	Improper cleaning procedures

Date	Location	Spilled Substance	Volume	Cause
2-20-92	East loading dock at refinery	Arsenic in mud	200 gallons	Overflow in transporter
4-28-95	Refinery	Electrolyte purification sludge	40 gallons	Loading refinery bin onto truck and material sloshed over the side
7-7-95	Precious metals plant	Effluent with metals As, Pb, Se.	780 gallons	Overflow of containment
9-1-95	Refinery	Electrolyte	500 gallons	Electrolyte storage tank - air lock in overflow pipe.
9-21-97	Refinery	Selenium water	100 gallons	Line entering sump ruptured.
6-7-98	Refinery	Arsenic	20 pounds	Level gauge failed on electrolyte storage tank

Because the refinery is an operational facility, compliance with a number of environmental statutes is verified through state and federal non-CERCLA authorities. Table 5.4 gives a summary of enforcement actions taken by state and federal environmental agencies.

TABLE 5.4
ENFORCEMENT ACTIONS INVOLVING THE REFINERY

DATE	MEDIA	ALLEGED VIOLATION	LOCATION
12-19-91	Land	Mismanaging PCB, failure to report releases	Refinery
4-11-95	Air	UDEQ, asbestos not removed before demolition	Refinery boiler building

DATE	MEDIA	ALLEGED VIOLATION	LOCATION
12-19-2000	Air	UDEQ, violation of operating permit, failure to keep daily records of fuel consumption for the boilers	Refinery

C. Site Characteristics

1. Size, topography. The Kennecott Refinery complex is about 45 acres in size and is located at the northern end of the Oquirrh Mountains. It is situated on a bench of the former Lake Bonneville at 4350 feet above sea level. The site gently slopes to the north and is bounded to the north and south by steep slopes.

2. Surface and subsurface features. In 1968, the refinery site was composed of one very large building housing the tankhouse and materials handling, 2 large buildings associated with the silver refinery, 2 storage tanks on the hillside above the refinery, a large pond behind the buildings, laydown yards, and 14 smaller buildings. The site is served by a network of road, railroads, and pipelines. The abandoned townsite of Garfield lies immediately north of the refinery complex.

   The sediments under the refinery are Quaternary and Tertiary sediments consisting of alternating beds of fine-grained lake and deltaic deposits. These overlay eroded coarse-grained sediments which eroded from the Oquirrh Mountains. The coarse grained sediments are largely carbonate and clastic rocks of the nearby Pennsylvanian Erda Formation. Bedrock is 65 - 310 feet below the surface and is highly fractured due to the nearby Black Rock and Pony Express faults.

3. Sampling strategy. Characterization of the site involved collection of samples in a grid pattern using 5 point composites. This was augmented with occasional grab samples from areas of discolored soils. Although the samples were analyzed for the typical suite of metals, the samples were also tested for SPLP and sometimes TCLP. Some samples were examined by x-ray diffraction to determine the species of the contaminants so that their potential to contribute to ground water contamination could be estimated. It was also common to conduct assays for gold and silver on soils in this area. This was done to determine if the soils had economic values worth recovery and recycling of the materials. In this area, the contaminated soils were typically discolored so that visual clues could be

used to aid in the soils excavation phase. Post removal and post reclamation sampling, like the initial characterization, involved establishment of a grid pattern with 5 point composites collected at each grid intersection.

4. Known or suspected sources of contamination, types, quantities

Table 5.5 summarizes the sources of contamination and the volumes and nature of the wastes.

TABLE 5.5
SOURCES OF CONTAMINATION AT THE REFINERY (OU 14)

Facility	Waste location	years of operation	process used	product	volume of waste	current status
Old Refinery	Under building	1950-1995	Electro-lytic oxidation/ reduction, pyrolitic refinement	Cathode copper, ingots of gold, silver and other precious metals, elemental selenium	See footprint	Capped
Old Refinery footprint	Under footprint, down-gradient ground-water	1950-1995	Leaks of process waters into sumps, broken pipes	Waste from leaks	7140 tons recycled to Barneys, 950 tons recycled to smelter, 2525 cu yd to Arthur Stepback, 16,400 cy left in place under cap.	Removed, wastes not accessible were capped

Facility	Waste location	years of operation	process used	product	volume of waste	current status
New Refinery	To new hydromet plant, hydromet tails to Magna Tailings Pond	1995 - present	Electro-lytic oxidation/ reduction, selective precipi-tation to recover precious metals	Cathode copper, ingots of gold, silver and other precious metals	See footprint	In operation
New Refinery footprint	Contami-nated soils on footprint prior to construc-tion	1995	Storage for old refinery soils	Recyclable materials from old refinery demolition	Volumes already included in old refinery footprint	New refinery built on top
Electrolyte Purif. Bldg	Contami-nated soils under building	1950-1995	Remove contami-nants from electrolyte	Purified electrolyte	1650 cu yd of soil under building, also demo-lition debris	Paved with asphalt, is used for access to the tank-house and boiler
Lead Shop	Mold lead liners for concrete electrolytic cells	1950 - present	Heat and mold lead	Lead liners	No contam-ination found.	In use as shop and lunch room
Oil storage	Oil storage for refinery	1950-1995	Storage	Oil storage	0	No removal needed
Boiler Bldg	Heat for buildings	1950-1995	Heat using oil	Heat	No underlying contam-ination found	Site of a new building

Facility	Waste location	years of operation	process used	product	volume of waste	current status
Assay Lab	Refinery physical and chemical laboratory	1950-1995	Testing of products	Product testing	3 cubic feet in duct works, no contam-ination in underlying soils	Building demo-lished
Bridge Crane	Lift anodes into tanks	1950-1995	Lifting	None	None	Sold
Refinery Evap Ponds	Waste pond for electrolyte	1950-1978	Disposal of wastes by percolation	Some recycled	400 cy removed in 1998, 830 tons removed in 1972. Unknown amounts recycled in 1982. Remaining contami-nation capped.	Capped
East Railyard	Dump near railroad	Unknown	Disposal of flyash, slag and metals	None	None	Covered with topsoil
Electrolyte Pipeline	Carried waste electrolyte from refinery to WWTP	1978-1995	Disposal pipeline for electrolyte	None	No removal needed in corridor	Into WWTP sludge ponds, now in Arthur Repository

Facility	Waste location	years of operation	process used	product	volume of waste	current status
West Laydown Yard	Dump for demolition debris and refinery wastes	1950-1995	Dump	None	14550 cy to Arthur Repository and 330 cy left and capped	Removed and regraded
Kessler Spring Dump	Dump of unknown materials	Unknown	Dump	None	4156 cubic yards	Removed to Arthur Repository
R1-R2 contain.	Diesel contami-nation	Unknown	Spillage	None	1500 cy of petroleum tainted soils	Sent to ECDC, area then capped by asphalt
Bosh Pond	Just west of Santa Fe basin	1950-1995	Cooling water sediment pond	Cooling water for Bosh furnace	Wastes were largely bone ash and barite.	Capped with asphalt and used for storage of electric rectifiers and trans-formers
Santa Fe Basin	Basin for decon sediments	Unknown	Was used as a decon facility	None	None	Demo'ed in 1997
Storm-water canal	Storm water canal for refinery area	Unknown	Sediment ponds	Storm water to wetlands	1700 cy	cleaned out 2001-2002

Facility	Waste location	years of operation	process used	product	volume of waste	current status
Garfield townsite	Homes for refinery and smelter workers, a company town	1905-1957	Townsite	Residential	No soils contam-ination found	Re-vegetated

5. Location of contamination, exposures

The contamination was scattered throughout the operable unit, usually associated with former facilities. The heaviest contamination was found underneath the old precious metals refinery and at the former refinery electrolyte purification evaporation pond. These areas are the source of a groundwater plume discussed in another operable unit (OU23). The on-site contamination would have been a threat to industrial and construction workers at the refinery. The groundwater contamination which reached the surface in the Garfield Wetlands posed a threat to wildlife, especially birds (see OU 23).

D. Scope and Role of Operable Unit

The refinery operable unit (OU14) concerns the solid wastes (both hazardous and non-hazardous wastes) and contaminated soils in the vicinity of the refinery and former refinery facilities. These surface wastes have been implicated in contamination of the groundwater in the vicinity of the refinery (OU 23). Some wastes from the refinery were also found dumped in various other locations around the Kennecott North Zone. Airborne emissions from the furnaces at the old refinery might have been a source of contamination to Magna Soils (OU 9), and were probably responsible for the abandonment of the town of Garfield. Waste water from the refinery was a source of metals in treatment sludges in the wetlands (OU 8). OU 14 concerns only those wastes which have stayed in the general vicinity of the refinery. Other refinery impacts farther away are discussed in the operable units in which they were found.

E. Current and potential Future Site and Resource Uses

The land on which the refinery is located is zoned M-2 (manufacturing, heavy industrial) by Salt Lake County. The site is likely to remain an industrial site due to nearby highways and rail service. It is possible that the refinery might continue to operate as a custom metals refinery even after mine closure. Although Kennecott, as the property

owner, has begun to explore options for redevelopment of the site after closure, no plans have been made. Other land uses are possible.

F. Summary of Site Risks

1. Chemicals of Concern

A summary of the concentrations of the various chemicals of concern is given in Table 5.6.

TABLE 5.6
RANGE OF LEAD, ARSENIC, AND SELENIUM CONCENTRATIONS
IN SOILS AT THE REFINERY (ppm)

Location	Arsenic Concentrations		Lead Concentrations		Selenium Concentrations	
	max	mean	max	mean	max	mean
Old refinery soils (1994) pre-removal	8930	3058	-	-	20,826	8873
Old refinery soils (1997) pre-removal	-	-	-	-	26,000	2901
Old Refinery soils (2000) pre-removal	7570	288.4	3370	160.9	42,600	1610
Old Refinery soils (post-removal)	6410	377.9	3530	265.3	15,200	978.2
Old Refinery soils (post-reclaim)	18.5	11.8	16.8	12.2	0	0

Location	Arsenic Concentrations		Lead Concentrations		Selenium Concentrations	
	max	mean	max	mean	max	mean
New refinery soils (1994) (stockpile area)	976	407.8	-	-	3710	567.0
Electrolyte Purif. bldg (pre-removal)	8450	519	2440	99	3180	118
Electrolyte Purif. bldg (pre-removal)	3420	1059	184	91.1	123	21.7
Electrolyte Purif. bldg post-removal	108	20.0	387	50.9	30.8	14.4
Electrolyte Purif. bldg post-reclaim	18.5	11.3	16.8	12.2	<0.5	<0.5
Lead Shop (no removal)	49.8	38.8	325	121	<0.5	<0.5
Oil Storage (no removal)	80.9	29.3	448	59.9	24.3	4.1
Boiler Bldg (no removal)	45.7	20.1	340	94.2	<0.5	<0.5
Assay Lab (duct dust only removed)	43.6	23	95.6	55.8	72.3	11.9

Location	Arsenic Concentrations		Lead Concentrations		Selenium Concentrations	
	max	mean	max	mean	max	mean
Refinery Evap Ponds (1994), pre-removal	730.5	677.9	-	-	347.1	319.9
Refinery Evap Ponds (1997) pre-removal	3240	193.8	9935	442.8	11,400	804.2
Refinery Evap Ponds (1999) (pre-removal)	513	126	9935	659	7732	700
Refinery Evap Ponds (1997) post removal, pre capping.	8970	1822.1	679	321.8	14,800	4136.8
Refinery Evap Ponds (2000), post capping	1.4	0.6	8.5	8.3	<0.5	<0.5
Refinery Evap Ponds, post-reclaim	18.5	11.3	16.8	12.2	<0.5	<0.5

Location	Arsenic Concentrations		Lead Concentrations		Selenium Concentrations	
	max	mean	max	mean	max	mean
East Railyard (1992) pre-removal	912	186	6060	492	402	80
East Railyard (1994) pre-removal	83.8	39.7	-	-	27.6	7.2
East Railyard (2000) pre-removal	211	23.5	830	75.8	28.8	8.0
East Railyard, post-reclaim	44	31	141	93.2	<0.5	<0.5
Electrolyte pipeline (no removal)	22.4	9.9	73.5	17.8	9.6	3.2
West Laydown Yard (1994) pre-removal	416.3	281.3	-	-	949.7	537.2
West Laydown Yard (2000) pre-removal	609	86.6	53,400	507	7210	149.4

Location	Arsenic Concentrations		Lead Concentrations		Selenium Concentrations	
	max	mean	max	mean	max	mean
West Laydown Yard (2000) post removal	189	87.6	558	146.6	715	105.5
West Laydown Yard (2000) post-reclaim	51.5	36.1	76.5	41.7	119	29.0
Kessler Spring Dump (pre-removal)	404	293	163	141	340	232
Kessler Spring Dump (post-removal)	129	55	306	118.1	139	36.9
Kessler Spring Dump (post-reclaim	<0.5	<0.5	<0.5	<0.5	139	46.5
R1-R2 contain (no removal)	<14	<14	16.7	5.7	<13	<13
Bosh pond, area capped with asphalt	not sampled, inaccessible					

Location	Arsenic Concentrations		Lead Concentrations		Selenium Concentrations	
	max	mean	max	mean	max	mean
Santa Fe Basin (pre-demo)	3200	771	449	348	593	229
Santa Fe Basin (post-demo), area now capped with asphalt	23.1	5.1	25.0	3.6	<0.5	<0.5
Storm-water canal (pre-removal)	542	199	707	241	667	179
Garfield townsite (1999)	190	50.7	1000	296.2	70	13.7
Garfield townsite, post-reclaim	86	58.1	832	361.6	25	11.3

G. Removal/Remedial Action Objectives

The objectives of the past removal activities and future remedial activities include the following goals:

1. Reduce or eliminate exposure of industrial workers to soils with unacceptable concentrations of hazardous contaminants;

2. Prevent additional contamination of ground water by eliminating source of groundwater contamination, or contain the contamination so that it does not continue to leach into the ground water.

3. Eliminate or contain contaminated materials which might wash down into sensitive wetland habitats;

4. Notify local governmental agencies of any wastes remaining on site which cost pose a threat to future occupants of the land following mine closure.

H. The Selected Remedy

1. Previous Actions. A summary of the previous cleanup actions is given in Table 5.7.

TABLE 5.7
PREVIOUS CLEAN UP ACTIONS AT THE KENNECOTT REFINERY

Location	Action Taken	Date
Old Precious Metals Refinery	Building demolished, some of the concrete recycled to recover precious metals	1996
Old Precious Metals Refinery Footprint	4200 cu.yds. containing gold sent to Barneys Canyon for gold recovery, 500 cu. yds sent to smelter for silver recovery, 2530 cu.yds disposed in the Arthur Stepback Repository. Remaining wastes (16400 cy) were capped with clay under a 6 inch gravel drainage blanket and 18 inches of soil with revegetation.	1997
New refinery soils	The new refinery footprint was originally used as a storage area for contaminated soils excavated from underneath the old refinery. The contaminated soils were either recycled or disposed in the Arthur Stepback Repository prior to construction of the new precious metals refinery	1997

Location	Action Taken	Date
Electrolyte purification bldg	The building was demolished and the contaminated soils which underlay the building were disposed in the Arthur Stepback Repository	1996
Lead shop	The interior of the building was cleaned and the building is now in use as a shop and lunchroom for the refinery	1997
Oil storage	Tanks and piping removed and sold for scrap. Site regraded, no removal	1997
Boiler Building	The building was demolished. The soils under the building were not contaminated.	1995
Assay Lab	The hoods and duct work of the building were cleaned and the building demolished.	1995
Bridge Crane	The crane, originally located in the tankhouse, was removed from the building and sold. No wastes were produced.	1996

Location	Action Taken	Date
Refinery Evap Ponds	In 1972, 830 tons of sediment were excavated and sent to the smelter for metals recovery. In 1982, the pond was again cleaned out with materials (unknown amount) recycled. In 1997, 400 cubic yards were removed from the top 2 - 3 feet of the pond and sent to the Arthur Stepback Repository. Remaining wastes (100,000 cy) were capped - same method as old refinery soils.	1997
East Railyard	There was no removal of soils. The area was regraded and revegetated.	1996
Electrolyte pipeline	There was no contamination found in the pipeline corridor.	2001
West Laydown Yard	Most of the contaminated soils were removed to the Arthur Stepback Repository and the remainder capped	1997
Kessler Spring Dump	The contaminated soils were excavated and taken to the Arthur Stepback Repository	1995
R1-R2 Containment area	Soils contaminated with petroleum removed to ECDC	1995?
Bosh pond	Inaccessible, no action	-
Santa Fe Basin	Demolished 1998	1998
Stormwater canal	The contaminated sediments were excavated and placed in the Arthur Stepback Repository	2002

Location	Action Taken	Date
Garfield Townsite	No action was taken. None of the soils exceeded action levels. Some revegetation took place at the site.	1996

2. Additional cleanups required as a part of this Record of Decision.

Following facility closure and demolition of any refining facilities, the land underneath each closed facility must be characterized and contaminated soils removed to the Arthur Stepback Repository. RCRA wastes must be recycled or removed to approved off-site facility. After removal of any contaminated soils and Bevill exempt wastes, the site will be capped with at least 18" of clean fill (if unexcavated wastes remain), regraded and revegetated, unless the site is to be re-used for construction of a new industrial facility.

Three maps shall be produced: (1) Map showing all known locations of wastes, regardless of hazardous substance content, because these wastes might pose challenges during any new construction - this map shall also include areas which have not been sampled due to inaccessibility; (2) Map showing all known locations of wastes and soils which exceed typical residential land use action levels for lead and arsenic (500 ppm lead, 50 ppm arsenic), which could be used by future land use planners and developers to determine if additional cleanups might be needed should the land use change; and (3) Map showing all known locations of wastes and soils which exceed the non-residential land use standards as detailed in this Record of Decision.

Remedial action may be required at the site of the former precious metals building at the time of facility closure and the wastes leading to a downgradient groundwater plume become accessible. At a minimum, the current cap over the former precious metal refinery must be extended to cover remaining wastes currently inaccessible underneath the tankhouse.

Section 6: Waste Water Treatment Plant and Sludge Ponds (OU 8)

A. Site Name, Location and Description

1. Site Type and description of operable unit.

The Waste Water Treatment Plant (WWTP) and Sludge Ponds site was a former industrial waste water treatment plant constructed by Kennecott. The sludges produced by the plant were slurried to nearby ponds for disposal. The WWTP received waste waters from the smelter (OU 13), the refinery (OU 14), the Magna Concentrator (OU 15) and sent the treated water to the Magna Tailings Pond (OU15) from whence it was recycled for use in processing at the mills or discharged to the C-7 ditch and the Great Salt Lake (OU22). A simplified flow chart is given in Figure 6.1. The site is located just to the west of the Magna Tailings Pond (OU15) and down gradient (to the north) of the Kennecott refinery (OU14).

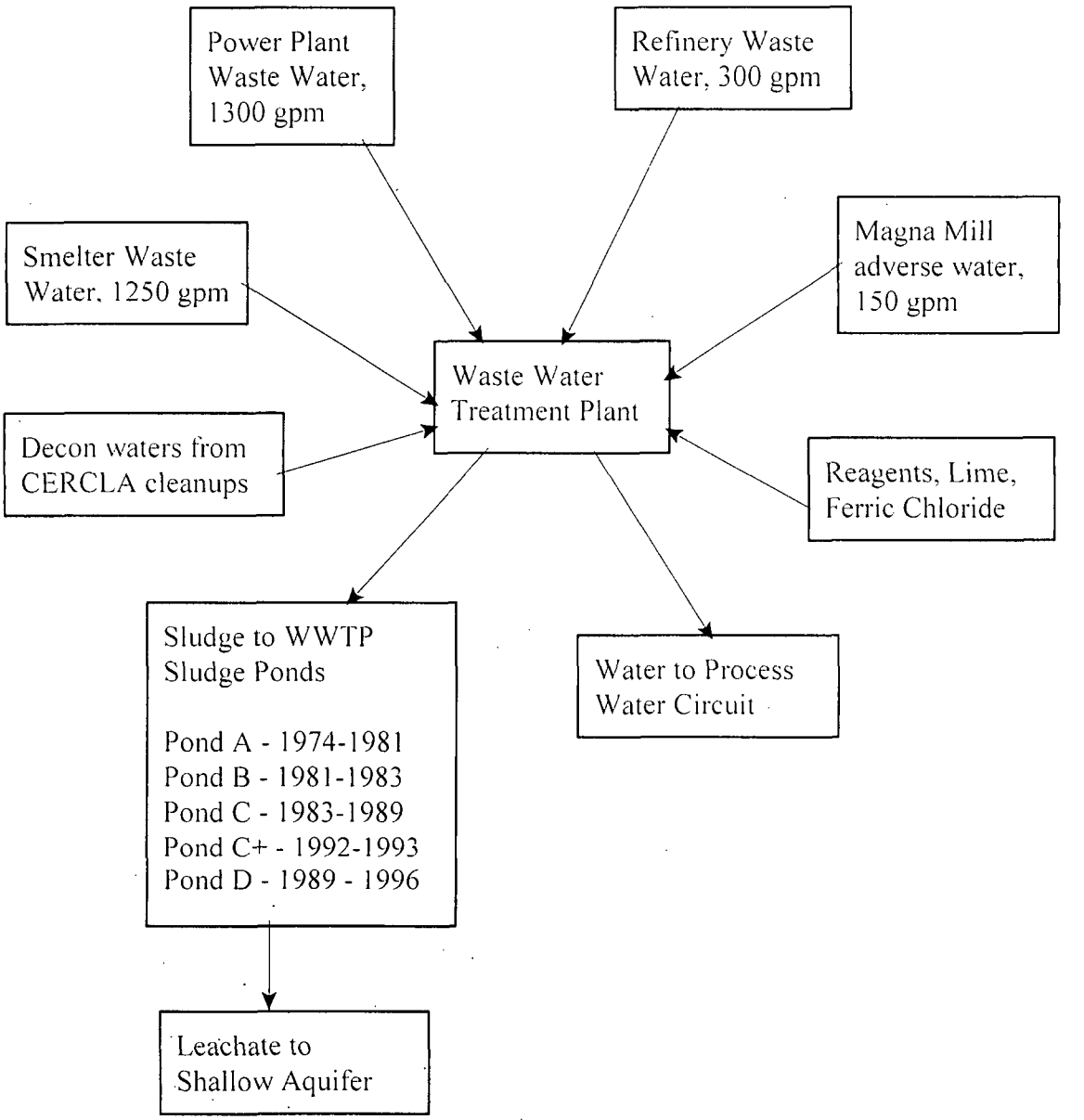
2. Facilities located within OU8.

A summary of the facilities located at the Waste Water Treatment Plant is given in Table 6.1.

TABLE 6.1
FACILITIES AT THE WASTE WATER TREATMENT PLANT

FACILITY	FUNCTION	RELATION TO OU8
Waste Water Treatment Plant	Treated waste waters from the smelter, refinery, and mills	Industrial waste water facility used for most of the north end operations
Waste Water Treatment Plant soils	soils underneath the WWTP	Leaks of reagents and waters from the plant
Pond A	WWTP sludge disposal	In the Garfield Wetlands, near I-80.
Pond B	WWTP sludge disposal	Near the WWTP
Pond C and C extension	WWTP sludge disposal	Near the WWTP in former quarry

Figure 6.1: FLOW CHART OF WASTE WATER TREATMENT PLANT



FACILITY	FUNCTION	RELATION TO OU8
Pond D	Treatment pond for adverse mill water, later used for WWTP sludge disposal	Near railroad and SH202.

B. Site History and Enforcement Activities

1. Activities at the site which led to contamination

Waste Water Treatment Plant: The Waste Water Treatment Plant (WWTP) was an industrial waste water treatment facility designed to treat typically acidic waters generated by the smelter, the refinery, and the North Concentrator. The waters contained high concentrations of metals, arsenic and selenium. The treated water was sent to the Magna Tailings Pond from whence it was either recycled for use as process waters in the mills, or discharged to drainages leading to the Great Salt Lake. The treatment process varied over time but generally added lime or ferric chloride or both. The sludges produced were sent by slurry pipelines to different sludge ponds, generally in sequence (Pond A was the oldest, Pond B was used next, and Pond D was the last one used.) The plant began operations in 1974. In 1977, the plant received flows of about 10,300 gpm with 1700 gpm coming from the smelter, 600 gpm from the refinery, 6700 gpm from the concentrators, and 1300 gpm from the power plant. In 1981, flows from the concentrators were rerouted around the WWTP in an effort to increase plant performance. After introduction of the Noranda smelter, the waste waters had increased arsenic content and higher sulfur dioxide/sulfite concentrations. The process was changed to add oxygen and provide treatment in two steps rather than one. When the concentrator waste waters were taken out of the system, the flow through was greatly diminished and provided the rest of the flows with longer contact times. The concentrator water was sent to the "new lagoon" (Pond D) for treatment. After the concentrator flow no longer came to the plant, the plant received flows of about 3000 gpm, of which 1250 gpm came from the smelter, 1300 gpm came from the power plant, 300 gpm came from the refinery and 150 gpm from the North (Magna) Concentrator. The plant produced about 250 wet tons of sludge per day. The plant ceased treating water from operations in 1996 when metal recovery circuits were added at the refinery and smelter (hydromet plants) and waste water treatment was no longer needed. The plant continued to treat decontamination waters during the demolition activities from 1996 until 2000. The plant was demolished in 2001. There were two chemical storage tanks on site: ferric chloride (17,000 gallons) and lime (150 tons).

Waste Water Treatment Plant Soils: Following demolition of the WWTP in 2001, the soils underlying the plant were characterized to determine if leakages from the

former plant had contaminated the soils in the exposed footprint.

Pond A: Pond A, located close to the I-80 pond, was an 58.5 acre impoundment surrounded by dikes on all sides. WWTP sludges were deposited there during 1974 - 1981. The sludges were not evenly distributed throughout the pond, but were located in mounds some up to 8 feet thick. Other areas of the pond had no sludges at all. The area impacted by the sludges was 25.7 acres. This includes two areas outside of the pond that had sludges that had escaped from the pond. During the time frame that this pond was used, the WWTP was treating the waters with ferric chloride and low lime additions. Following removal of the sludges in 1998, the ponds were recontoured and allowed to fill up with water for use as a wetland habitat area.

Pond B: Pond B, located just north of the WWTP covers about 6 acres and was about 16 feet deep. It was originally used from 1981 to 1983. The sludges stored in this pond were derived from high lime treatment of waters from the Noranda Smelter. In 1987, some of these sludges in pond B were used in an experiment to determine if the sludges could be stabilized in place with cement additions. About 65,000 tons of sludge were used in this experiment. Pond B was briefly used again for high lime sludges in 1989. After the sludges were removed to the Arthur Stepback Repository in 1997, the dikes were removed and the whole area was backfilled with tailings. An experiment was conducted there to determine if vegetative growth could be sustained on tailings by the simple addition of biosolids and rhysomes. It was a pilot project for later revegetation efforts on the main Magna Tailings Pond.

Pond C: Pond C, located just to the southeast of the WWTP covers about 8 acres and was 16 - 36 feet deep. It was used between 1983 - 1985 and again from 1987 - 1989 for storage of high lime and low lime Noranda smelter sludges. At the time of retirement, this pond still had some capacity (5 feet) and was later used as an overflow area for the sludge should Pond D and its pipeline be out of service during upset conditions. The sludge was fine-grained, sandy silt varying in color from white to bright green and blue. It had a high moisture content. Removal of the sludges was completed in 1998.

Pond C extension: Located adjacent to Pond C, Pond C extension was the only pond that was actually clay-lined. It covered 4 acres and was about 14 feet deep. It was used for sludge storage from 1992 - 1993, but received some use until 1995 when the sludges were too thick to be pumped to Pond D. Removal of these sludges was completed in 1998.

Pond D: Pond D was the last sludge storage pond used for storage of WWTP sludges. According to Kennecott, Pond D was first used to treat adverse waters

from the North Concentrator in 1981. The concentrator "adverse" water was treated with polymer, alum and lime. After treatment, the waters were discharged to the C-7 Ditch. The floc and sediments produced by this process were excavated, stockpiled and later recycled. Pond D received its first period of sludge between 1989 - 1993 when the pond reached its capacity. The dikes were raised to increase the capacity and the Pond was used again until 1996 for smelter waste water sludge storage, and later for decontamination waste water sludge until the smelter demolition activities were completed and the WWTP was shut down completely.

2. Investigations, cleanup activities, enforcement

INVESTIGATIONS: The processes used in the Waste Water Treatment Plant were investigated and tested before they were implemented. When the new Noranda process was introduced at the smelter, the chemistry of the waste water changed and the treatment process formerly used became less effective, especially for arsenic. This was partly because the smelter waters now had substantial quantities of sulfur dioxide gas which reacted with the ferric chloride to form the ferrous form. The ferric hydroxide was used to scavenge the arsenic. To keep the ferric ion available, the plant had to divert concentrator water away from the plant and also add oxygen to the plant waters to oxidize the sulfur dioxide. The process used at the plant required experimentation to optimize the treatment of the waste water.

Kennecott also experimented with sludge disposal techniques. In 1987, Kennecott tried to stabilize Pond B sludge in place by adding cement. In 1993, Kennecott hired a contractor to conduct a pilot project mixing 300 tons from each pond with 10% cement and 5% lime kiln dust. The product was originally stable, but began to leach after about a month of open air weathering. Later in 1993, Kennecott then experimented with a variety of additives to determine if a non-leachable sludge product could be formed. Each element in the sludge was non-leachable only in a narrow range of pH. Due to materials handling problems, such tight control on pH was not feasible on a large scale and stabilization by chemical treatment was abandoned. Kennecott and EPA decided to use a RCRA-like repository for the sludge. The sludge was only mixed with contaminated soils from the other parts of the site, dried, and then placed and compacted in the Arthur Stepback Repository. A description of the stabilization experiments is given in the OU8 EE/CA report of 1994. A report characterizing the sludge was conducted by RUST for Kennecott in 1994.

Pond D was the subject of a study conducted by SWCA for Kennecott to determine whether the area was suitable habitat for shorebirds. This study was conducted at the request of the US Fish and Wildlife Service.

SPILL HISTORY - The Waste Water Treatment Plant has been involved in a number of spillage incidents over the years. Table 6.2 gives the spills as reported to the Emergency Response Notification System (ERNS) from 1980 to 2001.

TABLE 6.2
SPILL INCIDENTS AT THE WASTE WATER TREATMENT PLANT
REPORTABLE RELEASES (1980 - 2001)

Date	Location	Spilled Substance	volume	Cause
9-16-91	WWTP	Industrial waste water	30,000 gallons	Line broke to plant, backflowed
1-12-93	WWTP	Waste water	45,000 gallons	Transfer line ruptured
4-25-93	WWTP	Sulfuric acid	Unknown	Unknown
9-29-94	WWTP	Sludge	500,000 tons	This is a report for the CERCLA operable unit
9-7-95	near WWTP	Creosote	1 pound	Railroad ties excavated

Enforcement Actions: There is ample evidence in EPA and UDEQ files that the agencies were concerned about the checkered treatment performance of the Waste Water Treatment Plant and gave encouragement for Kennecott to modify processes that were not performing well. There were no formal enforcement actions taken by the agencies. Rather there is a record of the agencies and Kennecott working to solve the problem.

In the 1970s and 1980s, there was a discussion as to whether or not the sludges produced by the treatment processes should be RCRA Subtitle C wastes. Kennecott submitted data at that time to EPA-HQ which suggested that the sludges were not-leachable and should not come under the purview of RCRA. EPA-HQ therefore decided that the calcium sulfate sludges would not be considered hazardous waste under RCRA. Since that time, changes in the process occurred and the sludges produced in the late 1980s and early 1990s were leachable, but their non-hazardous RCRA designation did not change.

In 1995, a dispute arose between Kennecott and the Army Corps of Engineers as

to whether Pond D was created in a jurisdictional wetland. Kennecott resolved this issue by providing replacement wetlands as a part of the Wetland Mitigation Area to compensate for the loss of the Pond D wetlands.

In 1995, EPA and Kennecott entered into an AOC for a non-time critical removal of the sludges (and other contaminated soils from the North Facilities). An EE/CA describes the alternatives considered at that time for the handling of the sludges.

C. Site Characteristics

1. Size, topography. The area of the WWTP and sludge ponds is relatively flat, varying in elevation by no more than 20 feet (except in those areas where berms, roads, and bridges have been constructed). Pond A and Pond D are located relatively close to the Great Salt Lake. The size of the various sludge ponds is given below:

   Pond A = 25.7 acres
   Pond B = 6 acres
   Pond C = 8 acres
   Pond C+ = 4 acres
   Pond D = 19.7 acres
   WWTP site = 3 acres

2. Surface and subsurface features: The site is composed of marsh lands, saline playas, mud flats, saline meadows, emergent marshes, open water, some uplands and man made features including dikes, roads, temporary bridges, drainage ditches, mainline rail tracks and sidings, and industrial spurs. All of the facilities involved storage of sludges in areas previously quarried or formed by dikes and berms. The storage tanks were above ground. Other than the WWTP office and facility (both of which were demolished) and some portable buildings used for security and contractors, there were no buildings on site.

3. Sampling strategy: Post removal sampling involved collection of 5 point composite samples with centers about 30 feet apart. Each composite sample was composed of a central spot, along with 4 additional aliquots 5 feet away to the north, south, east, and west of the central location. Samples were collected shortly after excavation so that the investigators could determine if the wastes had been removed.

4. Known or suspected sources of contamination: The wastes in the sludge ponds are the result of treatment of smelter, refinery and mill waste waters

with ferric chloride and lime or both. The waters were typically acidic with weak sulfuric acid and metals in solution. The lime treatment formed a product which was mainly calcium sulfate and the metals precipitated with it. In order to increase treatment of arsenic, ferric chloride was added to form a ferric hydroxide which precipitated and the arsenic was adsorbed to the ferric hydroxide precipitate. Theoretically, the sludge was stable and was not supposed to leach the metals back into rain waters. Later experiments indicated that this was not always true, especially for arsenic and selenium. The waste water composition varied with different changes in the smelting process. For example, the changes in arsenic concentrations of waters entering the WWTP with the change from the reverberatory smelter to the Noranda process is given in Table 6.3.

TABLE 6.3
CHANGE IN ARSENIC CONCENTRATIONS WITH CHANGE IN SMELTING PROCESS

DATES	ARSENIC CONCENTRATIONS in waste water going to WWTP	SMELTING PROCESS
Jan. 1977 to Sept. 1977	0.49 - 5.02 mg/L, Average = 1.59 mg/L	Reverberatory Smelter
Oct. 1977 to June 1978	0.59 - 4.66 mg/L, Average = 2.71 mg/L	Phase in of Noranda process
July 1978 to Dec. 1979	5.28 to 14.73 mg/L Average = 9.68 mg/L	Noranda Process

The increases in arsenic in the waste water were attributed to the additional air pollution equipment installed during construction of the Noranda Smelter. At the time, Kennecott scientists believed that in the reverberatory smelter a large fraction of the arsenic had been emitted to the atmosphere in stack emissions. The arsenic treated by the WWTP when the smelter switched to the Noranda process amounted to about 1500 pounds/day. About 90% of this arsenic eventually ended up stored in the sludge ponds.

The sources of water sent to the WWTP are the following:

Smelter	1250 gpm
Power Plant	1300 gpm
Refinery	300 gpm
Magna Mill	150 gpm

The WWTP created 250 wet tons of sludge per day, and discharged the treated water to the Magna Tailings Pond for reuse at the facilities or for discharge to the Great Salt Lake via the C-7 ditch and Lee Creek.

5. Types of contamination, quantities

The types and quantities of the wastes found at the WWTP and sludge ponds are given in Table 6.4.

TABLE 6.4
TYPES AND VOLUMES OF WASTES AT THE WWTP AND SLUDGE PONDS

Location	Waste	Waste Type	Volume
WWTP	Contaminated soils underneath facility	RCRA Subtitle D Solid Wastes, reagents	20,341 cy soils, 17000 gal Ferric chloride, 150 tons lime
Pond A	Calcium sulfate sludge from treatment of reverberatory smelter waste water with ferric chloride and low lime	RCRA Subtitle D Solid Wastes	145,842 cu yds.
Pond B	Calcium sulfate sludge from treatment of Noranda smelter waste water with high lime treatments	RCRA Subtitle D Solid Wastes	151,090 cu yds.
Pond C	Calcium sulfate sludge from treatment of Noranda smelter waste water with high and low lime additions	RCRA Subtitle D Solid Wastes	310,690 cu yds.

Location	Waste	Waste Type	Volume
Pond C extension	Calcium sulfate sludge from treatment of Noranda smelter waste water with high and low lime additions	RCRA Subtitle D Solid Wastes	77,101 cu yds.
Pond D	Calcium sulfate and ferric hydroxide sludges from treatment of Noranda smelter waste water with lime and ferric chloride	RCRA Subtitle D Solid Wastes	271,640 cu yds
	Materials used in dikes for Pond D	NA	15,715 cu yds
	Slag used in dikes for Pond D.	NA	28,594 cu yds

6. Location of contamination, exposures

The Waste Water Treatment Plant Sludge Ponds were located in an area remote from other industrial operations at the Kennecott North Zone, so exposure of industrial workers to these wastes was not a primary issue. However, the sludge ponds were adjacent to open space areas which were frequented by wildlife, including deer and other small animals. Sludge Ponds A and D were located adjacent to wetland areas and posed a risk to the birds.

D. Scope and Role of Operable Unit

The function of the Waste Water Treatment Plant and its associated sludge ponds (OU8) was to treat the waste waters generated at the smelter (OU13) and the refinery (OU 14) and discharge the treated water to the Magna Tailings Pond (OU 15). Operable Unit 8 concerns only the Waste Water Treatment Plant footprint and the sludge ponds. Adjacent wetlands are addressed in another operable unit (OU22).

E. Current and potential Future Site and Resource Uses

The land on which the former Waste Water Treatment Plant and Sludge Ponds are located is zoned M-2 (manufacturing, heavy industrial). The current land use is open space and

wetland restoration areas. It is likely that Pond A and Pond D will remain as restored wetlands providing habitat for shorebirds. The future land use of the Waste Water Treatment Plant, Ponds B, C, and C extension is still under discussion. Open space, industrial, institutional or commercial land use is possible.

F. Summary of Site Risks

1. Chemicals of Concern

Arsenic, lead, and selenium were the chemicals of concern at the WWTP and sludge ponds, and posed a threat to human health and wildlife. In addition, the arsenic and selenium were leachable and were a potential source of contaminants to groundwater. The concentrations found at the site are given in Table 6.5.

TABLE 6.5
CONCENTRATIONS OF CHEMICALS IN WWTP SOILS AND SLUDGES
(mg/Kg, dry weight, except where noted)

Location	arsenic concentrations (mg/Kg)		lead concentrations (mg/Kg)		selenium concentrations (mg/Kg)	
	max	mean	max	mean	max	mean
WWTP soils (pre-removal)	1100	118.9	766	106.1	163	9.7
WWTP soils (post-removal)	177	41.2	466	67.3	31.9	3.0
WWTP soils (post-reclaim)	10.6	8.8	17	15.9	5.3	4.6
Pond A (KUC, 1993, pre removal		2516		1863		51.2
Pond A (Rust, 1994), pre-removal	6700	3425	2700	1382	80	67.5

Location	arsenic concentrations (mg/Kg)		lead concentrations (mg/Kg)		selenium concentrations (mg/Kg)	
	max	mean	max	mean	max	mean
Pond A, 1997, pre-removal	19,900	2531	7670	1092	130	25.2
Pond A, 1999, post-removal	147	7.5	127	1.4	7.9	0.5
Pond B (KUC, 1993), pre-removal		4212		2373		152.5
Pond B (Rust, 1994), pre removal	5100	4162	3000	2537	200	157
Pond B (post-removal)	200	43.6	359	27.9	132	5.9
Pond B (post-reclaim)	14.4	4.4	35.5	12.3	9.3	6.6
Pond C (KUC, 1993, pre-removal)		4550		2133		276.7
Pond C (1994, pre-removal	7100	4566	4600	3116	290	252
Pond C (post-removal)	430	52.7	386	36.1	272	4.1
Pond C (post-reclaim	34.2	13.8	28	13.3	4.4	2.2

Location	arsenic concentrations (mg/Kg)		lead concentrations (mg/Kg)		selenium concentrations (mg/Kg)	
	max	mean	max	mean	max	mean
Pond C-ext (KUC, 1993, pre-removal)		3857		582.9		94.3
Pond C-ext (1994, pre-removal)	4600	2651	730	319	180	99.2
Pond C-ext (post-removal)	530	52.7	386	36.1	272	4.1
Pond C-ext (post-reclaim)	34.2	13.8	28.	13.3	4.4	2.2
Pond D (KUC, 1993, pre-removal)		4437		2081		156.3
Pond D (1994, pre-removal	3700	3467	3600	2071	200	149
Pond D (post-removal)	177	24.1	258	19.1	4.1	0.3
Pond D water (post removal)		14 ug/L		<5 ug/L	10 ug/L	3.75 ug/L

G. Removal/Remedial Action Objectives

1. Prevent ground water contamination through removal or capping of leachable materials.

2. Eliminate or contain contaminated materials which washed down into sensitive wetland habitats.

3. Eliminate or prevent exposure of contaminants to wildlife, especially wetland birds.

H. The Selected Remedy

Cleanup actions already implemented are given in Table 6.6.

TABLE 6.6
PREVIOUS ACTIONS AT THE WWTP AND SLUDGE PONDS

Location	Action Taken	Date
Waste Water Treatment Plant	Asbestos removed, facility demolished, underlying soils characterized and removed as needed	2001
Lime storage tank	Lime (150 tons) sent to Bingham Canyon Mine for use in reclamation of acidic soils	2001
Ferric chloride tank	Ferric chloride neutralized and mixed with soils, placed in Arthur Stepback Repository	2001
Pond A	Sludges inside and outside dikes removed, mixed with contaminated soils, dried and placed in Arthur Stepback Repository. This area was restored back to a wetland.	1998
Pond B	Sludges inside removed, mixed with contaminated soils, dried, and placed in Arthur Stepback Repository. The depression left was filled with tailings, covered with top soil and biosolids, and revegetated.	1997

Location	Action Taken	Date
Pond C	Sludges inside removed, mixed with contaminated soils, dried, and placed in the Arthur Stepback Repository. The dike between Pond C and Pond C extension was removed, the depression filled with tailings, covered with top soil and biosolids and revegetated.	1998
Pond C extension	See Pond C	
Pond D	The sludges from the concentrator treatment facility were removed in the 1980s and sent for recycling. The sludges from the WWTP were removed, mixed with contaminated soils, dried and placed in the Arthur Stepback Repository. Slag from the dikes was placed on the slag pile or disposed in the Arthur Stepback Repository. The area of Pond D was restored by adding islands, creating gentle slopes, and adding water management diversion structures to make the area suitable for wetland bird habitat.	2001

In addition to the previous cleanups, the following additional actions are needed:

1. See OU 23 (groundwater) for requirements involving monitoring of the effectiveness of ground water source control measures in the sludge pond area.

2. Provide maps to Salt Lake County (or any annexing municipality) showing locations of buried wastes above EPA's action levels for industrial land use and for unrestricted land use.

Section 7: Great Salt Lake and Associated Wetlands (Kennecott North Zone OU22)

A. Site Name, Location and Description

1. Site Type and description of operable unit

Operable Unit 22, the Great Salt Lake and Associated Wetlands, is composed of wetlands, creeks, springs, ponds, and marshes which are downgradient of the operational facilities at the Kennecott North Zone site. The Great Salt Lake is the ultimate receiving water of these wetlands either directly or indirectly. Therefore, this operable unit receives discharges from the Magna facilities and Magna Tailings Pond (OU 15), Magna Soils (OU 9), the smelter and acid plants (OU 13), the Refinery (OU 14), and the WWTP and sludge ponds (OU 8). Additionally, it is the location of the surface expression of the ground water contamination in the area as described in OU 23). The operable unit is located to the north of SH 201 up to and including the Great Salt Lake in the vicinity of Kennecott. A simplified water flow diagram is given on Figure 7.1.

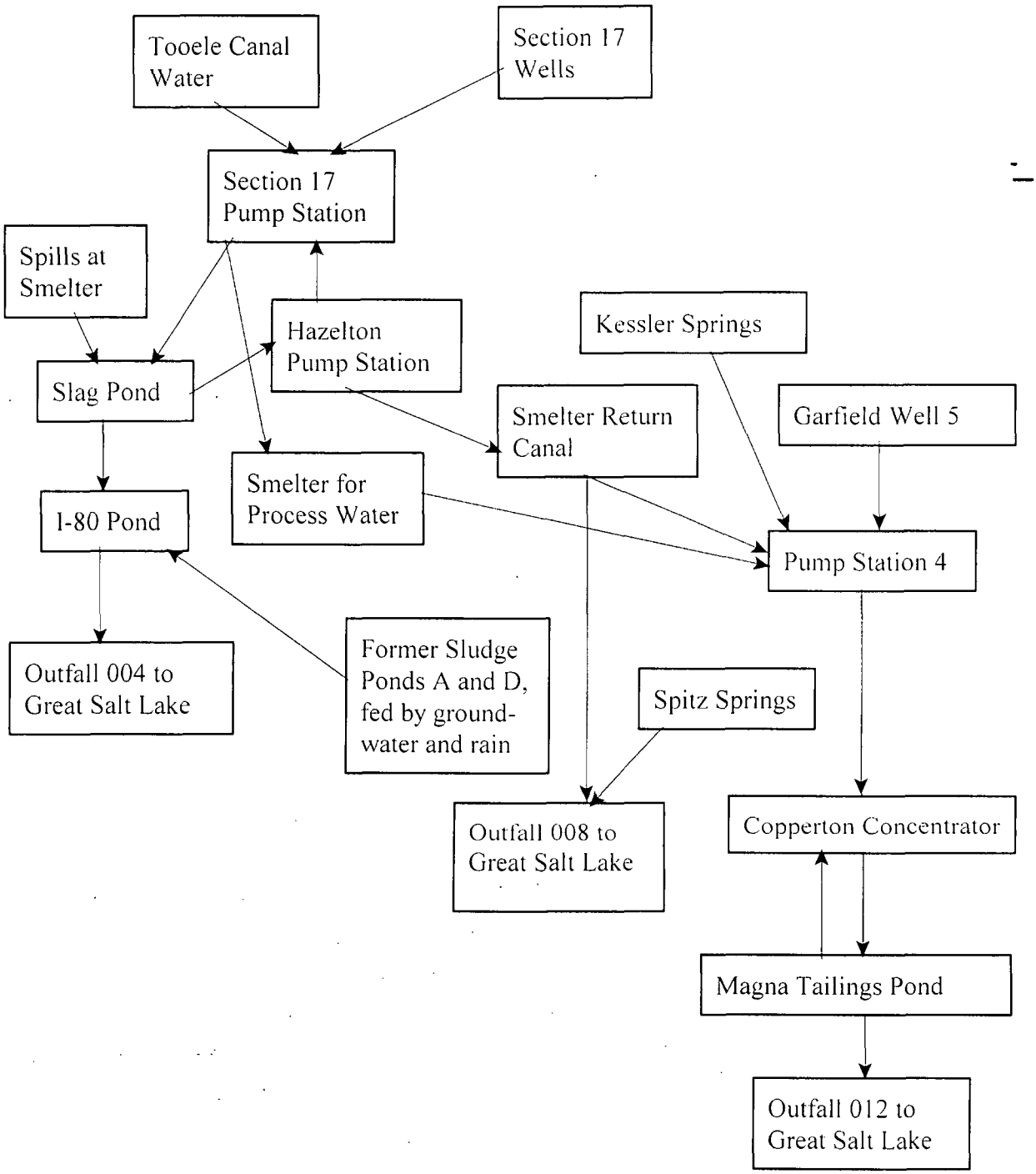
2. Facilities located within OU 22

The facilities and topographic features of OU 22 are categorized and listed in Table 7.1.

TABLE 7.1
LIST OF FACILITIES AND FEATURES IN OU 22

Facility	Function	Relationship to site
SPRINGS		
No Name Springs (West Kessler Springs Area)	Water source to wetlands, flow to Smelter Return Canal and then to process	Downgradient of some smelter infrastructure
Kessler Springs	Former water source to wetlands, now for Kennecott processing	Downgradient of the refinery
Spitz Springs (East Kessler Springs Area)	Water source to West C-7 Ditch	In vicinity of WWTP, between Pond C and B

Figure 7.1: WATER FLOW THROUGH THE GARFIELD WETLANDS



Facility	Function	Relationship to site
Toronto Spring, Spencer Spring, No. 10 Spring, No. 11 Spring (East Kessler Springs Area)	Water source to West C-7 Ditch, now called Spitz Springs	In vicinity of Magna Tailings Pond
Adamson Spring	water source to processing or to Clarification Canal and discharge to GSL	Historical source of mill water near mills and tailings pond
Tailings Pond Springs	Water source to Clarification Canal, processing or discharge to GSL	Water which seeps from the sides of the Tailings Pond dikes
WELLS		
Section 17 Well	Water source for processing or to Slag Pond	Water is used in smelting operations
Golf Course Well	Water source for power plant	Water is used at the power plant
Well 10	Water source for power plant	Water is used at the power plant
Garfield Well 1 (Garfield Wellfield Area)	Former water source for processing, or to wetlands, now sent to the West Cyclone at the new tailings pond	Discharged to Smelter Return Canal, now used at the West Cyclone at Magna Tailings Pond North Expansion
Garfield Well 4 (Garfield Wellfield Area)	Former water source for processing, or to wetlands, now sent to the West Cyclone at the new tailings pond	Discharged to Smelter Return Canal, now used at the West Cyclone at Magna Tailings Pond North Expansion
Garfield Well 5 (Garfield Wellfield Area)	Former water source for processing, or to wetlands, now hard piped to process water circuit	Now used in process water circuit (a portion of which can be discharged into Great Salt Lake after use)
Garfield Well 6 (Garfield Wellfield Area)	Former water source for processing, or to wetlands, now capped (valve is closed)	Formerly discharged to Smelter Return Canal

Facility	Function	Relationship to site
Garfield Well 8 (Garfield Wellfield Area)	Former water source for processing, or to wetlands, now capped (valve is closed)	Formerly discharged to Smelter Return Canal
CANALS		
Tooele Canal	Former and current water source for processing, excess to Slag Pond	Process Water source
Riter Canal	Former water source for processing, excess to C-7 ditch	Now discharges to C-7 Ditch
Utah and Salt Lake Canal	Former water source for processing, excess to C-7 ditch, now used to irrigate reclaimed portions of Magna Tailings Pond	Discharges to C-7 Ditch or used for reclamation irrigation
Right of Way Canal	Water Source to Lee Creek	Water Source to Lee Creek
CREEKS		
East Lake	Former water source for Kennecott processing and duck hunting preserve, now a marshy area drained by Riter Canal, a part of this area has been developed into an industrial park	Former Water Source to processing, now drained by Riter Canal and Lee Creek
Lee Creek	Drainage on East Side of Tailings Pond	Drainage on East Side of Tailings Pond and water pathway rerouted by Kennecott to flow into C-7 Ditch
Kersey Creek	Drainage on East Side of Tailings Pond	Drainage rerouted to go into the C-7 ditch
C-7 Ditch	Man made channel which drains excess water from Magna Tailings Pond and other Kennecott outfalls	UPDES receiving water for Kennecott Outfalls 7, 2, and 11. Flows to Great Salt Lake

Facility	Function	Relationship to site
West C-7 Ditch	Man made channel on west side of Magna Tailings Pond	Merges with C-7 Ditch
East C-7 Ditch (Reclaim Canal)	Man made channel on east and south of tailings pond, collecting water from tailings pond and allowing sediments to settle before water is reused in the process or discharged	Receives flow from Adamson Springs and the Tailings Pond, used as process water or discharge to the C-7 Ditch
GARFIELD WETLAND AREAS		
East Hazelton (Hazelton Area)	A dump area near the Hazelton Pump Station	Probably a former concentrate storage area
West Hazelton (Hazelton Area)	Two settling ponds used to collect runoff from the smelter area	Contaminated with a variety of smelter wastes and spills
Weak Acid Lift Station (Hazelton Area)	Pumped waste waters from smelter to the WWTP for treatment	Contaminated with acids and metals, malfunctions resulted in spills to the wetlands
Weak Acid Pipeline	Conveyed waste waters from the Weak Acid Lift Station to the WWTP for treatment	Waters contaminated with acids and metals, breaks in the pipeline lead to spills to the wetlands.
Slag Pond	Served as a process water reservoir and a stormwater collection reservoir.	Contaminated with a variety of smelter wastes and spills, especially concentrates.
I-80 Pond	At one time, part of the Slag Pond, storing process waters	Contaminated with smelter wastes near west end
Wetlands Landfill	A dump of lab wastes and debris, including crucibles	Lab waste and construction debris dump
Smelter Return Canal (West and Central Kessler Springs Area)	Used to return treated waters from the old WWTP to the smelter for reuse. Also collected waters from wetlands and spills	Heavily contaminated with spills of materials originating at the smelter

Facility	Function	Relationship to site
Wooden Bridge Site (West Kessler Springs Area)	Two dumps next to a bridge over the Smelter Return Canal	Acid tainted wastes probably associated with spills at the acid plants
Garfield Wetland Areas 1, 2, and 3	Wetlands between the Garfield Refinery and the Great Salt Lake	Received contaminated groundwater and surface waters from refinery and smelter
Marsh Areas 1, 2, and 3 (Smelter Wetland Area)	Wetlands between the smelter and the Great Salt Lake	Received contaminated surface waters from the smelter
Ponds 1, 2, 3, 4, 10a, and 10b (Oolitic Sand Ponds Area)	Ponds within the Garfield and Smelter Wetlands	Received contaminated surface waters from the smelter and refinery
Sample Unit 1 (Garfield Wellfield and Oolitic Sand Ponds and Kessler Springs Areas)	A wetland area near Sludge Pond D used for ecological studies	Received contaminated groundwater from the refinery
Freeway off-ramp pond	Pond near Sludge Pond D, now within the highway right of way	Suspected contamination from Kennecott operations.
SMELTER WETLANDS		
Smelter wetlands (Smelter Wetlands Area	Wetland areas between the smelter and the GSL	Suspected contamination from the smelter
EASTSIDE WETLANDS		
Sample Unit 2 (Eastside Wetlands Area)	Wetland area on the east side of the tailings pond near the confluence of Lee Creek, Kersey Creek, and C-7 Ditch	Suspected contamination for breaches in the eastern side of the Magna Tailings Pond
GREAT SALT LAKE		
Great Salt Lake	Closed basin receiving water body for all of Kennecott properties, either directly or indirectly	Suspected contamination near Kennecott outfalls

Facility	Function	Relationship to site
Outfall 012	New Kennecott outfall for discharging decant water from the new tailings pond and any excess process waters	Any contaminant entering the process waters could potentially be discharged via this outfall.
Great Salt Lake beaches	Shoreline of Great Salt Lake	Potential contamination due to proximity of Kennecott discharges to the GSL
Saltair and other beach resorts	Pavilion on shoreline of Great Salt Lake close to Kennecott operations	Potential contamination due to proximity of Kennecott discharges to the GSL.
Marina	Marina on shoreline of Great Salt Lake close to Kennecott smelter	Potential contamination due to proximity of Kennecott smelter

(names in parentheses note monitoring plan designations)

B. Site History and Enforcement Activities

1. Activities at the site which led to contamination

SPRINGS:

No Name Springs: Located near Praxair, this water flows into the smelter return canal and was formerly used in processing.

Kessler Springs: Kessler Springs, located under SH 201 and discharging via a culvert to the Garfield Wetlands, are bedrock contact springs downgradient of the refinery complex. The springs consist of 3 springs located within 100 yards. The springs are heavily contaminated with selenium from the past leakages at the old Precious Metals Refinery Building (see OU 14). The spring water has now been diverted away from the wetlands into the process water circuit. The flow is about 300 gpm.

Spitz Springs: Spitz Springs is located north of Sludge Pond C and south of the railroad tracks along the western base of the Magna Tailings Pond. There are two springs indicated on several maps, Spitz Springs and East Spitz Springs. Historic water quality measurements indicate that the water is elevated in arsenic, perhaps due to proximity to Sludge Ponds C and B.

Toronto Spring, Spencer Spring, No. 10 Spring, No. 11 Spring: These springs which show up on historical maps are collectively known as Spitz Springs today.

Adamson Spring: Adamson Spring, a very large bedrock contact spring with a flow of about 6000 - 8000 gpm, was the original source of water to the milling and smelting facilities when the facilities were first constructed. The clarification canal around the southern boundary of the Tailings Pond collects the water. Today, it is not used much and most of it is discharged to the Utah and Salt Lake Canal via UPDES Outfall 11. It is located between the tailings pond and SH 201 in the Diving Board Tailings Area. The water is collected in two sumps and can be directed to the process water circuit via the clarification canal or directly discharged when not needed. Adamson Spring water has been shown to be toxic to freshwater aquatic species, perhaps due to chloride content.

Tailings Pond Springs: These "springs" pour out of the lowest dikes of the Magna Tailings Pond through pipes inserted through the dikes. The pipes encourage drainage of the water from the tailings pond through these conveyances. Additional flow originates from wicks drilled into the dikes. As the Tailings Pond becomes dewatered these flows will slow considerably. The flow is collected in the clarification canal (tailings return canal) and is used as necessary in the process water circuit.

WELLS

Section 17 Well: The Section 17 well with a flow of about 500 gpm is used for process water at the smelter and fire protection water. Excess amounts can be directed to the Slag Pond or to Outfall 004.

Golf Course Well: The Golf Course Well, located on the Magna Golf Course close to the power plant, has a flow of 2,600 gpm and is used for cooling water at the Power Plant.

Well 10: Well 10 with a flow of 3000 gpm discharges to the clarification canal around the Tailings pond and can be used at the Power Plant.

Garfield Well #1: Formerly used for process waters, this water is now conveyed to the West Cyclone (which separates tailings into different size classes) along the edge of the new tailings pond.

Garfield Well #4: Formerly used for process waters, this water is now conveyed to the West Cyclone along the edge of the new tailings pond.

Garfield Well #5: The Garfield Well #5 was an artesian well that contained up to

1 mg/L of selenium. The water flowed into the wetlands surrounding the well. In 1998 the flow from Garfield Well #5 was captured and piped to UPDES Outfall 008 and the ponds near the well then mostly dried up. The well water from Garfield Well #5 has been decreasing over the past three years, but the flow from Kessler Springs has been increasing. In 2000, the Garfield Well water was re-directed to the process water circuit. Mixture of the water with tailings from Copperton serves to remove a portion of the selenium from the water and the selenium becomes a part of the solids disposed in the Magna Tailings Pond.

Garfield Well #6: Formerly used for process waters, this well is now capped (the valve is closed).

Garfield Well #8: Formerly used for process waters, this well is now capped (the valve is closed).

CANALS

Tooele Canal: The Tooele Canal ditch, located between the slag pond and I-80, carries water from Tooele County water sources to the Section 17 Pumphouse where it is used at the Smelter for process water. The Canal receives about 5000 gpm in the summer and 3000 gpm in the winter from wetlands in Tooele County delivered by a pipeline which follows the Interstate Highway. The water from Tooele County originates from springs located on the Old Droubay Ranch (10 Mile Springs, Cassidy Springs), 18 miles west of Garfield, and is delivered via a canal to the Mill Pond on the Clark Ranch. The waters from the Mill Pond are then delivered via a pipeline to a storage reservoir on the Castagno Ranch where it joins waters provided by Factory Creek (now called Factory Springs Pond). It is delivered to Lakepoint through an aqueduct. From thence, the water flows in a concrete aqueduct (Section 17 aqueduct) around the end of the mountains roughly along Interstate 80 and then on the north side of SH 201 to the Section 17 Pumphouse. The water is used for processing at the smelter.

Riter Canal: The Riter Canal is a drainage and irrigation canal which originates at 3800 W and SH 201, and then flows west along the south side of SH201. The water in the Riter Canal comes from urban and agricultural runoff and from the North Jordan Canal. The canal was dug in 1906 as part of the construction of the Magna Tailings Pond. The canal ends at the Reclaim Water Canal (Clarification Canal) and can be used in the Kennecott process water circuit or can be discharged to the C-7 ditch. The flow is about 30,000 gpm.

Utah and Salt Lake Canal: The Utah and Salt Lake Canal is an irrigation diversion canal receiving water from Utah Lake. It also receives urban and agricultural runoff. It passes just to the west of Magna. KUC can use the water

for processing or discharge the waters into the Riter Canal. The canal is the receiving water for UPDES Outfall 011 (now used to discharge Adamson Springs). The water will be used in the future to irrigate the vegetation on retired sections of the Magna Tailings Pond.

Right of Way Canal: The Right of Way Canal originates around 4800 W and travels west along the northern frontage road of I-80. It merges with Lower Lee Creek.

CREEKS AND LAKES:

East Lake: During the 1950s, an important water source for the Magna and Arthur Mills was East Lake. Located near SH 201 and 4000 W, East Lake was fed with water from the North Jordan Canal and the water was delivered to Kennecott via the Riter Canal. There was also a drainage outlet to the Great Salt Lake to the northwest (via Lee Creek?). The lake was also used as a duck hunting preserve by Kennecott employees. The lake was abandoned as a water source because there was a contaminant in it which was deleterious to the flotation circuits. Now the area is a wetland, marshy area - there is no lake. A portion of the area has been developed into an industrial park. The land is mostly owned by the LDS church.

Lee Creek: Upper Lee Creek originates in a spring fed wetland area near SH201, 2 miles east of the tailings pond. It passes by several landfills, and then flows into the C-7 Ditch. Due to heavy vegetation and landfill garbage along the creek, flows in the creek are choked during heavy precipitation periods creating several flooded pasture areas in the wetlands. Upper Lee Creek does not flow into Lower Lee Creek. Lower Lee Creek originates near Salt Springs (via the Brighton Drain), 5 miles east of the Mitigation Area. It was a wide shallow drainage area terminating into the Great Salt Lake. It typically receives water only from Kennecott discharges via UPDES 007 and 002. The flow from 007 is less than 5000 gpm, and 002 is not routinely used.

Kersey Creek: Kersey Creek originates from springs to the south and west of Lee Creek. It also receives effluent from Magna's WWTP. It then flows through a construction debris landfill and discharges into the C-7 Ditch. It does not appear to collect any discharges from Kennecott operations.

C-7 Ditch: The C-7 Ditch is a man-made canal constructed around 1917 as part of the first major tailings pond expansion. The C-7 Ditch is the receiving water body for several of Kennecott's outfalls including 007, 002, and 011. It receives flow from Lee Creek, Kersey Creek, Riter Canal and the Utah and Salt Lake Canal, resulting in a drainage area of 73 square miles. Until the recent tailings pond expansion, the C-7 ditch discharged into the Great Salt Lake. Now it has been

rerouted to flow into the Lower Lee Creek drainage. The Ditch does support aquatic life, including carp, Utah sucker, channel catfish, mosquitofish and walleye. The water quality in the ditch showed iron levels exceeding the chronic standard and copper levels exceeding the acute standard. However, the ditch is not considered as fisheries habitat and the freshwater standards do not apply to this water body.

West C-7 Ditch: The West C-7 ditch originates near Spitz Springs (near the former location of the WWTP at the intersection of SH 201 and SH 202), travels north along the foot of the Magna Tailing Pond berm and joins the C-7 ditch at the Northwest Corner of the Tailings Pond. It receives water from the tailings pond, the Garfield wells and surface runoff. Although it is a man-made canal it does support carp, Utah chub, mosquitofish, white bass and walleye.

East C-7 Ditch (Clarification Canal, Tailings Reclaim Canal): The Clarification Canal (East C-7 Ditch, Tailings Reclaim Canal) flows around the east and south side of the Tailings Pond. A clarification system was added to provide further settling of tailings from the decant water in the Tailings Pond. The canal collects water which is being drained from the former tailings ponds with pipes through the dikes and wicks. The water in the East C-7 Ditch can be recycled for use in the mills or discharged via outfall 011.

GARFIELD WETLAND AREAS

East Hazelton: Located just to the south of the slag pond and just to the west of the slag pile area are wetlands called Hazelton because the Hazelton pump station is located here. East Hazelton consists of a 3.5 acre area which was devoid of vegetation. It was formerly used as a dump site with a series of irregularly placed piles. Contamination at some places was at least 8 feet deep.

West Hazelton: The West Hazelton wetlands consists of two bermed settlement ponds covering about 6.5 acres. The area was thickly vegetated with Phragmites but was heavily contaminated with arsenic. This area was originally created by a delta of Kessler Canyon and was later contaminated with smelter runoff materials, spills at the smelter, and dumping of contaminated soils.

Weak Acid Lift Station: The weak acid lift station conveyed weak acid (blowdown from the smelter) to the WWTP. It was demolished in 2001 when it was no longer needed. The hydromet plant at the smelter now treats the blowdown waters.

Weak Acid Pipeline: The weak acid pipeline conveyed weak acid from the smelter to the Waste Water Treatment Plant until the new smelter was built. Then it was

used for decon water during the older smelter demolition projects. When the process water pipeline failed in 2001, the former weak acid pipeline (a double walled pipeline) was converted to use for the process water. It is still in service.

Slag Pond: The Slag Pond (a.k.a. the Slag Lagoon, the Smelter Lagoon, West Slag Pond) is a shallow unlined pond which was originally created by the mining of oolitic lime sands for use as process flux. In 1982, the slag pond covered an area of 31 acres. The pond received plant runoff from the smelter and any flows coming down Kessler Canyon. (The Kessler Canyon drainage is about 3000 acres.) In addition, the pond received waters from any waters or acids spilled at the smelter. It was equipped with a breakaway dike in 1981 so that the waters could be diverted to the Great Salt Lake rather than allow the slag pond to overflow. In 1987, the pond was divided into two ponds by a berm - the eastern pond is called the I-80 Pond and the western pond is the Slag Pond. The slag pile to the immediate south of the slag pond is dwindling in size with the use of the slag in the construction of the new tailings pond extension. As the slag pile footprint decreased, the slag pond open water has increased in size and now is about 67.5 acres. The new open water areas have a bottom composed of a layer (2 - 4 feet) of slag. Because the slag does not leach and is not exposed, this slag was not removed. The sediments of the original footprint of the pond were contaminated with concentrates that apparently washed down from the smelter. These contaminated sediments in the slag pond measure 3 - 15" thick, more near the inlet. The contamination has the chemical composition of concentrates.

I-80 Pond: The I-80 Pond (a.k.a. the East Slag Pond, and 120 acre pond) is located just to the east of the slag pond and is separated from it by a narrow berm. Water seeps through the berm and feeds the pond with water. The pond is long and narrow and is adjacent to the Interstate Highway which is just to the north of the pond. A culvert under the highway has been installed so that the ponds will overflow to the Great Salt Lake. Contamination is heaviest near the Slag Pond on the western side of the pond. The southwestern end of the Pond has been called Pond 12 in some reports.

Wetlands Landfill: Located near Sludge Pond A in the wetlands was a landfill which contained waste crucibles from one of the Kennecott laboratories. The crucibles were heavily contaminated, but the rest of the landfill debris was not. Rather than try to pick the crucibles out of the wastes, the entire landfill was excavated and placed in the Arthur Stepback Repository.

Smelter Return Canal: The Smelter Return Canal was used to transport waters back from the former WWTP to the Noranda Smelter for use in processing. The Smelter Return Canal also received runoff from the smelter area and up to 12 feet of concentrates were located there. Occasionally the Smelter Return Canal was

dredged with the dredge spoils piled up on the banks. This lead to contamination not only in the canal itself, but along the banks and up to 200 feet away in the adjacent wetlands.

Wooden Bridge Site: On either side of a wooden bridge formerly crossing the Smelter Return Canal were dumps each about 300 feet in diameter. Although the metals were not high in the dumps, the wastes were very acidic.

Garfield Wetland Areas 1, 2, and 3: Wetland soils, not associated with open water, were divided into three areas. Area 1 is located between SH 201 and the smelter return canal and formerly received waters from the Kessler Springs. Area 2 is located between the smelter return canal and the old mainline tracks of the Union Pacific before they were relocated in 1996. Area 3 is between the old mainline tracks and the I-80 pond.

Marsh Areas 1, 2, and 3: There are several other marshy areas in the vicinity of the smelter. Marsh Area 1 is located just to the south of SH 201 between the main entrance of the smelter on the east to the Cobalt Refinery road to the west. It is about 3000 feet long and about 180 feet wide. It is fed by Japanese Springs. The contamination originates from a variety of sources with different metals predominating in different locations. Marsh Area 2 is located just to the east of Praxair. It is about 1500 feet long and 300 feet wide at its widest. Marsh Area 3 is located to the north of SH202 just west of Pond B and south of the Smelter Return Canal. It was cleaned up as a part the Smelter Return Canal project.

Ponds 1, 2, 3, 4, 5, 10a, 10b, 11 and 12: Pond 1 is located just north of SH 201 on the other side of the road from Japanese Springs. Pond 2 is a small pond (375 ft x 100 ft) adjacent to I-80 opposite Black Rock close to the railroad overpass. Pond 3 is just to the east of Pond 2. It is long and narrow (1500 feet x 100 feet). Pond 4 is adjacent to I-80 just east of Pond 3 and just west of the marina and Hazelton Pump Station longitude. It is 1875 feet x 500 feet. Pond 5 is on the south side of SH201 and is associated with Japanese Springs. Pond 10a and 10b are located just to the west of Sludge Pond D. Both ponds have southern boundaries along the former mainline railroad grade recently abandoned. Pond 10a is on the west and measures 1000 feet x 750 feet. Pond 10b is between Pond 10a and Sludge Pond D and is 1000 feet x 180 feet. Pond 11 is located between Garfield Wells 5 and 6 just across the recently abandoned railbed from Sludge Pond D. Pond 12 is located on the extreme SW end of the Slag Pond, south of the Hazelton Pump Station. The water quality of Pond 12 was high in arsenic in 1997 and 1998 at 237 ug/L and 310 ug/L arsenic. After removal of the contaminated soils at East and West Hazelton, the water quality has improved to be <5 ug/L arsenic.

Sample Unit 1: Sample Unit 1 is a marshy area covered with phragmites located

close to the former recently abandoned mainline tracks on the south side. This area was used in ecological risk studies. It was apparently a subset of Garfield Wetlands Area 3.

Freeway off-ramp pond: There are some wetland areas located between I-80 (eastbound) and the off-ramp (eastbound) to SH 202 (SW quadrant of the intersection). This area is in the Freeway right of way, but the land was formerly owned by Kennecott.

SMELTER WETLANDS

Smelter Wetlands: The Smelter Wetlands are located to the west of the Slag Pile from SH 201 to Interstate 80. The wetlands cover an area of 4800 feet x 1600 feet (176 acres). Currently these wetlands receive water from ground water recharge, surface runoff and excess Tooele Valley water. Historically, it may have been used by Kennecott and Union Pacific Railroad for industrial activities.

EAST SIDE WETLANDS

Sample Unit 2: Sample Unit 2 (in the Ecological Risk investigations) was located in the wetlands just to the east of the Magna Tailings Pond in the area where Lee Creek, Kersey Creek, and the C-7 ditch all merge together. It covers an area of about 2600 acres and consists primarily of saline playas with scattered ephemeral wetland areas. Features include roads, railroads, and ditches. The area has been impacted in the past by tailings spills from breaches in the nearby tailings pond.

GREAT SALT LAKE

Great Salt Lake: The Great Salt Lake is a closed basin that collects water from a large part of northeastern Utah and parts of Idaho and Wyoming. It has no outlet and water losses are due to evaporation (or diversion into evaporative ponds for recovery of salts). The largest water sources are (1) the Bear River; (2) precipitation; (3) the Jordan River; and (4) the Weber River. The Great Salt Lake is about 70 miles long and 30 miles wide. The salinity of the lake varies between 5% and 27% (Seawater is about 3%). The salinity varies as a function of location with the North Arm, with few freshwater inputs, being the saltiest at about 20% today. In the South Arm, where Kennecott is located, the lake has two layers with the top 26 feet being oxygenated and the bottom waters are anaerobic.

There are several companies that mine the salts from the lake by pumping the water from the lake into solar evaporation ponds. The main products are salt, potash, and magnesium. This represents about $230 Million/year (1997). Kennecott does not engage in this activity.

The Great Salt Lake is a remnant of the ancient Lake Bonneville which had a surface elevation of 5090 feet. The historic high water mark for the Great Salt Lake was about 4220 feet above sea level and today's elevation, near low water, is about 4200 feet. The aquatic life in the lake includes bacteria, 6 species of algae, three species of brine flies, and brine shrimp. The harvesting of brine shrimp cysts is a $30 Million/year industry in Utah. The cysts are shipped mainly to Japan where they are hatched and used for food for aquacultured fish.

In 1963, Kennecott asked the State of Utah for permission to discharge tailings into the Great Salt Lake. The State was concerned that this would harm the lake for its other uses but gave permission for Kennecott to conduct a test. The test involved discharging enough tailings to determine if the tailings would stay where they were discharged or migrate some distance to other parts of the lake. The test was conducted in 1965. Kennecott used the tailings to create a dike. Tailings were discharged from a 12" transite pipe at a location about 2000 feet from the C-7 Ditch outfall. By 1968, the test was declared a structural failure because the tailings dike did not hold up to erosion. The experiment discharged about 2 million cubic feet of tailings into the Lake, of which at least 424,000 cubic feet washed away nearly immediately. Since little is left of the dike now, all of the tailings are now presumably spread out in the sediments of the lake. At least one environmental group was formed to lobby against the test and the proposal for wholesale dumping of tailings in the Lake. Eventually the whole idea was dropped. Today, nothing remains of the test dike.

Surrounding the lake are about 400,000 acres of freshwater wetlands which are home to both nesting and migratory waterfowl. The birds feed on the brine shrimp and brine flies from the Lake but also the freshwater fish species present in the wetlands.

The Great Salt Lake is used occasionally for recreational boating and bathing, but these activities were more prominent in the past than today.

Kennecott's major outfalls discharge either directly into the Great Salt Lake or indirectly to tributaries near the Great Salt Lake. In 1997, Kennecott estimated their inputs to the lake and compared it to other sources of contaminants (see Table 7.2):

TABLE 7.2
METAL INPUTS TO THE GREAT SALT LAKE

Contaminant	Rivers (kg/yr)	C-7 Ditch (kg/yr)*
As	16520	2600
Cd	2844	137

Cu	11224	1819
Pb	13920	298
Se	?	1154
Zn	35480	4800

* The C-7 Ditch was the major Kennecott outfall at the time.

Kennecott was the source of 3% of the water in the Lake, 13% of the arsenic, 5% of the cadmium, 14% of the copper, 2% of the lead, and 12% of the zinc. There were too many non-detects in the riverine selenium data to make a relative comparison. Although in comparison to the rivers, the Kennecott contributions appear small, the discharge goes into one place on the south arm and thus can strongly influence the local water quality of the lake in this area. It is coincidental that the recreational activities of the Great Salt Lake are located nearby.

Outfall 012: In 1999, Kennecott constructed a new outfall which discharges directly to the Great Salt Lake and began discharging effluent from the new Tailings Pond Expansion in 2000. The new outfall became necessary when the effluent from the tailings pond began to contain high levels of salt from the former Morton Salt evaporation ponds on which the new expansion was built. The high levels of salt proved toxic to freshwater test species indicating that the discharge should not go into the freshwaters of Lee Creek, even the short distance from the Great Salt Lake. The Great Salt Lake, already quite salty, was a more appropriate place for the discharge. The discharge pipe is long, about 600 feet and is equipped with a diffuser at the end of it to aid in dispersal. More and more of the Kennecott discharges are now being directed toward this outfall.

Great Salt Lake Beaches: Like most of the Great Salt Lake Shoreline, the beaches near the Kennecott site are barren of vegetation and fully exposed to the high winds and waves. Sediments of the beach are mainly oolites and brine shrimp fecal pellets. The oolitic sand extends into the water beyond the shelf area and for some distance inland as well. Underlying the sand is a layer of sodium sulfate which has some structural stability. The Utah Geological Survey suggests that the most effective transport of sediments along the beaches is via longshore currents. Because there were indications of some metal contamination in the nearby tributaries and the lake sediments offshore, EPA and BOR (1995) conducted a study to determine if metals would pose a risk to beach lovers in the area. The Great Salt Lake State Beach is located just east of Saltair and opposite the new Tailings Pond Expansion Area. The metal content of the beach sands from Lake Point to the Davis County Line was low even in comparison to typical residential action levels. EPA determined that the Great Salt Lake beach did not pose a threat to human visitors, resident or migratory.

Saltair and other beach resorts: According to Morgan (1947), the first record of a community beach excursion occurred in 1851 when Salt Lake City residents traveled by horse and carriages to Black Rock Beach. In 1878, a beach resort was founded at Black Rock. A competing establishment was founded at Garfield Beach (just west of Black Rock) in 1881. Both resorts were serviced by the Utah and Western Railroad. The Garfield Beach resort included a pavilion built over the water about 400 feet from the shore and the first steamboat was moored there. The Garfield Resort burned in 1904 and the Western Pacific Railroad laid its rails over the charred remains. The first Saltair pavilion was built in 1893 to cater to LDS customers. It was a huge structure, about the size of the Tabernacle, and was built 4000 feet out on a pier over the water. The first Saltair pavilion burned in 1925 and was rebuilt in 1926. Due to several dry years the Saltair pavilion found itself high and dry one half mile from the water. Even though the resort installed a railroad which would carry visitors to the water, the pavilion fell into disrepair and was sold to the state in 1959. The structure burned in 1970. Once again the pavilion was rebuilt in 1982, this time at a spot on the shore west of the original location. During the high water of 1984 the first floor of the new Saltair flooded to a depth of about 5 feet. When the lake receded, Saltair was sold in 1992 to Walter Plumb and restored. It is now open for business for meetings, concerts, and conventions.

In 1993, the new owner sued Kennecott alleging that Kennecott was responsible for the stinky beach in the vicinity of the resort. He concluded that water from the Slag Pond and I-80 Pond was seeping underneath the highway causing the beach to be soggy. Kennecott responded that the fault was due to the Utah Department of Transportation which had neglected to install any culverts in the area when the height of the highway was raised to avoid flooding in 1982. Eventually, the parties (including Saltair, the Department of Transportation and Kennecott) agreed to install a new culvert under the highway. Kennecott maintains their ponds at levels beneath the level of the lake to prevent any seepage. Note that the reason for the stinky beach was never proven one way or the other.

Marina: Boating on the lake has been popular from the early days of settlement. The Salt Lake Yacht Club was founded in 1877. Although interest in boating waned for a time, it revived in the 1920's. The Great Salt Lake Yacht Club was organized in 1929 and built a clubhouse beneath the south pier at Saltair. When the lake level began to drop in the 1930's, the salt began to crystallize on the boats and the Salt Lake County boat harbor was built near Black Rock because the water was fresher there due to "shoreline springs". The freshwater probably comes from the adjacent smelter and Garfield wetlands rather than springs.

2. Investigations, cleanup activities, enforcement

Investigations: A few preliminary investigations began on the wetland areas as a part of the Magna Tailings Pond Expansion Project when the source of selenium became an issue of interest to bird enthusiasts and local environmentalists. Shortly thereafter in 1993, EPA, UDEQ, and Kennecott developed a strategy to investigate the Kennecott North Zone generally. Three investigations began simultaneously. The first was a site-wide ecological risk assessment (see Section 1). Wetlands were identified by the ecological experts as one of the prime habitats of greatest sensitivity. Therefore, there was an intense data collection effort to determine the levels of contaminants in the sediments and water, in the wetland plants, in the macroinvertebrates, and in the bird eggs of birds nesting in the wetlands. An effort was made to determine the interrelationships between the various compartments. It was at this time that selenium was identified as the primary contaminant of interest because of its potential impacts to the wetland birds.

In the meantime, characterization work began on the surface wastes scattered about the Kennecott North Zone, including wastes in the ponds, sediments, landfills, dumps and canals in the wetlands area. This was conducted under the provisions of an Administrative Order on Consent in a Non Time-Critical Removal Action. The removal action goals were based on protection of industrial and recreational users at the site. Ecological impacts were not considered at this time. However, as this work proceeded, and the pockets of contamination were located and removed, the ecological group would collect more samples of macroinvertebrates and bird eggs to determine if exposures had been attenuated by the removal of the surface contamination.

Based on the initial findings of the ecological risk assessment and some of the water monitoring begun as a part of the Tailings Pond Expansion Project, EPA determined that a RI/FS on the groundwater and wetlands was needed. Kennecott agreed to perform this study voluntarily. EPA, Kennecott, and UDEQ agreed on the RI/FS work plan and the work proceeded without an order. During the RI/FS activities the source of selenium in the wetland waters was discovered. Rather than allow the sources to continue while the studies were ongoing, the affected spring and well waters were redirected away from the wetlands, first directly to the Lake, and then later into the process water circuit. (See also Section 8).

The Great Salt Lake itself has been studied a few times in the past, but little was known about the behavior of contaminants in the Lake, or the impacts of these contaminants on the biota of the Lake. Recognizing this information void, the USFWS conducted a survey of contaminant levels particularly in the South Arm of the Lake and the bioaccumulation factors into brine shrimp and their eggs.

Because the shrimp serve as food for migrating and nesting birds, it was important to know if the shrimp contained levels of contaminants that were potentially harmful.

The one place where the general public might be exposed to Kennecott-derived contaminants is at the Great Salt Lake Beach. EPA with the aid of the U. S. Bureau of Reclamation launched a study in 1995 to determine if the beach sands posed a risk to human visitors at the beach. Fortunately, the concentrations of both lead and arsenic were too low to be a significant risk to human visitors.

As a part of the ecological risk assessment, Kennecott conducted selenium toxicity testing on the most common biological species in the Great Salt Lake. The test species included brine shrimp, the most common algae, and the brine flies. The data were also used for the Magna Tailings Pond Project and the UPDES permit renewal. Although there are no numerical standards for contaminant levels in the Great Salt Lake, the bioassay results were used to estimate at what concentrations of selenium effects might occur. Instead of using these data to develop a CERCLA performance standard for discharges to the Great Salt Lake, the data were used to develop limits in Kennecott's UPDES discharges. Monitoring requirements are also included in this permit. The Kennecott UPDES discharge permit not only considers toxicity to organisms in the lake, in a manner similar to development of water quality standards, it also includes the problem of biomagnification from aquatic organisms to birds. This is not a standard technique for water quality limitations, but is an appropriate approach used in CERCLA responses.

C. Site Characteristics

1. Size, topography

The wetland areas located to the north of Kennecott's smelter and refinery encompass an area of about 1100 acres. The wetlands are created with surface water runoff (which has been contaminated by industrial operations), local artesian flow from wells and springs (which have also been contaminated by industrial operations), and canal water brought in for use as process water. The wetlands are interconnected with canals and culverts. The wetlands consist of open water ponds, marshy areas which have standing water but are overgrown with Phragmites, saline playas, and other wetland areas which are flooded only during periods of high precipitation, but are dry the rest of the year. The wetlands are connected directly to the Great Salt Lake via a culvert under the Interstate Highway on the western end of the I-80 Pond and indirectly to the Great Salt Lake via the Kennecott 012 outfall for excess process waters. The topography is flat with the exception of artificial dikes and canals, roads, and historic and current

railroad beds. The wetlands have been contaminated by water from industrial runoff and contaminated groundwater discharges, and by upgradient and local spills and dumps of a variety of mine wastes.

The Eastside Wetlands are located just to the east of the Magna Tailings Pond in the area where Lee Creek, Kersey Creek, and the C-7 ditch all merge together. They cover an area of about 2600 acres and consist primarily of saline playas with scattered ephemeral wetland areas. Features include roads, railroads, and ditches. The area has been impacted in the past by tailings spills from breaches in the nearby tailings pond.

The Great Salt Lake is about 70 miles long and 30 miles wide, but the entire Lake is not likely to be affected by the site. The part of the Lake which has received the most scrutiny in this action is the area described as the Salt Lake County line. The area of most concern in the Great Salt Lake is about 16 square miles.

2. Surface and subsurface features

The wetland areas are composed of ponds, marshes, and some uplands which are fed by canals, aqueducts, springs and artesian wells. In addition, the open waters are interconnected with culverts, and can discharge to the Great Salt Lake via a culvert under the Interstate Highway. For convenience, the wetlands are divided into three general areas: the smelter wetlands which are located to the west of the slag pile; the Garfield wetlands bounded by the slag pile on the west and the Magna Tailings Pond on the east; and the Eastside wetlands which are to the east of the Magna Tailings Pond in the general area where Lee Creek, Kersey Creek and the C-7 Ditch converge. In addition to the water management features, the area has some roads to access wells and the ponds, and is crossed by several historic rail beds and the active Union Pacific mainline which is double tracked through the area. There are several subsurface man-made structures including the Weak Acid Lift Station and several pipelines which generally follow the Smelter Return Canal. Formerly, there were several dumps in the area including the slag pile, the wetlands landfill, a dump near the Kessler Springs, dumps near the former Wooden Bridge across the Smelter Return Canal and dredge spoils from former dredging activities in the canal. With the exception of the slag pile, the dumps have been removed by the CERCLA activities at the site. Several of the open water areas have been equipped with water management structures including weirs, dikes and access roads.

3. Sampling strategy

The sampling strategy was quite diverse depending on the nature of the investigation. Typically, characterization studies were laid out in a grid pattern

with each sample composed of a 5 point composite. Water monitoring studies were done monthly or seasonally, again depending on the objective of the study. Ecological studies were done typically during nesting season with samples collected from wherever nests could be found. Post removal sampling of the soils and sediments from the wetlands were laid out in a grid pattern using 5 point composites. To measure progress toward ecological goals, macroinvertebrates were collected at various locations after each season where removals of contaminated sediments had occurred.

4. Known or suspected sources of contamination

The wetlands were contaminated from a variety of sources and the importance of each source varied widely with the specific area of the wetland. Both primary and secondary pathways of transport are important in this area. A summary of known sources of contamination is given in Table 7.3.

TABLE 7.3
SOURCES OF CONTAMINATION TO GREAT SALT LAKE WETLANDS

Location	Source of Contamination	Primary Transport Mechanism	Secondary Transport Mechanism
Kessler Springs	Refinery	Leaks from underneath old Precious Metals Building, dumping of electrolyte in EP Pond	Groundwater to springs
Tailings Pond Springs	Tailings Pond	Dewatering of pond by wicks and drain pipes	Surface water transport
Garfield Wells	Refinery	Leaks from underneath old Precious Metals Building, dumping of electrolyte in EP Pond	Groundwater to wells
Riter and Utah-Salt Lake Canals	Urban and agricultural lands	Urban and agricultural runoff	Surface water transport

Location	Source of Contamination	Primary Transport Mechanism	Secondary Transport Mechanism
Lee Creek	Urban and agricultural lands, landfills, Kennecott discharges	Urban, agricultural, landfill runoff, direct Kennecott discharges	Surface water transport
C-7 Ditch	Kennecott discharges of process waters and tailings pond decant waters	Direct discharges	Surface water transport
West C-7 Ditch	Tailings Pond	Discharge of water from wicks and drainage pipes on west side of tailings pond	Surface water transport
Clarification Canal	Tailings Pond	Discharge of water from decant pond in tailings pond	Surface water transport
East Hazelton	Smelter	Direct dumping of concentrates, runoff of contaminated smelter grounds, runoff from Kessler Canyon	Surface water transport
West Hazelton	Smelter	Sedimentation of smelter runoff water	Sedimentation and surface water transport
Weak Acid Lift Station and Pipeline	Smelter	Spills of weak acid	Surface water transport
Slag Pond and I-80 Pond	Smelter	Spills at smelter	runoff from spills and other smelter wastes
Wetlands Landfill	Assay Laboratory	Direct dumping	Potential leaching from wastes into surface and ground water

Location	Source of Contamination	Primary Transport Mechanism	Secondary Transport Mechanism
Smelter Return Canal	Smelter and Waste Water Treatment Plant	Direct discharge and spills	Surface water transport, sedimentation
Wooden Bridge Site	Acid Plant Wastes	Direct dumping	Potential leaching of acids into surface and ground waters
Garfield Wetlands	Refinery	Direct dumping, leaks from facility, dredge spoil dumping	Ground water transport to wetlands, followed by surface water transport within wetlands and out of wetlands, surface water transport of dredge spoils.
Smelter Wetlands	Smelter	Atmospheric fallout	Surface water transport
Eastside Wetlands	Tailings pond	Spills of tailings due to historic breaches in tailings pond dikes	Surface water transport and sedimentation
Great Salt Lake	All Kennecott facilities, urban and agricultural lands	Direct discharge of Kennecott process waste water and runoff	Surface water transport and sedimentation
Outfall 012	All Kennecott facilities	Direct discharge of excess Kennecott process waters and runoff	Surface water transport and sedimentation
Great Salt Lake Beach	All Kennecott facilities and nearby urban and agricultural lands	Direct discharge	Longshore and off shore transport of sediments, surface water transport

Location	Source of Contamination	Primary Transport Mechanism	Secondary Transport Mechanism
Saltair	Kennecott facilities, Interstate Highway	Ground water discharge under highway to beach (suspected, not proven)	Surface water transport, seepage, longshore and offshore transport
Marina	Smelter (suspected)	Atmospheric deposition on boats (alleged)	Surface water transport, longshore and offshore transport.

5. Types of contamination, quantities

The types of contamination found at the site and their quantities (if known) are summarized in Table 7.4.

TABLE 7.4
CONTAMINATION TYPES AND QUANTITIES TO GREAT SALT LAKE WETLANDS

Location	Source	Type of contamination	Quantity
No Name Springs	None	Minor	None
Kessler Springs	Refinery	Ground water	300 gpm for 15 years
Spitz Springs	None	Minor	None
Toronto Springs	None	Minor	None
Adamson Springs	Mills, GSL	Ground water	6000 gpm for 100 years
Toronto Springs	Tailings pond	Ground water (suspected)	Unknown
Tailings Pond Springs	Tailings pond interstitial waters	Ground water	Unknown
Section 17 well	None, yet	Minor	500 gpm, none
Golf Course Well	None, yet	Minor	2,600 gpm, none
Well 10			3000 gpm

Location	Source	Type of contamination	Quantity
Garfield Well #1			1000 gpm
Garfield Well #4	Refinery	Ground water	500 gpm
Garfield Well #5	Refinery	Ground water	500 gpm
Garfield Well #6	Refinery	Ground water	250 gpm
Garfield Well #8	Refinery	Ground water	250 gpm
Tooele Canal	None	None	6000 gpm, none
Riter canal	Agricultural and urban runoff	Surface waters	30,000 gpm
ROW Canal	Agricultural and highway runoff	Surface waters	Not calculated
East Lake	Formerly agricultural runoff	Surface water does not exist any longer	Unknown
Lee Creek	Agricultural, landfill and urban runoff	Surface water	Unknown
Kersey Creek	Agricultural runoff	Surface water	Unknown
C-7 Ditch	Tailings pond, refinery, smelter, mills	Surface water	Unknown
West C-7 Ditch	Tailings pond, refinery, smelter	Surface water	Unknown
Clarification Canal	Tailings pond	Surface water	Unknown
East Hazelton	Dump for smelter concentrates and wastes	Soils contamination	99,400 cy (159,040 tons)
West Hazelton	Sedimentation pond for smelter runoff and spills	Soils contamination	
Weak Acid Lift Station	Acid from blowdown	Soils contamination, from acid spills	9171 tons (5732 cy)

Location	Source	Type of contamination	Quantity
Weak Acid Pipeline	Acid from blowdown	Soils contamination, groundwater contamination from pipeline breaks	No removal needed
Slag Pond	Smelter runoff, spill containment	Sediment contamination, surface water	396,080 tons (247,600 cy removed, 35,000 cy left in place and capped)
I-80 Pond	Smelter runoff, spill containment	Sediment contamination, surface water	291,684 tons (182,302 cy)
Wetlands Landfill	Lab waste	A portion is RCRA Subtitle D	28,306 tons (17,691 cy)
Smelter Return Canal	Smelter runoff, spills	Sediments, water	356,052 tons (222,532 cy)
Wooden Bridge	Dump of acid wastes	Probably was RCRA Subtitle D.	See Smelter Return Canal
Garfield Wetlands 1, 2, and 3	Ground water, spills, dumps, runoff	Soils, waters	68,954 tons (49,780 cy)
Marshes 1, 2, and 3	Ground water, spills, dumps, runoff	Soils, waters	None
Ponds 1, 2, 3, 4, 10a, 10b, 11, 12	Ground water, spills, dumps, runoff	Soils, water	None
Sample Unit 1	Ground water, runoff		None
Freeway off ramp pond	Ground water, highway runoff		None
Smelter wetlands	Ground water, atmospheric deposition	Soils, water	Unknown
Sample Unit 2 - Eastside Wetlands	Tailings from breaks in tailings pond dikes	Soils	Unknown

Location	Source	Type of contamination	Quantity
Great Salt Lake	Tailings pond, smelter, refinery, mills	Sediments, water	Unknown
Outfall 012	Tailings pond, smelter, refinery, mills	Direct discharge to Great Salt Lake	10,000 gpm in winter
Great Salt Lake Beaches	Great Salt Lake sediments	Beach sediments	Unknown
Saltair	Seeps, Great Salt Lake sediments	Beach sediments, seeps	Unknown
Marina	Atmospheric fallout	Deposition	Unknown

6. Location of contamination, exposures

The contamination in the Kennecott North Zone wetlands and adjacent Great Salt Lake was scattered in ponds, dumps, and wetlands throughout the area. In the wetland areas to the south of Interstate 80, access is limited; therefore, exposure of people to the hazardous substances in the wetlands was not a prime issue. The issue was exposure to the shoreline birds via their food. On the north side of the highway, it is possible that people could have been exposed to hazardous material which migrated from Kennecott operations to the Great Salt Lake and its beaches. The Great Salt Lake is used recreationally for boating and wading. But of even more concern is the Great Salt Lake as a habitat for wildlife including birds, brine shrimp, algae, and brine flies (which are food for the birds). As a part of the ecological risk assessment, a series of bioassay experiments were conducted to determine the potential impact of site-related contaminants to the flora and fauna of the Great Salt Lake (see Section 1).

D. Scope and Role of Operable Unit

Operable Unit 22 (Great Salt Lake and wetland areas) is the receiving area for most of Kennecott's waterborne discharges including waters from the Magna Tailings Pond (OU15), the smelter (OU13), the refinery (OU14), the Waste Water Treatment Sludge Ponds (OU8) and the groundwater which discharges into the wetlands (OU23). It is a particularly important operable unit of the Kennecott North Zone because this is the area where most of the exposures to wildlife, especially birds, was occurring. And because of the variety of sources, the complexity of abating the exposure was particularly challenging.

E. Current and potential Future Site and Resource Uses

The wetland areas down gradient of Kennecott operations have been used for a variety of purposes in the past, including the mining of oolitic sands for use as flux at the smelter, a dumping ground for smelter and refinery wastes, a storage area for process waters and storm waters, and storage for smelter operations. Today the area is still used for some industrial operations, including pump stations and storage for fresh water for use at the smelter.

The remainder of the area is low-lying open space with a variety of habitats including perennial and ephemeral ponds, marsh and salt playa. These wetlands provide nesting and foraging sites for wildlife. The area is especially important for migratory shorebirds and, to a lesser extent, for ducks and blackbirds. Part of the area is classified as jurisdictional wetlands.

While Kennecott smelting and refining operations are on-going, this pattern of use is not likely to change much, but Kennecott has some interest in leasing a portion of these lands to other industries. The footprint of the slag pile and the area between the Smelter Return Canal and SH 201 (Garfield Wetlands Area 1) may also be appropriate for industrial use. Because this is the entry point of substantial amounts of selenium to the wetlands, these wetlands might be an attractive nuisance to wildlife. Its continued use as a wetland is inadvisable. With appropriate fill, this area could be used for light industrial purposes, and might be especially attractive for industry seeking close access to highways and rail.

This entire area is zoned M-2 Manufacturing.

Kennecott has just begun to explore options for future use of the wetlands area after mining ceases. In order to explore the various options, Kennecott sponsored a "Resources Roundtable" on November 15, 2000. Participating at these discussions were experts in business, real estate, land use planning, environment, tourism specialists, and neighbors from Magna. The all-day discussions were held at Saltair. Approximately 76 experts participated. The experts had a wide variety of ideas, but there were some common themes. (1) The smelter and refining operations may still be viable using feedstock from other mines. (2) The presence of nearby rail and highways make the site an attractive site for intermodal transfer operations, where rail containers could be loaded onto trucks or vice versa. Salt Lake is an important marshalling yard for rail traffic, but additional space in Salt Lake is limited. (3) The wetlands and the nearby Great Salt Lake form a very attractive entry point into the Salt Lake Valley. This resource could be exploited for its tourism, educational and research value.

F. Summary of Site Risks

1. Chemicals of Concern.

The concentrations of chemicals of concern in the Great Salt Lake Wetlands near Kennecott are given in Table 7.5 (sediments) and Table 7.6 (water).

TABLE 7.5
CONCENTRATIONS OF CONTAMINANTS IN SEDIMENTS AT OU 22
(units are mg/Kg, dry weight)

Location	Arsenic Concentrations		Lead Concentrations		Selenium Concentrations	
	maximum	mean	maximum	mean	maximum	mean
Lee Creek at GSL (EPA, 1995)		28		54		Not analyzed
C-7 Ditch at GSL (EPA, 1995)		38		39		Not analyzed
C-7 Ditch at GSL (USFWS, 2000)	50.8	48.8	62.6	60.3	6.48	5.24
East Hazelton (pre-removal)	807	241	41300	4185	64.5	15.9
West Hazelton (pre-removal)	735	203	1710	529	10.4	1.2
Hazelton (1988, pre-removal)	3300	1695	48	26.5	327	166

Location	Arsenic Concentrations		Lead Concentrations		Selenium Concentrations	
	maximum	mean	maximum	mean	maximum	mean
Hazelton (1999, pre-removal)	1730	233	84,000	4949	202	16.1
Hazelton (1999, post-removal)	640	131	39,600	2629	83.2	2.0
Hazelton (1999, post-reclaim)	5.8	0.9	167	55.9	<0.5	<0.5
Slag Pond (1979, pre-removal)	2000		20,000		120	
Slag Pond (1988, pre-removal)	520	250	1260	794	50	20
Slag Pond (1993, pre-removal)	910	356	4200	1363	300	30
Slag Pond (1993, pre-removal)		291		1235		15
Slag Pond (2000, pre-removal)	455	313	1150	431	73	60
Slag Pond (2001, pre-removal)	1569	377	2211	412	32.1	6.1
Slag Pile soils and Slag Pond (pre-removal)	1730	889	535,000	3099	202	32.4

Location	Arsenic Concentrations		Lead Concentrations		Selenium Concentrations	
	maximum	mean	maximum	mean	maximum	mean
Slag Pond (2001, post-removal)	122	17.4	142	14.9	8.9	2.4
East Slag Pond (I-80 Pond, 1988, pre-removal		120		4		6
East Slag Pond (I-80 Pond, 1993, pre-removal)		550		1746		169
I-80 Pond (1999, pre-removal)	1340	413	1480	176	19.2	0.7
I-80 Pond (2000, pre-removal)	2430	179	2032	156.3	139	6.7
I-80 Pond (post-removal)	132	32.3	119	15.5	9.9	1.8
Wetlands Landfill (pre-removal)	204	75.1	1930	423.5	996	120.7
Wetlands Landfill (post-removal)	38.9	14.1	84.1	13.8	8.7	2.2
Smelter Return Canal (pre-removal)	6724	425	4375	619	1032	13.2

Location	Arsenic Concentrations		Lead Concentrations		Selenium Concentrations	
	maximum	mean	maximum	mean	maximum	mean
Smelter Return Canal (post-removal)	276	28.7	552	39.4	52.5	1.5
East Wooden Bridge (pre-removal)	154	70.6	911	266	<0.5	<0.5
West Wooden Bridge (pre-removal)	691	202	591	270	5.6	1.4
Wooden Bridge (post-removal)	8.7	8.7	17.3	17.3	3.6	3.6
Garfield Wetlands (1988)	700	443	312	247	42	30
Garfield Wetlands Area 1 (1999)	846	72.5	1240	428	895	36.4
Garfield Wetlands Area 1	519	143.4	1250	639	150	19.2

Location	Arsenic Concentrations		Lead Concentrations		Selenium Concentrations	
	maximum	mean	maximum	mean	maximum	mean
Garfield Wetlands Area 2	849	146	1400	374	295	42
Garfield Wells Soils (pre-removal)	1248	297	1638	659	424.8	86.6
Garfield Wells Soils (pre-removal	611	79.7	1290	216.9	21,900	567
Garfield Wells Soils (post-removal)	32.6	10.4	36.6	3.9	16.4	3.8
Garfield Wetlands Area 3	188	26.2	1080	232	<0.5	<0.5
Marsh Area 1	1360	396	990	529	102	30.6
Marsh Area 2	140	115	253	197	16.8	11.4
Marsh Area 3	409	224.7	1010	699.8	21.6	13.3
Pond 1	436	252	1440	745	20.6	11.9
Pond 2	33.3	33.3	236	236	6.2	6.2
Pond 3	74.9	49.0	75	45	<0.5	<0.5
Pond 4	174		209		12.7	
Pond 10a	137	109	363	194	7.4	3.4
Pond 10b	169	96.4	240	192	6.2	4.8

Location	Arsenic Concentrations		Lead Concentrations		Selenium Concentrations	
	maximum	mean	maximum	mean	maximum	mean
Pond 11 (pre-removal)	56.4	32.3	310	118.5	22.3	8.8
Pond 12 (pre-removal)	155	146.5	8450	4940	<0.5	<0.5
Sample Unit 1	56.4	35.1	310	205	22.3	21.4
Spitz Springs Soils	552	287	384	199	<0.5	<0.5
Freeway off-ramp pond	56.9	28.8	37.8	27	<0.5	<0.5
Smelter Wetlands (1988)	124	70	440	152	7	4
Eastside Wetlands	291.5	21	295.5	64.2	33.6	2.2
Great Salt Lake (1979)	230	106	60	34	Not determined	Not determined
Great Salt Lake (1988)	62	28	170	57	4	<1
Great Salt Lake (USFWS, 2000)	29.6	17.6	129	51.4	2.52	1.71

Location	Arsenic Concentrations		Lead Concentrations		Selenium Concentrations	
	maximum	mean	maximum	mean	maximum	mean
Great Salt Lake Beaches (EPA, 1995)		14		35		Not analyzed
Great Salt Lake Beach State Park (USFWS, 2000)	44.6	44.6	108	108	3.56	3.56
Saltair (EPA, 1995)		12		29		Not analyzed
Saltair (USFWS, 2000)	49.6	48.0	46.7	42.9	2.17	1.59
Marina (EPA, 1995)		14		28		Not analyzed

TABLE 7.6
WATER QUALITY IN THE GREAT SALT LAKE WETLAND WATER SOURCES AND PONDS (units = mg/L)

Location	arsenic concentrations		lead concentrations		selenium concentrations	
	max	mean	max	mean	max	mean
No Name Springs	<0.005*	<0.005*	<0.005*	<0.005*	0.020	0.003
Kessler Springs	0.10*	0.05*	<0.005*	<0.005*	2.5	1.2

Location	arsenic concentrations		lead concentrations		selenium concentrations	
	max	mean	max	mean	max	mean
Spitz Springs (1991-2)	0.126	0.021	0.24	0.005	0.025	0.011
Spitz Springs (2000-2002)	0.031*	0.026*	<0.005*	<0.005*	0.003*	0.002*
Adamson Springs (1991-2)	0.083	0.041	0.022	0.006	0.017	0.006
Tailings Pond Springs	See clarifi-cation canal					0.025
Section 17 Well	0.016*	0.011*	<0.005*	<0.005*	0.023*	0.011*
Golf Course Well (1999-2002)	0.013*	0.009*	<0.005*	<0.005*	0.016	0.006*
Well 10	0.012*	0.009*	<0.005*	<0.005	0.005	0.002
Garfield Well 1 (1994)		<0.005*		<0.005*		0.012*
Garfield Well 1 (1999-2002	0.022*		<0.005*		0.018*	
Garfield Well 4 (1994)		0.011*		<0.005*		0.25*

Location	arsenic concentrations		lead concentrations		selenium concentrations	
	max	mean	max	mean	max	mean
Garfield Well 4 (1999-2002)	0.033*	0.018*	<0.005*	<0.005*	0.456*	0.157*
Garfield Well 5 (1994)		<0.005*		<0.005*		0.645
Garfield Well 5 (1996)						>1.0
Garfield Well 5 (1997)						0.630
Garfield Well 5 (1999)						0.250
Garfield Well 5 (1999-2002)	0.025*	0.013*	<0.005*	<0.005*	0.260*	0.171*
Garfield Well 6 (2002)	0.016*	0.007*	<0.005*	<0.005*	<0.002*	<0.002*
Garfield Well 8 (2002)	0.016*	0.012*	<0.005*	<0.005*	<0.002*	<0.002
Tooele Canal (2002)		0.017		<0.005		0.003
Riter Canal (1991-2)	0.044	0.024	0.043	0.009	0.013	0.007

Location	arsenic concentrations		lead concentrations		selenium concentrations	
	max	mean	max	mean	max	mean
Riter Canal (1972-3)	0.060*	0.026*	0.003*	0.003*	<0.005*	<0.005*
Utah and Salt Lake Canal (1991-2)	0.052	0.025	0.024	0.005	0.012	0.005
ROW Canal (1991-2)	0.123	0.55	0.030	0.008	0.024	0.010
Lee Creek (1971-1983)	0.775	0.197	0.170	0.057	0.021	0.004
Lee Creek (1979)		0.196				
Lee Creek (1991-2)	0.201	0.065	0.057	0.011	0.032	0.004
Kersey Creek (1991-2)	0.167	0.050	0.257	0.029	0.049	0.008
Kersey Creek (1980-2)	0.033	0.029	0.055	0.023	0.001	0.001
C-7 Ditch (1979)		0.577				
C-7 Ditch (1988)		0.023		0.018		<0.004
C-7 Ditch (1979-1992)	5.400	0.415	0.050	0.012	0.267	0.011
C-7 Ditch (1991-2)	0.099	0.045	0.043	0.013	0.033	0.017

Location	arsenic concentrations		lead concentrations		selenium concentrations	
	max	mean	max	mean	max	mean
West C-7 Ditch (1991-2)	0.126	0.049	0.019	0.011	0.084	0.061
Clarification canal (1991-2)	0.050	0.016	0.012	0.004	0.053	0.033
Clarification canal (1975-1994)	0.010	0.004	0.058*	0.014*	0.170*	0.023*
Hazelton (1988)	1.67	0.864	0.043	0.032	0.050	0.037
Slag Pond (1979)		1.5		0.14	Not determined	Not determined
Slag Pond (1988)	0.257	0.121	0.037	0.016	0.026	0.014
Slag Pond (1993)		0.090*		<0.005*		0.003*
Slag Pond (2000)	0.047*	0.018*	<0.005*	<0.005*	0.019*	0.012*
I-80 Pond (1980)		1.4		0.170		0.004
I-80 Pond (1988)	1.257	0.401	0.026	0.006	<0.004	<0.004
I-80 Pond (1993)		0.027*		<0.005*		0.010*
Smelter Return Canal (2001)		0.063*		<0.005*		0.026*

Location	arsenic concentrations		lead concentrations		selenium concentrations	
	max	mean	max	mean	max	mean
Garfield Wetlands (1988)	0.110	0.082	0.100	0.039	0.029	0.017
Garfield Wetlands (1997)						0.040
Garfield Wetlands (1999)	0.770*	0.082*	<0.005*	<0.005*	0.155* (hydride) 1.600* (ICP-MS)	0.013* (hydride) 0.238* (ICP-MS)
Garfield Wetlands (1999)						<0.002
Smelter wetlands (1980)		0.040		0.16		0.18
Smelter wetlands (1988)	0.090	0.061	0.008	<0.005	0.012	0.006
Smelter wetlands - Pond 12 (1997)		0.239				
Smelter wetlands - Pond 12 (1998)		0.310				
Smelter wetlands - Pond 12 (1999)		<0.005				
Freeway Pond (1980)		0.33		0.30		0.60

Location	arsenic concentrations		lead concentrations		selenium concentrations	
	max	mean	max	mean	max	mean
Great Salt Lake (1979)		0.235				
Great Salt Lake (1988)	0.120	0.085	0.054	0.031	0.032	0.007
Outfall 012	0.078	0.049	<0.005	<0.005	0.051	0.038

*dissolved fraction

G. Removal/Remedial Action Objectives

1. Eliminate or reduce the concentrations of hazardous substances in wetland habitats to reduce exposures to wildlife

2. Eliminate or reduce the concentrations of hazardous substances discharged into the Great Salt Lake

H. The Selected Remedy

The discharges of the various outfalls such as the Riter Canal, the Utah and Salt Lake Canal, the C-7 Ditch, the West C-7 Ditch, the Clarification Canals, and the discharges from the wetlands, all of which discharge directly or indirectly to the Great Salt Lake now come under the provisions of a UPDES permit which was recently renewed and included discharge limitations on selenium. The CERCLA actions were designed to lower the contaminants in the waters being discharged to the Great Salt Lake and into the wetlands. It was necessary to limit the concentrations in the Great Salt Lake and the wetlands so that these areas would become suitable habitat for wildlife, especially birds. There was a great deal of coordination between the UPDES program of UDEQ and the CERCLA program of EPA. CERCLA aided the UPDES program by conducting toxicity testing studies to determine what discharge limits would be appropriate. The UPDES implemented the permit limits and requires routine monitoring of the discharges to insure that the limits are met by Kennecott. The actions taken using CERCLA authorities and oversight are given in Table 7.7. In summary, about 825,040 cy of contaminated sediments were removed from the ponds and wetlands over a three year period from 1999 - 2001. The sediments were dried and placed in the Arthur Stepback Repository where they no long pose a threat to the wildlife of the wetlands.

TABLE 7.7
PREVIOUS CERCLA ACTIONS IN THE GREAT SALT LAKE WETLANDS

Location	Action	Objective
Garfield Well 5	Reroute flow to process water circuit	Remove selenium inputs to the wetlands
Kessler Springs	Intercept springs then direct it to West C-7 Ditch. Later the spring water was directed to the process water circuit for "treatment"	Remove selenium inputs to the wetlands, lower the selenium inputs to the Great Salt Lake.
East Hazelton	Removal of accumulated contamination in soils and sediment	Remove potential source of contaminants to the wetlands
West Hazelton	Removal of accumulated contamination in soils and sediment	Remove potential source of contaminants to the wetlands
Weak Acid Lift Station	Removal of contaminated soils	Demolish plant and remove any potential sources
Weak Acid Pipeline	No action	No action needed
Slag Pond	Removal of accumulated contamination in the sediments	Remove contaminants in the wetlands
I-80 Pond	Removal of accumulated contamination in the sediments	Remove contaminants in the wetlands
Wetlands Landfill	Removal of wastes	Remove potential source of contaminants to the wetland
Smelter Return Canal	Removal of contaminated sediments and dredge spoils dumped near the canal	Remove potential source of contaminants to the wetlands
Wooden Bridge	Removal of dumps	Remove potential source of contaminants to the wetlands

Location	Action	Objective
Garfield Wetlands 1, 2, and 3	Removal of most severely contaminated sediments in the wetlands	Remove contaminants in the wetlands
Marsh 1, 2, and 3	No action	
Ponds 1, 2, 3, 4, 10a, 10b, 11, 12	No action except in Hazelton Area	
Sample Unit 1	Removal of contaminated sediments	Remove contaminants in the wetlands
Freeway off ramp pond	No action taken	Concentrations of contaminants not high enough to pose a threat
Smelter wetlands	No action taken	Concentrations of contaminants not high enough to pose a threat
Sample Unit 2	No action taken	Concentrations of contaminants not high enough to pose a threat
Great Salt Lake	No action taken (cooperation with UPDES to limit future discharges to lake)	Deferred to another authority for implementation and monitoring
Great Salt Lake Beach	No action taken	Concentrations of contaminants not high enough to pose a threat
Saltair	Culvert installed underneath highway to drain excess waters from I-80 and Slag Ponds (action taken in a private settlement agreement with Kennecott, Saltair and the Utah Dept. of Transportation	Curtail seepage of potentially contaminated waters, eliminate nuisance ponding on beach
Marina	No action taken	New smelter emissions much lower than previous smelters.

In addition, to the removal of accumulated contaminated sediments in the wetlands,

steps were taken to improve the water quality of the water sources to the wetlands. Interim measures included the rerouting of Garfield Well No 5 and Kessler Springs discharges to the process water circuit. The effect of these changes has been effective over the last few years in reducing selenium discharges to the wetlands and the Great Salt Lake as demonstrated in Table 7.8.

TABLE 7.8
IMPACT OF ABATEMENT OF WATER-BORNE SELENIUM SOURCES ON DISCHARGES TO THE GREAT SALT LAKE, MASS BALANCE CALCULATIONS

Year	Action	Selenium discharges to Great Salt Lake
1999	Well and Spring waters directed away from wetlands to West C-7 Ditch	6055 lbs/year
2000	Well and Spring waters directed to process water circuit in April, 2000; Direct outfall to GSL constructed	2647 lbs/year
2001	More process waters directed to the new GSL outfall	1228 lbs/year

Although the interim measures have been effective in reducing the selenium discharges to the Great Salt Lake and completely eliminating the spring and well sources of selenium to the wetlands, this is only possible while the mining operations continue. Use of the process water circuit for treatment will not be possible after mining and milling operations cease and the process water option is no longer available. See OU 23 for post-closure treatment options.

After the cleanup of the sediments and the abatement of water pollution sources, most of the wetlands were recently restored and habitat improved for shoreline bird habitat. Restoration projects included building islands in the open waters to increase shoreline habitat and to provide protection from predators. Also, the shoreline was recontoured to provide inlets and curvy shores to increase the shoreline habitat. Finally, the wetlands were revegetated with an emphasis on native wetlands plants to reduce the former predominance of phragmites.

Scientists agreed that the most serious toxicity problem in the wetlands was the selenium which concentrated in bird eggs and has been strongly linked to birth defects of the chicks at other locations. Because the relationship of water quality, sediment quality, and bird egg selenium is uncertain at this site, governmental and industry investigators could not

directly derive a site-specific action level for selenium concentrations in either the sediments or the water. A more direct relationship is the relationship between the selenium in the diet and the selenium in the bird eggs. The primary diet of the shorebirds of this area is macroinvertebrates (insects, larvae, benthic organisms).

Therefore, the goal of this project is to clean up the sediments and water sufficiently to produce macroinvertebrates (bird food) with low concentrations of selenium in accordance with Table 7.9.

TABLE 7.9
GOALS FOR WETLANDS CLEANUP PROJECT

Category	Range of Concentrations of selenium in macroinvertebrates (bird food) in ppm, dry weight	Action
Acceptable	0 - 5 ppm Se	No action needed
Warning	5 - 10 ppm Se	Increased monitoring frequency and number of sampling locations
Unacceptable	>10 ppm Se	Determine additional sources and abate sources, perform additional sediment removals, and/or provide cleaner water to wetlands.

The goals for macroinvertebrate selenium concentrations are meant to be a benchmark. Because there are annual variations in the habitat (acres of saline playas, water depth, and other non-toxic issues), a general trend should be determined. For example, if the insects in one sampling location are consistently above 10 ppm Se for three years in a row, investigators should determine what makes that location unique relative to the other locations with acceptable levels and reduce the exposures accordingly (either sediments, vegetation, water, or all). If the maximums occur only occasionally, or varies in location each year, the situation bears vigilance, and an attempt to discover special events at that location, but no action or disturbance of the ecosystem.

The details of the monitoring program will be developed during remedial design. The objectives of the monitoring program is to identify the remaining sources of selenium (if any), evaluate the effectiveness of the sediment and soil removals, evaluate the effectiveness of the spring and well water diversions, and develop a site-specific water quality goal for selenium. The monitoring plan will include all North Zone wetlands including the triangle formed by

SH-202, SH-201, and I-80, the Spitz Springs Area, the Eastside Wetlands, and the Japanese Springs Wetlands.

If a site-specific water quality goal can be developed as part of the monitoring activities, it can be used in lieu of the macroinvertebrate selenium standards.

Should the monitoring program reveal a continuing selenium exposure problem in the area of Kessler Springs, further cleanup of this area will be needed. An acceptable alternative in this case is to change the land use from wetland habitat to upland habitat or industrial use.

Section 8: North End Ground Water (Kennecott North Zone OU 23)

A. Site Name, Location and Description

1. Site Type and description of operable unit

The North End Ground Water operable unit describes the ground water underneath a number of the Kennecott facilities. Located along the northern end of the Oquirrh Mountains close to the shores of the Great Salt Lake, this operable unit is composed of several ground water plumes originating mainly in the vicinity of Kennecott's smelter (OU13) and refinery (OU14) from whence the plumes travel in the direction of the Southshore Wetlands (OU22). In one case, the plume comes to the surface via springs and seeps which formerly discharged into the wetlands. A diagram is given in Figure 8.1.

2. Facilities located within OU 23

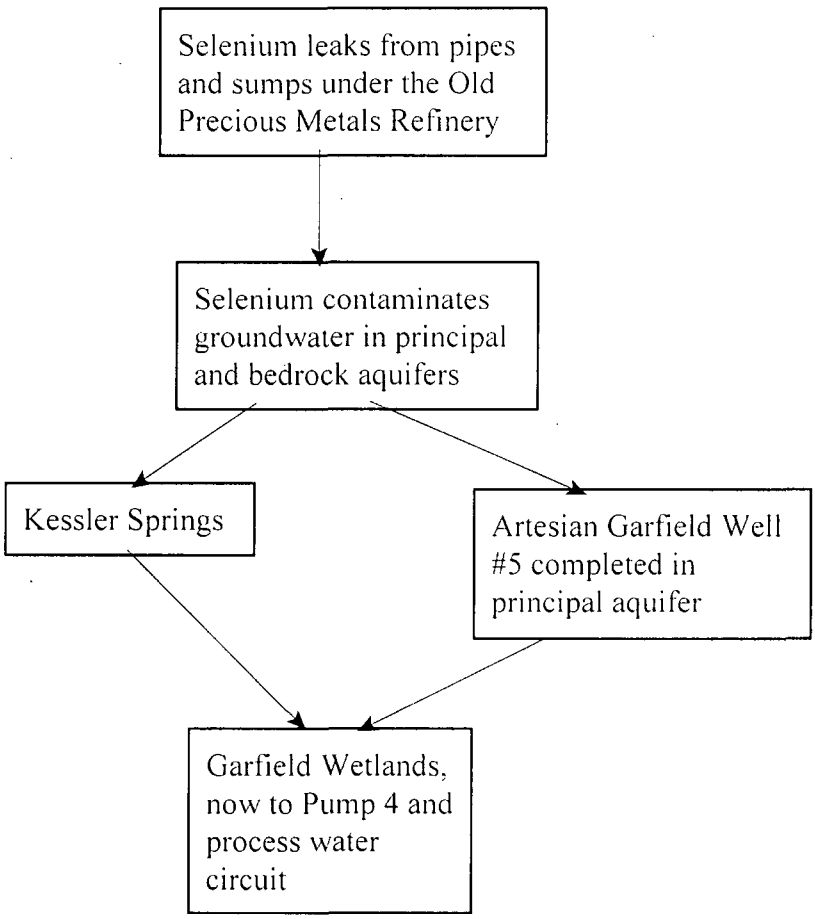
The North End Ground Water Plumes underlie a number of Kennecott facilities and former facilities. Included are the smelter and associated acid plants (OU13), the refinery (OU14), the south shore wetlands (OU22), the Slag Pile (part of OU13), the Slag Pond (part of OU22), the former Waste Water Treatment Plant and Sludge Ponds (OU8), Praxair (an adjacent plant near the smelter), and the Magna Tailings Impoundment and North Expansion (OU15).

B. Site History and Enforcement Activities

1. Activities at the site which led to contamination

Contamination entered the ground water at several locations, but the major contaminated areas are located at or near the smelter and refinery. There are two areas of selenium contamination in the principal aquifer at the refinery, one starting in the vicinity of the former precious metals refinery building, and a minor area near the waste water treatment plant sludge pond C. There were isolated pockets of ground water contamination in the wetlands close to waste water treatment plant sludge ponds A and C, in the wetlands near Kessler Springs, and on the south side of the highway between the refinery and the wetlands. An arsenic plume in the principal aquifer starts in the vicinity of the refinery evaporation pond and there are pockets of arsenic contamination in the shallow aquifer near the smelter return canal and Pond A. An area of high sulfate in the ground water of the principal aquifer was found along the edge of the South Tailings Impoundment close to Pond B and near the smelter return canal.

Figure 8.1: SELENIUM INPUTS TO WETLANDS VIA GROUND WATER



There were 4 areas of selenium contamination in the principal aquifer at the smelter. The largest plume there was down gradient of the former historic reverberatory smelter. Other areas were located close to the Noranda smelter acid plants, the slag mill area, and along the slag bluff on the south side of the highway. An arsenic plume in the principal aquifer starts in the area of the former acid plants down gradient of historic flues associated with the reverberatory smelter. Contamination in the shallow aquifer was found along the slag bluff and under the slag lagoon. An area of high sulfate in the principal aquifer ground water was found under the entire smelter complex and a very high concentration of sulfate was found associated with the acid tank farm near Praxair.

The activities which led to the contamination at these locations have been previously described in earlier chapters describing the surface conditions and spill histories at the refinery and smelter. In summary, the plume of selenium starting at the refinery was probably due to leaks of pipes underneath the precious metals refinery. Extremely high concentrations of selenium were found at the footprint of the refinery following demolition. The location of the highest concentrations (nearly pure selenium) was found in an area where selenium was recovered from the refinery slimes. The shear volume of the soils contamination and the ground water contamination suggests that the leakage in the selenium recovery process circuit went on for several years.

A plume with elevated arsenic at the refinery apparently starts in the vicinity of the refinery evaporation ponds. In the early days of refinery operations, spent electrolyte and other contaminated waste waters were simply piped to a topographic low spot behind the refinery and allowed to evaporate. Subsequent studies revealed that evaporation was not a major factor. The water seeped into the ground. Insoluble components (such as gold and silver) precipitated out, but the more soluble components entered the groundwater. This dumping persisted for several years and soils were contaminated down to groundwater 45 feet or more.

At the smelter, the groundwater was contaminated with arsenic, selenium, and sulfate. The source of the selenium at the smelter can only be conjectured at this point. The slope behind the reverberatory smelter was a well-known dumping ground and storage area at one time. Kennecott investigators speculate that some refinery slimes, perhaps off-specification, were stored behind the smelter prior to recycling. The area behind the smelter was also used to thaw the concentrates prior to smelting. The water which had accumulated in the railroad cars was simply allowed to drain onto the ground behind the smelter. The pocket of selenium contamination close to the Noranda acid plants probably came from spills of weak acid waste water, a rather common event (see spill list for OU13).

The pocket of selenium contamination close to the slag mill probably came from the former slag concentrate thickener where waste water spilled out from time to time. The area of contamination along the slag bluff probably came from water which had percolated through the slag deposit. There are several former seeps along this bluff.

The arsenic in the groundwater near the reverberatory smelter probably originated as flue dusts which were leached with water from leaks in the air handling system (flues, underground mixing chambers, etc.). Flue dust is very high in arsenic and is extremely leachable. The arsenic near the acid plant probably came from the spills of weak acid or leaks in the Noranda air handling system. The whole smelter area groundwater is contaminated with sulfate, undoubtedly from the numerous sulfuric acid and weak acid spills at the site over the years. The very high sulfate in the acid tank farm area originated from a failure of one of the acid storage tanks on site. (This incident is being addressed by a RCRA corrective action.)

There were other pockets of contamination in the wetlands downgradient of the smelter and refinery. The groundwater contamination in the shallow aquifer near the sludge ponds came from leaching of the selenium and arsenic from the sludge into the underlying soils. Pockets of contamination near the smelter return canal came from either the contaminated water in the canal or from the dredge spoils dumped along the side of the canal. Again, a full history of each of these areas is described in the preceding chapters of this Record of Decision.

2. Investigations, cleanup activities, enforcement

Kennecott conducted several studies of the ground water problems at the North End, primarily to support various operating permit applications. A summary of these studies is given in Table 8.1.

TABLE 8.1
GROUND WATER INVESTIGATIONS AT THE SMELTER AND REFINERY

Date	Study	Authority
1992	Hydrogeologic Report for the Great Salt Lake Area	State Ground Water Permit application
1994	Phase I Remedial Investigation for the Kennecott Utah Copper Refinery	Determine extent and seriousness of soils contamination at the refinery prior to initiation of CERCLA removals and investigations.

Date	Study	Authority
1995	Estimates of Background Concentrations of Metals and Non-metals in water, Kennecott Utah Copper Corporation, North Area, Salt Lake Valley	Support for State Ground Water Permits and later RI/FS. The approach used here had been previously used and approved for the South End ground water plume CERCLA studies.
1995	Final Environmental Impact Statement, Tailings Modernization Project, Kennecott Utah Copper	Gather needed information to support issuance of a Clean Water Act 404 permit from the Army Corps of Engineers.
1998	Selenium Ecological Risk Assessment for the South shore Wetlands, and other ecological risk documents	Support for the RI/FS, also used for UPDES permit renewal application.
1999	Non-residential preliminary remediation goals for the Kennecott sites	Support for the RI/FS
2000, 2001	Remedial Investigation and Feasibility Study Reports	CERCLA RI/FS

The cleanups of the surface wastes, some of which led to ground water contamination problems, are described in the preceding chapters. Several interim measures to address either the groundwater itself or to lessen the impacts of the groundwater plume on the wetland areas were instituted, usually shortly after the problems were identified. All of these interim measures were approved by EPA prior to installation.

When the selenium discharges to the wetlands from the Garfield Well # 5 were discovered, Kennecott directed this discharged to the West C-7 Ditch so that the selenium would go into the Great Salt Lake rather than further degrade the water quality in the wetlands - a known habitat for birds. Although at the time, there were no selenium discharge limits to the Great Salt Lake imposed by the UPDES program, the Army Corps of Engineers had imposed a limit of 200 ppb Se as a part of the CWA 404 permit. Before the selenium from Garfield Well #5 was added to the West C-7 Ditch calculations confirmed that the additional selenium inputs from the well would not cause a violation of the CWA 404 permit.

Likewise, when the Kessler Springs discharge was re-discovered and found to have extremely high concentrations of selenium, it too was re-directed away from

the wetlands. This discharge afforded an opportunity to test what the selenium would do in Kennecott's process water circuit. The addition of this relatively small discharge to the process water would not be noticeable given the large volume of water within the process water circuit. Kennecott did discover that the reduction of selenium concentrations was not due to dilution alone. The iron in the tailings slurry had adsorbed the selenium and the selenium had settled out with the tailings in the North Tailings Impoundment. Again, the differences could not be measured in the pond itself because of the high volumes.

Likewise, investigators have found that the tailings slurry is also effective in adsorbing arsenic. A pumping well in the heart of the arsenic plume at the smelter has been installed and has been pumping since 2001. The water is discharged into the process water circuit.

The cleanup activities associated with the sulfuric acid spill at the acid tank farm continue. A recovery trench was dug at the boundary of the site and the plume is shrinking. This activity is being conducted under the provisions of a RCRA corrective action.

The RI/FS which was conducted at the site was not the result of a CERCLA enforcement action, but rather was a provision included in the Memorandum of Understanding signed by EPA, UDEQ and Kennecott in 1995. Although there was no order, the work was supervised by EPA and UDEQ with the help of the USGS.

The surface removals which addressed the sources of the groundwater contamination were done under the provisions of an Administrative Order on Consent. This work began in 1995.

C. Site Characteristics

1. Size, topography

When all of the areas underlain by plumes are added together, the size of the area of interest is about 500 acres in size. As described in the Remedial Investigation report, the project area is located between the northern end of the Oquirrh Mountains and the southern shore of the Great Salt Lake in north-central Utah in the eastern part of the Lake Bonneville Basin of the Great Basin physiographic province. Steep slopes cut by moderately deep gulches and rounded ridges characterize the northernmost edge of the Oquirrh Mountains. From south to north the geology of the project area changes from bedrock outcrops to alluvial deposits, which decrease in elevation to lacustrine clays in wetland surrounding the southern shore of the Great Salt Lake. The refinery and smelter are located on

a former Lake Bonneville shoreline terrace at elevations of 4380 and 4350 feet amsl, respectively; the elevation of the Great Salt Lake is currently about 4198 feet amsl.

2. Surface and subsurface features

The surface of the area impacted by the ground water contamination is occupied by heavy industrial activities. The refinery complex is composed of a very large electrolytic refining facility with concrete tanks filled with electrolyte to which copper anodes from the smelter are added along with cathode starter plates. The entire facility is highly automated using robotic carts. Adjacent to the tank house is the materials handling building where the cathode copper plates are broken loose from the starter plates, and the copper plates are corrugated and bound for shipment by rail to customers. Associated with the facility is a precious metals recovery building where sequential extractions purify gold, silver and other precious metal byproducts. The former precious metals building footprint is between the tankhouse and the new precious metals operations. It used pyrometallurgical techniques to purify the gold and silver byproducts. Associated with the operations buildings are several administrative and support facilities.

As described in the Remedial Investigation Report, the refinery is situated on a lacustrine terrace which was deposited at the base of the Oquirrh Mountains during the Lake Bonneville lake cycle. The Lake Bonneville lake cycle was responsible for wave-cut benches and shoreline erosion observed in the area of the refinery. The unconsolidated Quaternary and Tertiary sediments beneath the refinery consist of alternating beds of fine-grained lake and deltaic deposits that lie on eroded coarse grained sediment (colluvium) from the Oquirrh Mountains. The majority of the colluvium consists of carbonate and clastic rocks of the Pennsylvanian Erda formation. The Erda Formation is highly brecciated in this area due to the Black Rock and Pony Express thrust faults that have been mapped northwest of the refinery. The sediments beneath the refinery consist of angular sand and gravel deposited on about 15 to 20 feet of interlayered highly organic lacustrine clay and silt and thin layers of silty sand and poorly graded sand. The bedrock underlying the sediments in the refinery area is composed of folded and faulted Paleozoic quartzites, limestones and dolomites that are intruded by Tertiary rocks which have been subsequently uplifted and tilted by Plio-Pleistocene Basin and Range faulting. Consequently the bedrock in the Oquirrh Mountains has been highly fractured. Depth to bedrock varies beneath the refinery due to the shape of the canyon in which it is situated. Generally, depth to bedrock is about 65 feet at the southern boundary of the refinery and 310 feet at the northern boundary.

The principal aquifer in the refinery area is recharged from waters in the fractured

bedrock. It is unconfined near the mountains, but becomes confined under the wetlands adjacent to the refinery. The head of water from the mountains creates an upward gradient in the wetland areas resulting in artesian wells and contact springs and seeps.

The smelter complex is composed of a smelter built on the footprint of the first smelter at the site. Attached to the smelter is a hydrometallurgical plant that recovers metals from the stack gases. A new double contact acid plant recovers the sulfur gases. Associated with the smelter are conveyors, materials handling areas, overhead flues and pipes, a 1200 foot smoke stack, an administration and laboratory building and complex of mobile buildings used by contractors. Also present at the site is a slag mill, which grinds up the slag produced by the smelter, separates the metals by flotation and recycles the slag concentrate back to the smelter. Crossing the site are a number of pipelines including a concentrate slurry pipeline, pipelines for fire fighting water and industrial process water, and pipelines for various types of waste water. There are underground sumps at various locations, but these are typically concrete today. The whole complex is built on the footprint of 2 former smelting facilities; some of the ruins of these buildings remain. An example of this is the reverberatory smelter mixing chamber, located at basement level, where gases were mixed with cool air prior to discharge to the smoke stacks. The foundations of this facility are still present and a road is now built on top of them. Because of the baffles in this building, the area is called the catacombs.

As described in the Remedial Investigation report, the smelter is situated on a partially eroded alluvial fan between the south shore line of the Great Salt Lake and the northern end of the Oquirrh Mountains at the mouth of Kessler Canyon. This canyon is a relatively large south-north trending canyon emanating from the northern end of the Oquirrh Mountains. Unconsolidated Quaternary and Tertiary sediments beneath the smelter have been deposited and shaped by similar processes at the refinery area, with the exception that resistant bedrock outcrops south of the smelter appear to have shielded some of the colluvium from wave erosion. The sediments beneath parts of the smelter area consist of about 15 to 20 feet of interbedded lacustrine clay and silt with local thin layers of quartz-rich silty sand and oolitic beach sands. Underlying these lacustrine deposits is a sequence of northward-trending colluvial deposits that appear to have been transported down the canyon by mud flows. This layer of fine grained sediments mixed with gravel ranges in thickness from 30 to 100 feet. Bedrock in the area is highly fractured and varies in depth but increases toward the Great Salt Lake.

3. Sampling strategy

The objectives of the sampling were (1) to determine the location and extent of

groundwater contamination; (2) to determine the sources so that they could be addressed; (3) to determine the composition and speciation of the contaminants in the plumes; (4) to determine the potential impacts; and (5) to collect the data necessary to support modeling of plumes so that various containment and treatment options could be evaluated. Therefore, monitoring wells were established with different completion depths, including several nested wells with multiple completions. Wells were installed along the axis of various plumes and downgradient of facilities. Historic wells were monitored and used to determine the history of plume movement. Other wells in the plumes were installed to monitor progress of plume movement and/or treatment. There is one well that was installed in the smelter plume so that heavily contaminated water could be withdrawn from the aquifer. An injection well where microbes could be added directly to the selenium-tainted ground water to test out the feasibility of in-situ biological treatment was installed in the former Garfield townsite area. In all, there were 140 wells monitored during the course of the RI/FS.

4. Known or suspected sources of contamination

The plume of selenium starting at the refinery was probably due to leaks of pipes underneath the precious metals refinery. Extremely high concentrations of selenium were found at the footprint of the refinery following demolition. The location of the highest concentrations (nearly pure selenium) were found in an area where selenium was recovered from the refinery slimes. The shear volume of the soils contamination and the ground water contamination suggests that the leakage in the selenium recovery process circuit went on for several years.

A plume with elevated arsenic at the refinery apparently starts in the vicinity of the refinery evaporation ponds. In the early days of refinery operations, spent electrolyte and other contaminated waste waters were simply piped to a topographic low spot behind the refinery and allowed to evaporate. Subsequent studies revealed that evaporation was not a major factor. The water seeped into the ground. Insoluble components (such as gold and silver) precipitated out, but the more soluble components entered the groundwater. This dumping persisted for several years and soils were contaminated down to groundwater 45 feet or more.

At the smelter, the groundwater was contaminated with arsenic, selenium, and sulfate. The source of the selenium at the smelter can only be conjectured at this point. The slope behind the reverberatory smelter was a well-known dumping ground and storage area at one time. Kennecott investigators speculate that some refinery slimes, perhaps off-specification, were stored behind the smelter prior to recycling. The area behind the smelter was also used to thaw the concentrates prior to smelting. The water which had accumulated in the railroad cars was

simply allowed to drain onto the ground behind the smelter. The pocket of selenium contamination close to the Noranda acid plants probably came from spills of weak acid waste water, a rather common event (see spill list for OU13). The pocket of selenium contamination close to the slag mill probably came from the former slag concentrate thickener where waste water spilled out from time to time. The area of contamination along the slag bluff probably came from water which had percolated through the slag deposit. There are several former seeps along this bluff.

The arsenic in the groundwater near the reverberatory smelter probably originated as flue dusts which were leached with water from leaks in the air handling system (flues, underground mixing chambers, etc.). Flue dust is very high in arsenic and is extremely leachable. Another potential source of arsenic in that area was the concentrate piles that were stacked behind the smelter for temporary storage. The arsenic near the acid plant probably came from the spills of weak acid or leaks in the Noranda air handling system. The whole smelter area groundwater is contaminated with sulfate, undoubtedly from the numerous sulfuric acid and weak acid spills at the site over the years. The very high sulfate in the acid tank farm area originated from a failure of one of the acid storage tanks on site. (This incident is being addressed by a RCRA corrective action.)

There were other pockets of contamination in the wetlands downgradient of the smelter and refinery. The groundwater contamination in the shallow aquifer near the sludge ponds came from leaching of the selenium and arsenic from the sludge into the underlying soils. Pockets of contamination near the smelter return canal came from either the contaminated water in the canal or from the dredge spoils dumped along the side of the canal.

5. Types of contamination, locations, and quantities

A summary of locations of the plumes is given in Table 8.2.

TABLE 8.2
LOCATIONS AND SIZES OF GROUNDWATER PLUMES

Location	Aquifer	contaminants	acreage (estimated)
Refinery	Principal and bedrock	Se, As, Sulfate	206.6 (the estimated volume of this plume is about 12,000 to 24,000 acre-feet.)
Pond C	Principal and shallow	Se	5.7

Location	Aquifer	contaminants	acreage (estimated)
Reverberatory smelter	Principal	Se	17.2
Slag bluff	Principal and shallow	Se, As	31.5
Acid plants	Principal and shallow	Se, As, Sulfate	126.2
Slag mill area	Principal and shallow	Se, Sulfate	5.7
Kessler Spring	Shallow	Se	2.9
North of Garfield Townsite	Shallow	Se	4.3
Pond A	Shallow	Se, As, Sulfate	34.4
Smelter Return Canal	Shallow	As	5.7
Smelter Return Canal	Shallow	As	5.7
Slag Lagoon	Shallow	As	8.6
Slag Lagoon	Shallow	As	8.6
Wetland	Principal	Sulfate	5.7
Pond B	Principal	Sulfate	22.9
Acid tank farm	Principal and shallow	sulfate	5.7

6. Exposures

The ground water contamination does not pose a human health risk because all of the water rights in the area are owned by Kennecott. When the water is used, it is used for industrial process water and not for culinary purposes. In addition, because of the proximity of the Great Salt Lake and saline layers in the sediments, the groundwater is not useful for culinary purposes due to its high salt content.

The plumes at the smelter have not yet surfaced in the wetlands; however, the plume of high selenium originating at the refinery has surfaced downgradient in the Garfield wetlands in at least two locations. Until recently, this ground water plume surfaced via artesian flow at Garfield Well #5 and at Kessler Springs and nearby seeps. The selenium from the groundwater inputs to the wetlands has resulted in elevated selenium concentrations in macroinvertebrates. Since birds feed on the macroinvertebrates, selenium has entered the food chain for birds causing elevated selenium concentrations in bird eggs at the site. Investigators

could not find a relationship between water concentrations and either macroinvertebrate concentrations or bird egg selenium. Therefore, a site specific water quality goal could not be established. Instead, EPA recommends that success of the ground water project be based on selenium content in the bird food chain as measured by selenium content in the macroinvertebrates. The goal for selenium content in macroinvertebrates is 5-10 mg/Kg (dry weight) during nesting season (see Section 7).

D. Scope and Role of Operable Unit

Operable Unit 23 underlies the Kennecott North Zone site but is interconnected to other operable units in significant ways. The contaminated groundwater is particularly significant under the smelter (OU13) and the refinery (OU14). Operations at these Operable Units led to the groundwater contamination. The groundwater in OU23 is one of the sources of contamination to the South shore wetlands (OU 22).

E. Current and potential Future Site and Resource Uses

The land surface above the contaminated plumes is zoned M-2 (manufacturing, heavy industrial, mining). The upland areas currently occupied by the smelter and refinery will remain industrial for the foreseeable future, even after the facilities are closed. These areas are serviced by a network of road and rail transportation infrastructure which makes them attractive for industrial development. Downgradient of the smelter and refinery is the Garfield Wetlands. The wetlands are also zoned M-2, but are currently used as open space/wildlife habitat. The ground water, when it is used, is used for industrial process waters. Because of the proximity of the Great Salt Lake, the groundwater is high in TDS and would have limited usefulness as a culinary source unless treated. The ground water does serve as a source of water to the wetland area and could be rather important especially after closure of the facilities.

F. Summary of Site Risks

1. Chemicals of Concern

The concentrations of chemicals of concern varied widely. The maximum concentrations found in 1999 of those elevated chemicals are summarized in Table 8.3.

TABLE 8.3
CONCENTRATIONS OF CONTAMINANTS IN GROUNDWATER PLUMES
IN 1999 (units are in μg/L, or ppb)

Location of plume	Maximum selenium (ug/l)	Maximum arsenic (ug/l)	Maximum sulfate (mg/l)
Refinery	6970	400	-
Pond C	111	-	-
Reverberatory smelter	638	-	-
slag bluff	79	1000	-
Acid Plants	360	3200	1870
Slag Mill area	53	-	-
Kessler Springs (shallow)	411	-	-
North of Garfield Townsite	65	-	-
Pond A	80	222	1120
Smelter Return Canal	-	195	-
Smelter Return Canal	-	680	-
Slag Lagoon	-	250	-
Slag Lagoon	-	285	-
Wetland	-	-	538
Pond B	-	-	1420
Acid tank farm	-	-	6100

G. Removal/Remedial Action Objectives

1. Remedial Action Objectives

Minimize or remove the potential for on-site (wetlands and Great Salt Lake) ecological risk to receptors of concern by limiting the migration and uptake of constituents of concern in excess of risk-based concentrations for sensitive species.

Minimize or remove the potential for on-site human risk via ingestion by limiting exposure to ground water containing constituents of concern exceeding risk-based concentrations for human health or drinking water MCLs.

Minimize or remove the potential for on-site ecological risk via artesian flow and springs into the Garfield wetlands to receptors of concern by limiting the migration of constituents of concern in excess of risk-based concentrations for sensitive species.

2. Remedial Action Levels

In order to achieve human health protection, the typical action level for ground water with the potential to be used for culinary purposes are the MCLs. In this case, culinary uses is not anticipated and these levels would not apply.

In order to achieve ecological protection for the Great Salt Lake, the current discharge limit in the UPDES permit for selenium is 54 ug/L, which includes a mixing factor of 2, and a suggested water quality goal of 27 ug/L. To achieve full protection for the Great Salt Lake, the remedial action level for Se in any groundwater or treated groundwater discharged to the Great Salt Lake should not exceed 27 ug/L.

In order to achieve ecological protection for the Garfield wetlands, the surface waters in the wetlands should not produce macroinvertebrates with concentrations of selenium exceeding 5 -10 mg/Kg (dry weight), as monitored during nesting season for the birds. Additional risk information may be later used to develop limits on macroinvertebrates for other COCs.

If during the course of wetlands monitoring, a water quality goal can be derived which sets a concentration level in water which produces macroinvertebrate selenium concentrations less than 5 mg/Kg, this water quality goal can be used as a limit for discharge of groundwater or treated groundwater to the wetlands (see Chapter 7, wetlands). The interim groundwater treatment goal is 5 μg/L selenium which may be modified when the wetlands monitoring program produces this site-specific standard.

H. Remedial Alternatives

The Feasibility Study (March 16, 2001) for the ground water operable unit detailed several alternatives for addressing the ground water issues at the site.

1. Alternative 1 - No further action

This response assumes that no further action, except groundwater and surface water monitoring and continuing source control, will be taken at the site.

a. Major elements:

- Maintain source controls including low permeability caps on the footprint of the electrolyte purification pond, the former refinery electrolyte purification building and former refinery precious metals buildings to reduce the leaching of selenium in the soils present there into the groundwater. If source controls are disturbed during construction activities, they must be restored.

- Maintain source controls at the smelter including asphalt caps over the footprint of the Acid Plant #7 site, and the Acid Plant #8 site to reduce the leaching of acids and arsenic into the groundwater.

- Pump the smelter wells installed immediately downgradient of the source areas to remove highest concentrations of leachates

- Monitor migration of the plume and track any groundwater contaminants discharged into nearby surface waters.

b. Key ARARs

Continued participation in the State Ground Water Protection Program which requires the operations and maintenance of the source control measures is required. After mine closure the operations and maintenance of the source control measures must be maintained and state clean closure standards would apply.

c. Long Term Reliability

The source control measures have been demonstrated to be effective thus far, but will require some maintenance as they age.

d. Quantity of untreated waste and treatment residuals

Because there is no treatment, the quantity of untreated water may decrease slowly over time only because there would be some dispersion along the fringes of the plume. There would be no treatment residuals as a result of this option.

e. Estimated time for design and construction

The source control measures have already been designed and constructed.

f. Estimated time to reach remediation goals

It is estimated that it will take about 30 years for the plume to course through the aquifer system to the discharge points at Kessler Springs and Garfield Wells.

g. Estimated costs (from Appendix A of the Feasibility Study)

TABLE 8.4
COSTS OF ALTERNATIVE 1

Activity	Capital costs	O+M costs for 30 years	Net present value
Source controls	Already implemented	$29,000 per year	
Ground water monitoring	0	$88,000 per year	
TOTAL (6% discount, 1% EPCM, 5% contingency)	0	$123,000 per year	$1,816,000

h. Use of presumptive remedies or innovative treatment

No presumptive remedies or innovative treatment technologies are used in this alternative.

i. Expected outcome

The groundwater in the aquifer would remain a risk to human health for the next 30 years and preclude its use for culinary purposes. The groundwater would continue to seep into the wetlands and enter the food chain for the birds living there.

2. Alternative 2 - Alternative 1 plus institutional controls.

This alternative includes maintenance of source controls as described in

Alternative 1 and restrictions on land use and water use to prevent exposures.

a. Major elements of Alternative 2

- Maintain source control measures as described in Alternative 1.
- Monitor plume migration and wetland waters as described in Alternative 1.
- Management of land and groundwater use in the area by the property and water rights owner (Kennecott) until plumes naturally attenuate to ensure contact with contaminated groundwater is prevented.

b. Key ARARs

Continued participation in the State Ground Water Protection Program which requires the operations and maintenance of the source control measures is required. After mine closure the operations and maintenance of the source control measures must be maintained and state clean closure standards would apply.

c. Long Term Reliability

The source control measures have been demonstrated to be effective thus far, although some maintenance will be required as the controls age. The institutional controls would be reliable so long as Kennecott continues to own the property and the water rights. If the operational facilities were to close, and the property and water rights sold, the reliability of the institutional controls might be less certain.

d. Quantity of untreated waste and treatment residuals

Because there is no treatment, the quantity of untreated water may decrease slowly over time only because there would be some dispersion along the fringes of the plume. There would be no treatment residuals as a result of this option.

e. Estimated time for design and construction

The source control measures have already been designed and constructed.

f Estimated time to reach remediation goals

It is estimated that it will take about 30 years for the plume to course through the aquifer system to the discharge points at Kessler Springs and Garfield Wells.

g. Estimated costs (from Appendix A of the Feasibility Study)

TABLE 8.5
ESTIMATED COSTS OF ALTERNATIVE 2

Activity	Capital costs	O+M costs for 30 years	Net present value
Source controls	Already implemented	$29,000 per year	
Ground water monitoring	0	$88,000 per year	
Alternative 1 activities (6% discount, 1% EPCM, 5% contingency)	0	$123,000 per year	$1,816,000
Water Rights and Land Use Restrictions	0	$10,000 per year	
TOTAL (6% discount, 1% EPCM, 2% contingency)		$134,000 per year	$1,964,000

h. Use of presumptive remedies or innovative treatment

No presumptive remedies or innovative treatment technologies are used in this alternative.

i. Expected outcome

Human exposures to ground water and the surface water discharge areas would be limiting by restricting access to the water, both ground water and surface water. The wildlife, however, which do not recognize water rights or property boundaries would continue to be exposed until the groundwater plume flushes out of the aquifer and the surface water then flushes out of the wetlands.

3. Alternative 3A - Collection and beneficial use - use as process water

In addition to Alternatives 1 and 2, this alternative involves collection of the contaminated groundwater as it surfaces into the wetlands and redirecting these

flows from the wetland area into the Kennecott industrial process water circuit.

a. Major elements of Alternative 3A

- Maintain source control measures (Alternative 1)
- Monitor migration of the ground water plumes and the surface waters (Alternative 1)
- Restrict water rights and land use (Alternative 2)
- Collect contaminated artesian flows and springs
- Deliver artesian well and spring water to Kennecott's industrial process water circuit for use in mining, milling, and smelting operations.
- Discharge of waters and any solids produced into Magna Tailings Pond along with the rest of the waters in the industrial process water circuit.

b. Key ARARs

The key ARAR of interest in this alternative is meeting the discharge requirements of the UPDES permit which limits the amount of selenium which can be discharged from the industrial process water circuit to the Great Salt Lake.

c. Long Term Reliability

This alternative would be reliable so long as Kennecott continues to operate its mining, milling, and smelting facilities while the groundwater plume courses through the aquifer system. Although there are occasional process water circuit spills, these are typically contained in the operational areas and do not cause a discharge to the Great Salt Lake.

d. Quantity of untreated waste and treatment residuals

Research has indicated that when the selenium and arsenic tainted waters enter the industrial process circuit and are then mixed with tailings in the mill, 49% of the selenium and 97% of the arsenic are precipitated or adsorbed to the tailings and settle out in the tailings pond. Therefore, all the waters collected from the artesian wells and springs are "treated",

albeit unconventionally. At current conditions, the Garfield well produces about 191 lbs of Se/year; the Kessler Spring produces about 2430 lbs of Se/yr for a total of about 2630 lbs of Se/yr. About half of that, or 1315 lbs/yr would end up as treatment residual along with the tailings in the Magna Tailings Pond and the other half would be discharged to the Great Salt Lake.

e. Estimated time for design and construction

This alternative has already been constructed as an interim measure. It has been in operation since 2000.

f Estimated time to reach remediation goals

It would still take 30 years for the contamination to flush out of the aquifer, but the surface water in the wetlands should recover within a year now that the selenium rich water is being diverted elsewhere.

g. Estimated costs (Appendix A of the Feasibility Study)

TABLE 8.6
ESTIMATED COSTS OF ALTERNATIVE 3A

Activity	Capital costs	O+M costs for 30 years	Net present value
Source controls	Already implemented	$29,000 per year	
Ground water monitoring	0	$88,000 per year	
Alternative 1 activities (6% discount, 1% EPCM, 5% contingency)	0	$123,000 per year	$1,816,000
Water Rights and Land Use Restrictions	0	$10,000 per year	
Alternatives 1 and 2 (6% discount, 1% EPCM, 2% contingency)		$134,000 per year	$1,964,000
Containment system, pumps, piping (already installed)	$91,000	$13,962 per year	

Activity	Capital costs	O+M costs for 30 years	Net present value
TOTAL	$91,000	$152,000 per year	$2,321,000

h. Use of presumptive remedies or innovative treatment

There are no presumptive remedies used in this alternative. The treatment used in this alternative is innovative from a management perspective in that it takes advantage of a pre-existing water management system already in place. This strategy has been used successfully for management of treatment residuals for ground water at the Kennecott South Zone site.

i. Expected outcome

This alternative ensures that the water being discharged from the contaminated aquifers does not enter the wetlands and expose the wildlife there. It also has the advantage that the water is being put to beneficial use while the contaminated plume courses through the aquifer. This alternative cannot be used post-closure because the process water circuit will not be available then.

4. Alternative 3B - Collection and beneficial use - treatment ex-situ

In addition to Alternatives 1 and 2, this alternative involves collection of the contaminated groundwater as it surfaces into the wetlands and redirecting these flows from the wetland area into a treatment plant using bioremediation technology.

a. Major elements of Alternative 3B

- Maintain source control measures (Alternative 1)
- Monitor migration of the ground water plumes and the surface waters (Alternative 1)
- Restrict water rights and land use (Alternative 2)
- Collect contaminated artesian flows and springs
- Deliver artesian well and spring water to a treatment plant using bioremediation technology.

- Use treated water for beneficial use including Kennecott process water circuit or water supply for the wetlands.

- Dispose treatment residuals in the Arthur Stepback Repository (if hazardous) or the North Tailings Impoundment (if non-hazardous and the impoundment is still operational).

b. Key ARARs

The key ARAR of interest in this alternative is meeting the discharge requirements of the UPDES permit which limits the amount of selenium which can be discharged from the industrial process water circuit to the Great Salt Lake.

c. Long Term Reliability

This alternative would be reliable if there is sufficient storage capacity for the contaminated artesian and spring waters should there be an upset of the biological treatment system. The biological treatment system has been shown to be extremely efficient in removal of selenium from the water, but has had a few upsets during testing. None of the selenium would enter the wetlands or the Great Salt Lake.

d. Quantity of untreated waste and treatment residuals

All of the waters discharged at the artesian wells and springs would be treated. At current conditions, the Garfield well produces about 191 lbs of Se/year; the Kessler Spring produces about 2430 lbs of Se/yr for a total of about 2630 lbs of Se/yr. The biomass and the selenium would be disposed in the Arthur Stepback Repository. Resource recovery is possible.

e. Estimated time for design and construction

Additional pilot scale testing would be needed to determine the optimum operating conditions, but the plant would be fairly simple to design and construct. A two year design and construction phase should be sufficient.

f Estimated time to reach remediation goals

It would still take 30 years for the contamination to flush out of the aquifer, but the surface water in the wetlands should recover within a year now that the selenium rich water is being diverted elsewhere.

g. Estimated costs (Appendix A of the Feasibility Study)

TABLE 8.7
ESTIMATED COSTS OF ALTERNATIVE 3B

Activity	Capital costs	O+M costs for 30 years	Net present value
Source controls	Already implemented	$29,000 per year	
Ground water monitoring	0	$88,000 per year	
Alternative 1 activities (6% discount, 1% EPCM, 5% contingency)	0	$123,000 per year	$1,816,000
Water Rights and Land Use Restrictions	0	$10,000 per year	
Alternatives 1 and 2 (6% discount, 1% EPCM, 2% contingency)		$134,000 per year	$1,964,000
Containment system, pumps, piping (already installed)	$91,000	$13,962 per year	
Biotreatment plant (includes 20% EPCM and 25% contingency)	$2,413,000	$342,000 per year	
TOTAL	$2,505,000	$494,000 per year	$9,304,000

h. Use of presumptive remedies or innovative treatment

There are no presumptive remedies used in this alternative. Biological system treatment plants are still fairly innovative as a technology.

i. Expected outcome

This alternative ensures that the water being discharged from the contaminated aquifers does not enter the wetlands and expose the wildlife there. It also has the advantage that the water is being put to beneficial use while the contaminated plume courses through the aquifer. It could be used either pre-mine-closure or post-mine-closure.

5. Alternative 4A - Management of Ground Water by Monitored Natural Attenuation.

This alternative includes the provisions of Alternatives 1, 2, and 3A or 3B plus management of the groundwater through natural attenuation. From a practical sense, this is the same as alternatives 3a or 3b. The Feasibility Study suggests that the site is qualified for selection of a monitored natural attenuation alternative for the ground water itself. This is because Kennecott owns all the land and the water rights and the aquifer is flushing itself out by discharge to the wetlands at the artesian wells and springs. This alternative will not be described again here - See Alternatives 3A or 3B.

6. Alternative 4B - Management of Ground Water by in-situ biological treatment

This alternative includes the provisions of Alternatives 1, 2, and 3A or 3B plus management of the groundwater plume by injection of selenium reducing microbes into the aquifer to convert the mobile selenate into the immobile elemental selenium.

a. Major elements of Alternative 4B

- Maintain source control measures (Alternative 1)
- Monitor migration of the ground water plumes and the surface waters (Alternative 1)
- Restrict water rights and land use (Alternative 2)
- Collect contaminated artesian flows and springs
- Deliver artesian well and spring water to Kennecott's industrial process water circuit for use in mining, milling, and smelting operations.
- Discharge waters and any solids produced into Magna Tailings Pond along with the rest of the waters in the industrial process water circuit.
- Inject selenium-reducing microbes and needed nutrients into the aquifer via injection wells

b. Key ARARs

The ARAR most crucial to the success of this alternative is obtaining permission from the State Underground Injection Program to inject microbes and nutrients into an aquifer. This permission has been obtained by Kennecott for the purposes of testing the efficiency of the technique. The surface water discharges collected at the springs and artesian wells would have to meet discharge requirements of the UPDES permit.

c. Long Term Reliability

Because the springs and artesian well flow would be collected and taken out of the wetlands system where they could expose wildlife, any failures of the injection program would not impact the receiving waters. This back up allows use of experimental technology without risking damage to wetland wildlife. Although the technology itself has shown promise, it is unproven in-situ at large scale.

d. Quantity of untreated waste and treatment residuals

Research has indicated that when the selenium and arsenic tainted waters enter the industrial process circuit and are then mixed with tailings in the mill, 49% of the selenium and 97% of the arsenic are precipitated or adsorbed to the tailings and settle out in the tailings pond. Therefore, all the waters collected from the artesian wells and springs are "treated", albeit unconventionally. At current conditions, the Garfield well produces about 191 lbs of Se/year; the Kessler Spring produces about 2430 lbs of Se/yr for a total of about 2630 lbs of Se/yr. About half of that, or 1315 lbs/yr would end up as treatment residual along with the tailings in the Magna Tailings Pond and the other half would be discharged to the Great Salt Lake. The amount of water in the aquifer itself which could be treated is unknown at present. Initial in-situ pilot testing was successful in immobilizing over 90% of the selenium. Treatment residuals, immobilized selenium in the form of elemental selenium would remain in the aquifer.

e. Estimated time for design and construction

Substantial testing and monitoring would be required during remedial design to optimize treatment, disperse the microbes within the aquifer, and determine how much nutrients to inject and when. Design and construction could take 4 years.

f Estimated time to reach remediation goals

If the highest selenium concentrations have to pass through a zone with selenium-reducing microbes which immobilize the selenium, the remediation time should take less than 30 years, assuming 30 years is the baseline. The time for remediation has not been modeled yet, but should be done once the testing provides the needed information for the model.

g. Estimated costs (Appendix A of the Feasibility Study)

TABLE 8.8
ESTIMATED COSTS OF ALTERNATIVE 4B

Activity	Capital costs	O+M costs for 30 years	Net present value
Source controls	Already implemented	$29,000 per year	
Ground water monitoring	0	$88,000 per year	
Alternative 1 activities (6% discount, 1% EPCM, 5% contingency)	0	$123,000 per year	$1,816,000
Water Rights and Land Use Restrictions	0	$10,000 per year	
Alternatives 1 and 2 (6% discount, 1% EPCM, 2% contingency)		$134,000 per year	$1,964,000
Containment system, pumps, piping (already installed)	$91,000	$13,962 per year	
Alternatives 1, 2, and 3A (6% discount, 5% EPCM, 25% contingency)	$91,000	$152,000 per year	$2,321,000
Injection system of 50 wells, tanks, pipes, pumps (20% EPCM, 25% contingency)	$2,248,000	$2,600,000 per year (artesian system for 10 years, injection for 5 years)	
TOTAL (6 % discount)	$2,339,000	$2,752,000 per year	$6,674,000

h. Use of presumptive remedies or innovative treatment

This alternative does not use a presumptive remedy. Biological treatment of selenium has been demonstrated successfully ex-situ (on the surface) where it is very effective, although still considered innovative. Within the aquifer, the use of microbes in the aquifer has met with mixed success for petroleum hydrocarbons; it has not been tried before in this situation for selenium. Therefore, this alternative is not only innovative, it is still somewhat experimental and does come with some risk of failure.

i. Expected outcome

Because this alternative is coupled with Alternative 3, it will keep the selenium out of the wetland whether or not the microbe treatment of the groundwater succeeds or fails. If the project succeeds, the cleanup of the aquifer will be faster. Yet to be determined is whether or not the immobilized elemental selenium will be re-mobilized after treatment ceases. This is possible but seems unlikely.

7. Alternative 4C - Management of ground water by in-situ barrier walls.

This alternative includes the provisions of Alternatives 1, 2, and 3A or 3B plus management of the groundwater plume by allowing the plume to pass through a barrier wall impregnated with iron filings

a. Major elements of Alternative 4C

- Maintain source control measures (Alternative 1)
- Monitor migration of the ground water plumes and the surface waters (Alternative 1)
- Restrict water rights and land use (Alternative 2)
- Collect contaminated artesian flows and springs
- Deliver artesian well and spring water to Kennecott's industrial process water circuit for use in mining, milling, and smelting operations.
- Discharge waters and any solids produced into Magna Tailings Pond along with the rest of the waters in the industrial process water circuit.

- Install a pervious reactive wall across the plume which would force the plume water to come in contact with a chemical reagent such as iron filings.

- Occasionally replace reactive wall and dispose the spent reactive wall matrix now containing selenium in the Arthur Stepback Repository.

b. Key ARARs

The surface water discharges collected at the springs and artesian wells would have to meet discharge requirements of the UPDES permit.

c. Long Term Reliability

Because the springs and artesian well flow would be collected and taken out of the wetlands system where they could expose wildlife, any failures of the pervious reaction wall would not impact the receiving waters. This back up allows use of experimental technology without risking damage to wetland wildlife. Although the technology itself has shown promise, it is unproven in-situ.

d. Quantity of untreated waste and treatment residuals

Research has indicated that when the selenium and arsenic tainted waters enter the industrial process circuit and are then mixed with tailings in the mill, 49% of the selenium and 97% of the arsenic are precipitated or adsorbed to the tailings and settle out in the tailings pond. Therefore, all the waters collected from the artesian wells and springs are "treated", albeit unconventionally. At current conditions, the Garfield well produces about 191 lbs of Se/year; the Kessler Spring produces about 2430 lbs of Se/yr for a total of about 2630 lbs of Se/yr. About half of that, or 1315 lbs/yr would end up as treatment residual along with the tailings in the Magna Tailings Pond and the other half would be discharged to the Great Salt Lake. The amount of water in the aquifer itself which could be treated is unknown at present. Treatment residual volumes would include the selenium plus the volume contained in the reactive wall when cleaned out on a periodic basis. The frequency of this is also unknown. This treatment technology is only feasible for shallow contamination.

e. Estimated time for design and construction

Substantial testing and monitoring would be required during remedial design to determine whether this alternative would work as theorized. The iron fillings technique work in an ex-situ situation, but operational details in a permeable reactive wall are unknown. Testing, design and construction could take 4 years.

f Estimated time to reach remediation goals

If the highest selenium concentrations have to pass through a zone with a reactive wall which immobilizes the selenium, the remediation time should take less than 30 years, assuming 30 years is the baseline. The time for remediation has not been modeled yet, but should be done once the testing provides the needed information for the model.

g. Estimated costs (Appendix A of the Feasibility Study)

TABLE 8.9
ESTIMATED COSTS OF ALTERNATIVE 4C

Activity	Capital costs	O+M costs for 30 years	Net present value
Source controls	Already implemented	$29,000 per year	
Ground water monitoring	0	$88,000 per year	
Alternative 1 activities (6% discount, 1% EPCM, 5% contingency)	0	$123,000 per year	$1,816,000
Water Rights and Land Use Restrictions	0	$10,000 per year	
Alternatives 1 and 2 (6% discount, 1% EPCM, 2% contingency)		$134,000 per year	$1,964,000
Containment system, pumps, piping (already installed)	$91,000	$13,962 per year	
Alternatives 1, 2, and 3A (6% discount, 5% EPCM, 25% contingency)	$91,000	$152,000 per year	$2,321,000

Activity	Capital costs	O+M costs for 30 years	Net present value
Permeable reactive barrier system (includes 20% EPCM, 25% contingency	$4,635,000	Replace media every 5 years at a replacement cost of $4,156,000	
TOTAL (6 % discount)	$14,380,000 (includes replacement costs)	$2,229,000	$16,609,000

h. Use of presumptive remedies or innovative treatment

There are no presumptive remedies in this alternative. The concept of using permeable reactive walls, though not new, has not been tried for selenium treatment.. Therefore the remedy would be experimental.

i. Expected outcome

Because this alternative is coupled with Alternative 3, it will keep the selenium out of the wetlands whether the reactive wall treatment of the groundwater succeeds or fails. If the project succeeds, the cleanup of the aquifer will be faster. Yet to be determined is how often the wall would have to be replaced and how effective it will be.

8. Alternative 5A - Extraction of Groundwater and beneficial use in industrial process water circuit

This alternative involves extraction of sufficient amounts of groundwater to lower the water table which would prevent flows of contaminated groundwater into the wetlands

a. Major elements of Alternative 5A

- Maintain source control measures (Alternative 1)
- Monitor migration of the ground water plumes and the surface waters (Alternative 1)
- Restrict water rights and land use (Alternative 2)
- Install and pump wells located close to Kessler Springs, Garfield Well #5, or both.

- Deliver the well water to Kennecott's industrial process water circuit for use in mining, milling, and smelting operations.

- Discharge waters and any solids produced into Magna Tailings Pond along with the rest of the waters in the industrial process water circuit.

b. Key ARARs

The key ARARs in this case would be compliance with the UPDES permit discharge limit on selenium and coordination with the Army Corps of Engineers (Clean Water Act 404) because some of the wetland habitats would be destroyed.

c. Long Term Reliability

Technical feasibility is uncertain because it would take a lot of pumping to lower the water table sufficiently to stop flow of contaminated waters into the wetlands. If this strategy works, exposures of birds to these contaminants in the wetlands would not occur because the wetlands would dry up destroying this area as useful habitat for shorebirds. An upland habitat might evolve.

d. Quantity of untreated waste and treatment residuals

Research has indicated that when the selenium and arsenic tainted waters enter the industrial process circuit and are then mixed with tailings in the mill, 49% of the selenium and 97% of the arsenic are precipitated or adsorbed to the tailings and settle out in the tailings pond. Therefore, all the waters collected from the artesian wells and springs are "treated", albeit unconventionally. At current conditions, the Garfield well produces about 191 lbs of Se/year; the Kessler Spring produces about 2430 lbs of Se/yr for a total of about 2630 lbs of Se/yr. About half of that, or 1315 lbs/yr would end up as treatment residual along with the tailings in the Magna Tailings Pond and the other half would be discharged to the Great Salt Lake. The amount of water in the aquifer itself which could be treated is unknown at present.

e. Estimated time for design and construction

This alternative is rather simple to construct, but it would take some time to do sufficient modeling to determine exactly where and at what flow

rates the aquifer should be pumped. EPA estimates that 2 years might be required.

f Estimated time to reach remediation goals

Preliminary modeling results suggest that this alternative might shorten the 30 year cleanup by a minor amount.

g. Estimated costs (Appendix A of the Feasibility Study)

TABLE 8.10
ESTIMATED COSTS OF ALTERNATIVE 5A

Activity	Capital costs	O+M costs for 30 years	Net present value
Source controls	Already implemented	$29,000 per year	
Ground water monitoring	0	$88,000 per year	
Total Alternative 1 (6% discount, 1% EPCM, 5% contingency)	0	$123,000 per year	$1,816,000
Institutional Controls (Alternative 2)	0	$10,000 per year	
Extraction and Recycle System (wells, piping, pumps)	$2,132,000	$112,000 per year	
TOTAL (6% discount)	$2,011,000 (2 yrs)	$2,513,000 (15 yrs)	$4,524,000

h. Use of presumptive remedies or innovative treatment

This alternative does not involve either use of presumptive remedies or innovative treatment.

i. Expected outcome

If this approach works, exposure of wetland wildlife to contaminants would be prevented because the wetlands would dry up and the habitat would change to a more upland environment with a completely different kind of wildlife structure. Before flow ceases, the flows would have to be collected as in Alternative 3 to prevent recontamination of the soils of the

area. After pumping ceases, the water level might return to normal and the whole area would flood, changing the habitat again.

9. Alternative 5B - Extraction of Groundwater and treatment

a. Major elements of Alternative 5B

- Maintain source control measures (Alternative 1)
- Monitor migration of the ground water plumes and the surface waters (Alternative 1)
- Restrict water rights and land use (Alternative 2)
- Install and pump wells near the Garfield Well #5, Kessler Springs, or both to lower the water table until artesian flow and spring flow ceases.
- Deliver well water to a biological treatment plant with treatment residuals going to Arthur Stepback Repository
- Recover the selenium if possible.

b. Key ARARs

The key ARARs in this case would be compliance with the UPDES permit discharge limit on selenium and coordination with the Army Corps of Engineers (Clean Water Act 404) because of the wetland habitats would be destroyed.

c. Long Term Reliability

Technical feasibility is uncertain because it would take a lot of pumping to lower the water table sufficiently to stop flow of contaminated waters into the wetlands. Treatment at these high flow rates has not been tested. If this strategy works, exposures of the birds to these contaminants in the wetlands would not occur because the wetlands would dry up, destroying this area as useful habitat for shorebirds. An upland habitat might evolve.

d. Quantity of untreated waste and treatment residuals

At current conditions, the Garfield well produces about 191 lbs of Se/year; the Kessler Spring produces about 2430 lbs of Se/yr for a total of about

2630 lbs of Se/yr.

e. Estimated time for design and construction

It would take some time to do sufficient modeling to determine exactly where and at what flow rates the aquifer should be pumped. It would also take time to design a high flow treatment system which would work reliably. EPA estimates that 4 years might be required.

f. Estimated time to reach remediation goals

Preliminary modeling results suggest that this alternative might shorten the 30 year cleanup by a minor amount.

g. Estimated costs (Appendix A of the Feasibility Study)

TABLE 8.11
ESTIMATED COSTS OF ALTERNATIVE 5B

Activity	Capital costs	O+M costs for 30 years	Net present value
Source controls	Already implemented	$29,000 per year	
Ground water monitoring	0	$88,000 per year	
Total Alternative 1 (6% discount, 1% EPCM, 5% contingency)	0	$123,000 per year	$1,816,000
Institutional Controls (Alternative 2)		$10,000 per year	
Extraction System (wells, pumps, pipes) (20% EPCM, 25% contingency)	$2,132,000	$112,000 per year	
Treatment System (bioreactors, media, pumps, inoculum) (20% EPCM, 25% contingency)	$24,133,000	$3,564,000 per year	
TOTAL Alternative 5B (6% discount)	$23,314,000 (2 yrs)	$37,004,000 (15 yrs)	$60,318,000

h. Use of presumptive remedies or innovative treatment

This alternative does not involve use of presumptive remedies. Use of biological treatment for selenium is innovative, and is experimental at high flow rates.

i. Expected outcome

If this approach works, exposure of wetland wildlife to contaminants would be prevented because the wetlands would dry up and the habitat would change to a more upland environment with a completely different kind of wildlife structure. After pumping ceases, the water level might return to normal and the whole area would flood, changing the habitat again.

I. Comparative Analysis of Alternatives

The National Contingency Plan (NCP) requires that the various remedial action alternatives be evaluated individually and then compared relative to each other using nine criteria. The nine criteria in the National Contingency Plan and how the alternatives compare are described below:

1. Overall protection of human health and the environment

Overall protection of human health and the environment addresses whether each alternative provides adequate protection of human health and the environment and describes how risks posed through each exposure pathway are eliminated, reduced, or controlled, through treatment, engineering controls, and/or institutional controls.

Alternative 1 might protect human health in the short term but would not protect the wildlife in the wetlands from exposure to selenium. Alternative 2 would protect human health, but it too, would not protect the wildlife in the wetlands. Alternatives 3 and 4 would protect both human health and the wetland wildlife from exposures to selenium and arsenic. Alternative 5, if it worked, would protect both human health and wetland wildlife from exposures to contaminants but comes at the expense of complete habitat destruction.

2. Compliance with Applicable or Relevant and Appropriate Requirements

CERCLA and the NCP require that remedial actions at CERCLA sites at least attain legally applicable or relevant and appropriate Federal and State requirements, standards, criteria, and limitations which are collectively referred to as ARARs, unless such ARARs are waived under conditions outlined by CERCLA.

Applicable requirements are those cleanup standards, standards of control, and other substantive requirements, criteria, or limitations that are promulgated under Federal environmental or State environmental or facility siting laws. These regulations specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance found at a CERCLA site. Only those State standards that are identified by a state in a timely manner and that are more stringent than Federal requirements may be applicable. Relevant and appropriate requirements are those cleanup standards, standards of control, and other substantive requirements, criteria, or limitations that are promulgated under Federal environmental or State environmental or facility siting laws. These requirements, while not applicable to a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site do address problems or situations sufficiently similar to those encountered at the CERCLA site that their use is well-suited to the particular site. Only those State standards that are identified in a timely manner and are more stringent than Federal requirements may be relevant and appropriate.

The NCP Criterion of compliance with ARARs addresses whether a remedy will meet all of the applicable or relevant and appropriate requirements of other Federal and State environmental statutes or provides a basis for invoking a waiver.

Alternatives 1 and 2 would not achieve clean closure requirements which would come into effect when the facilities are closed. Alternatives 3 and 4 would meet ARARs if performance standards are met. Alternative 5 would result in the destruction of wetlands and would require replacement wetlands to met the CWA 404 ARAR.

3. Long Term Effectiveness and Permanence

Long term effectiveness and permanence refers to expected residual risk and the ability of a remedy to maintain reliable protection of human health and the environment over time, once clean-up levels have been met. This criterion includes the consideration of residual risk that will remain onsite following remediation and the adequacy and reliability of controls.

Alternatives 1 and 2 could be effective and permanent for protection of humans from exposure but would not be effective at all for protection of wildlife for a period of 30 years. Alternatives 3, 4, and 5 would be effective and permanent in reducing exposures to wildlife and the public.

4. Reduction of Toxicity, Mobility, or Volume through Treatment

Reduction of toxicity, mobility, or volume through treatment refers to the anticipated performance of the treatment technologies that may be included as part of a remedy.

Alternatives 1 and 2 do not involve treatment and would not reduce toxicity, mobility or volume of the groundwater plumes. Alternatives 3, 4, and 5 involve treatment of the groundwater either in the aquifer or as it surfaces. The treatment process would reduce particularly mobility and volume.

5. Short Term Effectiveness

Short term effectiveness addresses the period of time needed to implement the remedy and any adverse impacts that may be posed to workers, the community and the environment during construction and operation of the remedy until cleanup levels are achieved.

Alternative 1 would not protect workers or wildlife from exposures while the aquifer is flushed. Alternative 2 would not protect wildlife while the aquifer is flushed. Alternatives 3 and 4 would be effective short-term while the aquifer is being remediated. Alternative 5, if it works, might be effective in reducing exposures, but would come at the cost of destruction of the wetland habitat.

6. Implementability

Implementability at this site is a function of the complexity of the remedy.

Alternatives 1, 2, and 3 are fully implementable, and the technology, although innovative has worked successfully on a pilot scale. Alternative 4B shows promise and has been tested on a pilot scale. Alternative 4C has not been tested in situ for reduction of selenium. Alternative 5 might not be successful due to high flow rates required to reduce the water levels in the wetland areas. The technology for treatment or recycling has not been tested at high flow rates and scalability is uncertain.

7. Costs

The types of costs that are assessed include capital costs, annual operation and maintenance costs and net present value of capital and O+M costs.

Alternatives 1 and 2 are relatively inexpensive but do not achieve protection for

the wildlife in the wetlands. Alternatives 3 and 4 are moderate in cost but do protect the wetlands. Alternative 4 also achieves an accelerated cleanup of the aquifer itself. Alternative 5A is relatively inexpensive but has the negative drawback of drying up the wetlands. Alternative 5B is expensive, does not clean up the aquifer much faster and also dries up the wetlands.

8. State acceptance

This includes the state's position and key concerns related to the alternatives and comments on ARARs and proposed use of waivers.

The state indicates that Alternative 3 is necessary at a minimum, with elements of Alternative 4 used in addition to speed the clean up.

9. Community acceptance

This determines which components of the alternatives the community support, have concerns about, or oppose.

The community did not express an opinion about the groundwater in this area. They were concerned about future land use issues. An active environmental group, the Friends of the Great Salt Lake, supported Alternative 4 combined with Alternative 3.

A summary of the alternatives relative to the nine NCP criteria is given in Table 8.12.

J. Principal Threat Wastes

The principal threat wastes at this site include spills of selenium and arsenic which occurred over the years at the smelter and refinery. The principal threat wastes have already been addressed through removal actions at the smelter and refinery. All of the alternatives for addressing the groundwater already assume that the principal threat wastes are no longer an issue.

K. The Selected Remedy

1. Summary of the Rationale for the Selected Remedy.

EPA selects Alternative 4B coupled with 3A during operations and Alternative 4B coupled with 3B post closure if needed. Alternatives 1 and 2 are unacceptable because they do nothing to protect wildlife in the wetlands from unacceptable exposures to selenium. Alternative 5 is unacceptable because it destroys the

TABLE 8.12
COMPARATIVE ANALYSIS OF ALTERNATIVES
(adapted from the Feasibility Study, Version B, June 1, 2002)

Alternatives	National Contingency Plan Criteria								
	protective	ARARs	permanent	treatment	short term	implement	cost	state	community
Alternative 1 - no action	GW - no SW -no	no	no	no	no	yes	low	not acceptable	not acceptable
Alternative 2 - institutional controls	GW - yes SW - no	no	no	no	no	yes	low	not acceptable	not acceptable
Alternative 3A - collection and beneficial reuse	GW - yes SW - yes	yes	yes before closure, no after closure	yes before closure no after closure	yes before closure, no after closure	yes	low	acceptable before closure	acceptable before closure
Alternative 3B - collection and treatment	GW - yes SW - yes	yes	yes	yes	yes	yes	medium	acceptable	acceptable
Alternative 4A - essentially the same as Alternatives 3A or 3B									
Alternative 4B - in-situ biological treatment plus 3A or 3B	GW - yes SW - yes	yes	yes	yes	yes	yes	medium	preferred, because faster and proven	preferred, because faster and proven
Alternative 4C - in-situ permeable reactive barriers plus 3A or 3B	GW - yes SW - yes	yes	yes	yes	yes	maybe	medium to high	acceptable	acceptable

Alternatives	National Contingency Plan Criteria								
	protective	ARARs	permanent	treatment	short term	implement	cost	state	community
Alternative 5A - extraction and beneficial reuse, plus 3A or 3B	GW - yes SW - yes	yes	maybe	yes	maybe, but could dry up wetlands	maybe	low	not acceptable	not acceptable
Alternative 5B - extraction and treatment, plus 3A or 3B	GW - yes SW - yes	yes	maybe	yes	maybe, but could dry up wetlands	maybe	high	not acceptable	not acceptable

wetland habitat for 30 years. Although Alternatives 3 and 4A protect the wetland wildlife from unacceptable exposures to selenium, it does nothing to address the contamination in the aquifer itself. Alternative 4C is unproven and the technology is inferior in treatment efficiency when compared to bioremediation. Alternative 4B uses a technology (bioreactor with selenium-reducing microbes) which was highly successful when used ex-situ and has recently been proven to work in a test in the aquifer itself. Although some additional testing might be required, it shows promise in potentially cleaning up the aquifer in a short time frame, hopefully before closure of the facilities. If the alternative does not work perfectly and some selenium escapes, the collection of artesian and spring flow, as described in Alternatives 3A and 3B would still prevent exposures.

Alternative 4B has two main advantages over the other alternatives. It is an active remedy - in-situ biological treatment - and can actively sequester all or part of the selenium before the groundwater reaches the springs and wells. If the injections of the selenate reducing microbes occur in the upgradient half of the plume, the selenate there never reaches the springs and wells. If the natural attenuation of the selenium over time requires 30 years to reach action levels, then the active remediation might take only half of the time, or 15 years to achieve. The second advantage is that the faster remediation time might allow this aquifer to achieve the action level for selenium before the mining and milling activities close. If this is the case, then it will not ever be necessary to build a separate treatment system for the springs, seeps, and wells. It allows maximum utilization of the process water circuit infrastructure.

2. Description of the Selected Remedy

The selected remedy includes the following elements:

a. Design and installation of a well field composed of injection wells and monitoring wells with particular emphasis on the locations of highest selenium concentrations in the groundwater;

b. Determine optimum conditions for survival and selenium reduction efficiency for the microbes;

c. Develop a plan for injection of microbes and injections of necessary nutrients to sustain their selenium reduction capacity at near maximum efficiency.

d. Monitor progress of selenium reduction and make operations adjustments as needed

e. While the mining and milling facilities remain operational and the process water circuit is available, collect and convey contaminated seep, spring and artesian well waters to the process water circuit. Overflows of the process water circuit which are discharged via UPDES Outfall 012 currently have discharge limit for selenium. This discharge limit must be achieved or the selenium-tainted waters must be treated separately.

f. When the mining and milling activities cease and the tailings process water circuit is no longer available for use, collect and convey the selenium-tainted seep, spring, and artesian well waters to a treatment plant using bioreactor technology. The treatment of these waters may be needed also if additions of selenium-tainted waters cause the process water circuit system to violate the Kennecott UPDES discharge permit for selenium.

g. The performance standard for the treated waters is 27 μg/L selenium for discharge directly into the Great Salt Lake. As an interim goal treated water may be discharged into the wetlands only if the concentration of selenium is 5 μg/L selenium or less, until a site-specific water quality goal can be established (see p. 7.46)

h. Establish a monitoring program to evaluate the progress of remediation of selenium in the aquifer, determine if overflows of the process water circuit to the Great Salt Lake continue to achieve the discharge limits in the UPDES permit, and determine if any ex-situ bioreactor treatment of seeps and springs achieve discharge limits and or performance standards for discharge into the Great Salt Lake (or wetlands).

3. Summary of the Estimated Remedy Costs

An estimate of the costs associated with the selected remedy was provided in the Feasibility Study. This estimate will be refined further during remedial design when more is known about the optimum operating conditions (number of injection wells, frequency of nutrient additions, etc.). A breakdown of the costs are given in Table 8.13.

TABLE 8.13
ESTIMATED COSTS FOR THE SELECTED REMEDY
(From the Feasibility Study, 2002)

ACTIVITY	QUANTITY	UNIT COST	TOTAL COST x $1000
Capital Cost:Contain and Recycle Contaminated Artesian Flow	1 Lump Sum	$63.123	$63
Containment System, pumps, piping, etc (already in place)			
Sub Total			$63
EPCM	20%		$13
Contingency	25%		$16
Sub Total			$91
Capital Cost: In-situ Biological Treatment System	1 Lump Sum	$1,550,000	$1,550
Injection system of 50 wells, tanks, pipes, pumps, etc.			
Sub Total			$1,550
EPCM	20%		$310
Contingency	25%		$388
Sub Total			$2,248
TOTAL CAPITAL COSTS			$2,339
Operating: Source Control and Monitoring			
Ground water monitoring personnel and equipment	1 Tech	$50,000	$50
Ground water monitoring analytical	350 each	$50	$18
Ground water monitoring annual report preparation	1 Lot	$20,000	$20
Source Control Operating and Maintenance	1%	$2,900,000	$29
Sub Total			$117
EPCM	1%		$1
Contingency	5%		$6
Sub Total			$123
Operating: Water Rights and Land Use Restrictions	1 Lot	$10,000	$10
Sub Total			
EPCM	1%		$0
Contingency	2%		$0
Sub Total			$10
Operating: Contain and recycle contaminated artesian flow	1 Lump Sum	$13,962	$14
Sub Total			$14
EPCM	5%		$0.7
Contingency	25%		$3.5
Sub Total			$18
Operating: In-situ Biological Treatment in Aquifer	1 Lump Sum	$2,000,000	$2,000
Sub Total			$2,000
EPCM	5%		$100
Contingency	25%		$500
Sub Total			$2,600

ACTIVITY	QUANTITY	UNIT COST	TOTAL COST x $1000
TOTAL YEARLY OPERATING COSTS			$2,752
NET PRESENT VALUE			
Capital Costs	6% discount	$2,339	$2,325
Operating Costs	6% discount	$2,752	$4,349
TOTAL NPV			$6,674

4. Expected Outcomes of the Selected Remedy

Because there are a number of different locations where the groundwater or treatment residuals can be disposed, the goals of the groundwater collection/treatment project are a function of disposal location. For the collection of contaminated spring, seep and artesian well waters, there is no selenium concentration limitation so long as the waters enter the process water circuit. In this case, the interaction of the selenium in the water with the solid tailings matrices result in treatment of the selenium. There is a selenium discharge limit in the UPDES permit which applies to outfalls 012 and 008. This limit must be met. For collection of contaminated spring, seep and artesian well waters following closure of mining and milling activities, the water may be discharged into the Great Salt Lake without treatment if the selenium concentrations are below 0.027 mg/L Se. If the concentration of selenium in the spring, seep, and artesian well waters exceed this limit, the waters must be treated, as described in the selected remedy. For discharge to the Great Salt Lake, the effluent shall contain selenium concentrations no greater than 0.027 mg/L Se. If the discharge of the groundwater is directed to any portion of the wetlands, the groundwater must achieve the site specific water quality goal as derived in the wetlands monitoring project (see ROD Section 7, OU22). If the treatment effluent is to be discharged to any portion of the wetlands, it must achieve the site specific water quality goal for the wetlands. There is no specific goal for the in-situ remediation project area. The point of compliance is to be measured at the Kessler Springs/Seep system.

L. Statutory Determinations

Under CERCLA §121 and the NCP, the lead agency must select remedies that are protective of human health and the environment, comply with applicable or relevant and appropriate requirements (unless a statutory waiver is justified), are cost-effective, and utilize permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable. In addition, CERCLA includes a preference for remedies that employ treatment that permanently and significantly reduces

the volume, toxicity or mobility of hazardous wastes as a principal element and a bias against off-site disposal of untreated wastes. The following sections discuss how the Selected Remedy meets these statutory requirements.

1. Protection of Human Health and the Environment

The Selected Remedy will protect human health and the environment through the treatment of groundwater tainted with selenium. There is human no exposure to because the water is not a current or potential drinking water source. The wildlife exposures are reduced to acceptable levels by diversion of the seeps and springs away from sensitive habitats and treatment of the groundwater before discharge into the environment.

2. Compliance with Applicable or Relevant and Appropriate Requirements

Section 121(d) of CERCLA, 42 U.S.C. § 9621(d), the National Oil and Hazardous Substances Pollution Contingency Plan (the "NCP"), 40 CFR Part 300 (1990), and guidance and policy issued by the Environmental Protection Agency ("EPA") require that remedial actions under CERCLA comply with substantive provisions of applicable or relevant and appropriate standards, requirements, criteria, or limitations ("ARARs") from State of Utah and federal environmental laws and State facility siting laws during and at the completion of the remedial action. These requirements are threshold standards that any selected remedy must meet.

This document identifies ARARs that apply to the activities to be conducted under the North End Groundwater remedial action. The ARARs or groups of related ARARs contained in Appendix B are each identified by a statutory or regulatory citation, followed by a brief explanation of the ARAR and how and to what extent the ARAR is expected to apply to the activities to be conducted under this remedial action.

Substantive provisions of the requirements listed in Appendix B are identified as ARARs pursuant to 40 CFR § 300.400. ARARs that are within the scope of this remedial action must be attained during and at the completion of the remedial action.

ARARs are either "applicable" or "relevant and appropriate." Both types of requirements are mandatory under Superfund guidance. Applicable requirements are those cleanup standards, standards of control, and other substantive requirements, criteria or limitations promulgated under federal environmental or state environmental facility siting laws that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance found at a CERCLA site. Only those state standards that are identified by a state

in a timely manner and that are more stringent than federal requirements may be applicable.

Relevant and appropriate requirements are those cleanup standards, standards of control, and other substantive requirements, criteria or limitations promulgated under federal environmental or state environmental or facility siting laws that, while not "applicable" to hazardous substances, pollutants, contaminants, remedial actions, locations, or other circumstances at a CERCLA site, address problems or situations sufficiently similar to those encountered at the CERCLA site that their use is well suited to the particular site. Only those state standards that are identified in a timely manner and are more stringent than federal requirements may be relevant and appropriate.

The determination that a requirement is relevant and appropriate is a two-step process: (1) determination if a requirement is relevant and (2) determination if a requirement is appropriate. In general, this involves a comparison of a number of site-specific factors, including an examination of the purpose of the requirement and the purpose of the proposed CERCLA action; the medium and substances regulated by the requirement and the proposed requirement; the actions or activities regulated by the requirement and the remedial action; and the potential use of resources addressed in the requirement and the remedial action. When the analysis results in a determination that a requirement is both relevant and appropriate, such a requirement must be complied with to the same degree as if it were applicable.

ARARs are contaminant, location, or action specific. Contaminant specific requirements address chemical or physical characteristics of compounds or substances on sites. These values establish acceptable amounts or concentrations of chemicals which may be found in or discharged to the ambient environment.

Location specific requirements are restrictions placed upon the concentrations of hazardous substances or the conduct of cleanup activities because they are in specific locations. Location specific ARARs relate to the geographical or physical positions of sites, rather than to the nature of contaminants at sites.

Action specific requirements are usually technology based or activity based requirements or limitations on actions taken with respect to hazardous substances, pollutants or contaminants. A given cleanup activity will trigger an action specific requirement. Such requirements do not themselves determine the cleanup alternative, but define how chosen cleanup methods should be performed.

Many requirements listed as ARARs are promulgated as identical or near identical requirements in both federal and state law, usually pursuant to delegated environmental programs administered by EPA and the state. The Preamble to the NCP provides that such a situation results in citation to the state provision and

treatment of the provision as a federal requirement.

Also contained in this list are policies, guidance or other sources of information which are "to be considered" in the selection of the remedy and implementation of the record of decision (ROD). Although not enforceable requirements, these documents are important sources of information which EPA and the State of Utah Department of Environmental Quality (UDEQ) may consider during selection of the remedy, especially in regard to the evaluation of public health and environmental risks; or which will be referred to, as appropriate, in selecting and developing cleanup actions.

This list in Appendix B constitutes EPA's and UDEQ's formal identification and detailed description of ARARs for the remedial action at the Kennecott North Zone Site, North End Groundwater Operable Unit (OU23).

3. Cost Effectiveness

The selected remedy is cost effective because, of the low-moderate cost remedies, it stands the best chance of remediation of the groundwater in a timely manner, perhaps before mine closure. This allows the use of existing infrastructure perhaps throughout the entire project. The small investment up front could yield significant savings in the future. The remedy meets the NCP criteria because its costs are proportional to its overall effectiveness.

4. Utilization of Permanent Solutions and Alternative Treatment Technologies

All of the treatment methods used in the selected remedy fit the category of innovative treatment technologies. The use of tailings and the iron in the tailings slurry line removes selenium. Although the chemistry is not unique, the technique of using pre-existing infrastructure is unusual. The use of selenium reducing microbes as a treatment technology is innovative and the site was actually used to evaluate the technique. To our knowledge, in-situ use of these microbes was tested for the first time at this site. The treatment technology addresses the selenium contamination by reducing its mobility (selenate is converted to elemental selenium), toxicity, and volume. The selected remedy results in permanent cleanup. The selected remedy satisfies the statutory preferences for use of permanent solutions and use of innovative technology.

5. Preference for Treatment as a Principal Element

Because the disposal of spring, seep and artesian waters in the process water circuit provides treatment for selenium (by sequestering the selenium into the solid matrix of the tailings in the circuit), because the aquifer is being treated in-situ by selenium reducing microbes, and because the bioreactor treatment system

will be used ex-situ for the spring water should the process water circuit no longer be available, all of the elements of the selected remedy involve treatment. By utilizing treatment as a significant portion of the remedy, the statutory preference for remedies that employ treatment as a principal element is satisfied.

6. Five-Year Review Requirements

Because this remedy will result in hazardous substances, pollutants, or contaminants remaining on-site above levels that allow for unlimited use and unrestricted exposure, a statutory review will be conducted within five years after initiation of remedial action to ensure that the remedy is, or will be, protective of human health and the environment.

M. Documentation of Significant Changes

The Proposed Plan for the Kennecott North Zone Site identified Alternative 4B coupled with Alternatives 3A and 3B for the refinery plume and Alternative 2 for the smelter plumes. After review of the public comments, it was determined that no significant changes to the remedy, as originally identified in the Proposed Plan, were necessary or appropriate (see Appendix A).

Section 9: Smelter Fallout (Kennecott North Zone OU 19)

A. Site Name, Location and Description

1. Site Type and description of operable unit

Fallout from smelter emissions is a suspected source of elevated metals in nearby soils. The older reverberatory smelter, although equipped with some emission control, had two short stacks and massive amounts of particulates and gases spewed from the stacks. The severity of the problem is demonstrated by the fact that the sulfur dioxide emissions killed most of the vegetation in the canyons downwind of the smelter.

With the introduction of a new smelting process in 1979 (Noranda process), and erection of a 1200 foot stack with improved emission controls, the stack emissions of both particulates and gases were much reduced. Revegetation efforts in the denuded canyons behind the smelter began to show some success. With the current smelter which started up in 1996, smelter emissions were reduced even further.

A summary of north facilities emission rates is given in Table 9.1.

TABLE 9.1
SUMMARY OF NORTH FACILITIES ATMOSPHERIC EMISSION RATES

Dates of operation	Facility	Emissions to the atmosphere via stacks (lbs/day)		
		Arsenic	Lead	Selenium
MILLS				
	Magna Molybdenite Heat Treater	0.68	29.7	0.01
	Arthur Molybdenite Heat Treater	4.45	3.0	0.21
NORANDA SMELTER				
1979-1995	Main Stack	41.6	75.2	4.92
1979-1995	Dryer	0.3	4.5	0.00

Dates of operation	Facility	Emissions to the atmosphere via stacks (lbs/day)		
		Arsenic	Lead	Selenium
REFINERY				
1950-1995	Refined furnaces	0.00	0.01	0.01
1950-1995	Anode furnaces	0.04	0.08	0.53
1950-1995	Sludge Roasters	8.02	0.18	41.49
1950-1995	Cooling Tower	4.52	0.27	10.35
1950-1995	Dore Precipitator	0.07	0.67	0.30
1950-1995	By-product retort	0.17	0.32	3.30
HISTORIC REVERBERATORY SMELTER				
1906-1979	Reverberatory Smelter	1416	518.6	27.4

The largest source of arsenic and lead atmospheric emissions was the various smelting operations, in particular the older reverberatory smelter; whereas, the largest source of selenium was the refinery. The severity of the atmospheric pathway can be estimated using arsenic as an example. If the 1416 lbs/day emission rate was representative of the entire history of the reverberatory smelter (1906 -1979), the total arsenic emitted from the stack would be amounted to 18,864 tons of arsenic. If the Noranda smelter (1979 - 1995) emissions are added (122 tons), the total arsenic emitted by the smelters would amount to 18,986 tons.

The smelter emissions would have impacted all lands and water in the vicinity of the smelter and refinery. This Operable Unit (OU 19), however, includes only those areas which were not impacted by dumping, leaks or spills from the smelting and refining operations. For example, the Garfield wetlands were undoubtedly impacted by atmospheric fallout, but they were also impacted by dumps, spills, contaminated springs, contaminated wells and dredge spoils. Therefore, the Garfield Wetlands, though certainly impacted by atmospheric emissions, are not included in this particular operable unit. Areas included in OU 19 include: upper Kessler Canyon (above the first dam), Black Rock Canyon (above the Black Rock Tailings Pond), Little Valley, and northern Tooele Valley.

It should be noted that the investigations were designed to determine what

contaminants are present in these airsheds now. The investigations did not attempt to drill through the years of sediment to discover the original emissions, but were designed to determine what was left of the residual contamination in the surface soils. Because of the smaller particle sizes of the emissions, the deposited particles were suspected to have migrated via surface water runoff and wind erosion to respective down gradient retention areas (i.e., water control dams, wetlands, lower elevation areas, etc.) Hence, surficial soils were determined to be the remaining exposure point and source of risk to both ecological and human receptors from elevated levels of the contaminants of concern. To date, the majority of the canyons are inaccessible to the general public, as well as the majority of on-site workers. Current risks of exposure to wildlife potentially remain because of selenium concentrating plants, such as white top.

2. Facilities located within OU 19

The locations within OU 19 include the following areas: Kessler Canyon (above the lowest dam), Little Valley, Black Rock Canyon (except Black Rock Tailings Pond), and the Erda Airshed. Areas below the lowest dam in Kessler Canyon are included in OU 13, the Smelter operable unit.

The Erda Airshed includes the more northern portions of Tooele County although samples were collected farther south. Elevated heavy metal concentrations were found near the former International Smelter. These areas are NOT included in this OU, nor are they a part of the Kennecott sites any longer. The International Smelter impacts on agricultural grounds in Tooele Valley are being investigated and addressed if necessary as a part of the International Smelting and Refining NPL site.

B. Site History and Enforcement Activities

1. Activities at the site which led to contamination

Kessler Canyon: Kessler Canyon is a drainage at the northern end of the Oquirrh Mountains. Because the Kennecott smelter complex is located at the mouth of this canyon, and the prevailing wind direction was toward the canyon, this area was most severely impacted by smelter emissions. The canyon is characterized by a large gently sloping valley with steep hillsides surrounding the valley on the east, west and southern sides.

In the early days of smelter operations, recoveries of emissions were not very good leading one observer to note that most of the metals exited the smelter not in product, but up the smokestack depositing all over the nearby hillsides. Sulfur emissions were virtually uncontrolled and the sulfur dioxide devastated the

vegetation in the nearby mountains, especially in Kessler Canyon located directly behind the smokestacks.

Kessler Canyon's denuded hillsides could no longer hold water from storms and mudflows were fairly common. A storm event in 1927 resulted in a mudflow which knocked 3 lines of ore cars behind the smelter off their tracks and then flowed into the smelter roaster house. The mudflow was so strong it contained large boulders and tree stumps. In response to this event, several flood control projects were initiated. Three dams were built in Kessler Canyon behind the smelter and the 4' x 6' culvert under the smelter was enlarged to 22' x 22'. The three barrier dams had to be raised as sediment filled up the basins behind the dams following storms in 1938, 1939, and 1945. Today, one spillway crest has reached a height of 114 feet above the original canyon floor. Undoubtedly, former smelter emissions were remobilized during these events. One study of a 90 minute storm event indicated that the water had mobilized 5.3 kg of arsenic, 12.9 kg of lead and 1.9 kg of selenium. EPA suspects that a fraction of the atmospheric fallout has washed down from the slopes and collected in the sediment basins behind the dams.

Kennecott also began a revegetation campaign to reduce the runoff events in the canyon. Non-native plants were used, especially alfalfa. Recently, an ecological risk assessment found that in Kessler Canyon, the native plants comprised 56% of the total vegetation in comparison to nearby Coon Canyon which had 73% native plants. Kessler Canyon is frequented by a large elk herd today.

Kessler Creek, which flows only following rain events, is unclassified by the state. The areas behind the dams are dry as well.

Little Valley: Little Valley, located just across the south divide from Kessler Canyon, was also denuded of vegetation due to high sulfur emissions of the smelters at Garfield. Like Kessler Canyon, Little Valley was prone to mudflows during storm events because the soils, lacking vegetation, could not hold the water. Major flood events occurred in Little Valley at the same time as in Kessler Canyon. In 1930, a flood originated in Little Valley and flowed throughout downtown Magna, even washing away homes on First West and Second West streets. Ditches became rivers of mud.

In response, during the Great Depression, the government built two dikes, and a culvert under the Bingham and Garfield Railroad tracks was improved to prevent boulders from clogging the structure. The dikes saved Magna on several occasions from further flood events. The revegetation efforts in Little Valley by the citizens of Magna began as a civic project, and was later continued by Kennecott. Non-native species were featured in both efforts. A survey during the

ecological risk assessment found that the vegetation was 54% native species. Until recently, the land was leased to a local rancher for use in grazing livestock. Currently, Little Valley remains privately owned and is used primarily by the deer and elk herds located in the northern Oquirrh Mountains for grazing. KUCC maintains its main north/south rail corridor for potential future land use and also maintains a tailings pipeline through the canyon.

The Bonneville Crusher is in the watershed of Little Valley and runoff containing mine wastes collected in basins created by the dikes. (See the Bonneville Crusher of OU15). Operations at the Bonneville Crusher began in 1966 and operated until the facility was shut down in 2001. Ore from the Bingham Pit was brought to the site via rail cars and placed onsite prior to processing. The process involved placing the ore rock into large rotating drums with steel rods in it and rotating the material until the rock was broken up into small pieces. The ore slurry (comprised mostly of fine particles) was sent via gravitational flow to the mills located at the North End for concentrating. Process materials such as ore, coal and concentrate were dumped at or near the site for processing and storage. These materials were subject to erosion and leaching by surface water, potentially impacting down gradient retention areas and localized ground water. The site was eventually cleaned up by Kennecott prior to closure.

Black Rock Canyon: Located just west of Kessler Canyon is Black Rock Canyon, about ½ mile southwest of the smelter. Like Kessler Canyon and Little Valley, smelter emissions of sulfur dioxide devastated the vegetation in Black Rock Canyon. At the mouth of Black Rock Canyon is a geologic feature called Black Rock along the shores of the Great Salt Lake.

The area was settled by ranchers and two Great Salt Lake resorts were founded near Black Rock. Although the vegetation in Black Rock was destroyed by smelter emissions, the area was largely unsettled and no flooding events were recorded. (Attention was probably focused on nearby Kessler Canyon and Little Valley impacts.)

The floor of the canyon has been used as a borrow area by Kennecott and the Utah Department of Transportation when the roadbed of I-80 was elevated due to rising lake levels. Located near the mouth of the canyon was a dump of slag tailings which were placed in one of the borrow areas and then covered and revegetated (see OU 13). Today, the floor of the canyon is being leased to Monroc for sand and gravel mining. At the suggestion of the agencies, the lease requires that no materials leave the site with concentrations exceeding 500 mg/Kg lead and/or 50 mg/Kg arsenic. Because the sand and gravel can be used in any setting and at any land use, the values must coincide with unrestricted land use levels. Following sand and gravel mining, Monroc is required by Kennecott to replace the topsoil

and revegetate the area.

Erda airshed: Smelter emissions potentially impacted the soils in the inhabited Salt Lake Valley and Tooele Valley. The potential contamination in Salt Lake Valley at Magna was studied as part of a separate operable unit (OU9). Tooele Valley is located just to the west of the Oquirrh Mountains and was, until recently, largely agricultural and ranch land. Three communities, Lake Point, Stansbury Park, and Erda, are located in the north part of the valley and would have been most seriously affected by Garfield smelter fallout in Tooele Valley. The main agricultural products of the area are alfalfa and hay, but there are numerous gardens there also. A screening study of this area indicated very little residual contamination in the soils of this area.

2. Investigations, cleanup activities, enforcement

Kennecott investigators have studied stack emissions and atmospheric fallout for a long period of time. A compilation of selected results were included in the ERI-Logan report, which also includes investigations during 1988. The compilation covers emission rates and studies during the time when the older reverberatory smelter was in operation and later information during the Noranda Smelter operations. Included in these studies were dust fall measurements (actual fallout rates), emission rates as a function of time, and chemical characterization of the fallout. It was clear that some of these early studies were not performed for the purposes of environmental impact studies, but rather was an assessment of how much product was lost out the stacks. It was common for the studies to include copper, gold and silver among the analytes. A summary of the more recent studies is given in Table 9.2.

TABLE 9.2
CHARACTERIZATION OF CANYONS BEHIND THE SMELTER

Date	Study	Performed by
1988	Study of soils, plants, animals in airshed of Kennecott facilities	ERI-Logan (Utah State University personnel)
1994	Study of soils and plants in several canyons of the Oquirrh Mountains for ecological risk assessment	ep&t for Kennecott, under supervision of EPA
1994	Study of soil concentrations in Tooele Valley (Erda area)	SAIC for UDEQ

Date	Study	Performed by
1998	Study of sediments behind Kessler dams as part of the North End Soils characterization	Kennecott under supervision of EPA.

The focus of the studies in the canyons centered on ecological risk due to residual contamination from the smelters. The various canyons (Coon, Little Valley, Kessler, Black Rock, and Pine) within the fallout zones of the historic smelters were investigated to determine if there was a risk posed by the many years of smelter emissions containing elevated concentrations of arsenic, lead, copper, selenium, cadmium and zinc (contaminants of concern). The investigation combined information on exposure and potential ecological effects with site-specific information on the concentrations of the contaminants of concern, into an overall assessment of the potential ecological risks to plants and wildlife.

The ecological risk assessment was performed to answer two questions: (1) Were the current concentrations of the chemicals of concern high enough in the soil and vegetation to adversely affect populations of herbivorous mammals in the northern Oquirrh Mountains? (2) Were the current concentrations of the chemicals of concern high enough in terrestrial invertebrates and small mammal tissues to suggest the potential for observable adverse effects to populations of insectivores and carnivores in the northern Oquirrh Mountains?

Both questions were addressed by comparing the measured chemicals of concern concentrations in the soil and potential food material at the time the study was conducted, with the lowest No Observable Adverse Effects Level (NOAELs) based on laboratory toxicity tests, and with site specific information on presence or absence of effects to animals. The comparisons lead to the development of a specific risk quotient, applicable for each particular sample group and for each of the chemicals of concern.

The investigation determined that exceedances of the risk quotient occurred relative to copper, lead and selenium, for all six of the sampled groups. Some of the information was speculative as it was based on information that may not best represent the particular site conditions, but was the closest representative information for the species group at that time. Table 9.3 provides a listing of the species demonstrating a risk quotient greater than 1 for a particular chemical of concern. It is theoretically possible to observe an environmental effect if the risk quotient exceeds a value of one.

TABLE 9.3
ECOLOGICAL HAZARD QUOTIENTS EXCEEDING 1
Hazard Quotient = Site Concentrations/No Observable Adverse Effects Level
(Hazard Quotient = Site Concentrations/Lowest Observable Adverse Effects Level)

	Arsenic	Cadmium	Copper	Lead	Selenium	Zinc
Omni-vorous mammals	-	-	1.97 (1.55)	1.38 (0.12)	1.55 (0.62)	-
Herbi-vorous mammals	-	-	1.44 (1.13)	1.11 (0.10)	1.76 (0.70)	-
Insecti-vorous birds	-	-	-	-	1.98 (1.58)	1.40 (0.70)
Insecti-vorous mammals	1.66 (no data)	-	1.54 (1.05)	-	1.89 (1.51)	-
Carni-vorous birds	-	-	-	-	1.59 (0.53)	-
Carni-vorous mammals	-	-	1.19 (0.81)	2.15 (0.33)	2.92 (1.94)	-

At the end of the investigation, the ecological consultants concluded that:

- None of the chemicals of concern in the soil and the vegetation were adversely affecting populations of herbivorous mammals in the northern Oquirrh Mountains.

- None of the chemicals of concern in the soil and the invertebrates were adversely affecting populations of omnivorous mammals, such as Peromyscus, in the northern Oquirrh Mountains.

- Although zinc concentrations in invertebrates throughout the northern Oquirrh Mountains were near the toxicity thresholds for birds, these concentrations may have reflected background concentrations in the invertebrates and may not have represented a risk to birds. Invertebrate

concentrations were not correlated with soil concentrations and did not appear to be a function of smelter emissions.

- Selenium in the insectivore food chains in Kessler Canyon may not present a risk to insectivorous birds or mammals.

- Selenium concentrations in the invertebrates and small mammals of Kessler and Black Rock Canyons may present a risk to some carnivorous birds and mammals.

- The higher selenium concentrations in the diets of insectivores and carnivores at some of the sampling sites were related to the dominance of palatable, selenium concentrating plants, such as white top, at these sites.

- The spring 1995 Releve sampling identified 31 species not found in the summer of 1994. The 1995 findings supported the conclusion from the screening level ecological risk assessment that there are no chemical of concern-related inhibitions of the plant community diversity or structure.

The agencies extrapolated that the highest risk was from selenium and it was concluded that this was related to the presence of palatable selenium concentrating plants such as white-top. One of the factors that control the ability to observe an effect in the selected sample group is the actual concentration of the chemical of concern and its potency at that concentrations. Though the concentrations of the contaminants of concern in some of the canyons were found to be at or near levels that would indicate a significant potential risk to the survival, growth and reproduction of the sampled species, the investigation did not find evidence of effects in the sampled species.

It was reported that plant communities were slowly increasing in acreage covered, as the soil has been reconditioned, the sources of the chemicals of concern have been eliminated or significantly reduced. Kennecott continues to promote the growth and prosperity of the native vegetation to assist the plant and wildlife groups in the canyons to prosper.

C. Site Characteristics

1. Size, topography: The three canyons in this operable unit are characterized by a gently sloping central valley surrounded by steep mountain sides. The types of vegetation vary as a function of elevation and degree of revegetation efforts. The northern Oquirrh block where these canyons are located is comprised of Paleozoic sedimentary rocks, typically dark gray interbedded limestones, limey quartzite with thin beds of shales and

sandstone. Kessler Canyon is 3883 acres; Little Valley is 3696 acres; and Black Rock Canyon is 1434 acres.

The Erda airshed is located in the northeastern part of the Tooele Valley. (Salt Lake Valley is located on the east side of the Oquirrh Mountains, and Tooele Valley is located on the west side.) The site included the communities of Erda, Stansbury Park, and Lakepoint. The area of Tooele Valley characterized by UDEQ was 18,560 acres.

2. Surface and subsurface features:

The main man-made features in Kessler Canyon are three dams which were built to protect the smelter at the mouth of the canyon. Sediments collect behind the dams following cloudbursts. Dominating the landscape is the 1200 ft. smelter stack which can been seen anywhere in the canyon.

Likewise, the main man-made features in Little Valley are earthen dikes built to slow the runoff and protect the town of Magna at the mouth. There are some corrals and fences which are remnants of the days when Little Valley was leased to local ranchers.

Black Rock Canyon, named for a geologic feature at the mouth of the canyon, was formerly used as a borrow area for construction soils and gravels used in the elevation of the nearby Interstate 80 highway. The canyon floor is now the site of a sand and gravel mining operation (Monroc with land leased from Kennecott). The Interstate Highway, Black Rock, and the Great Salt Lake are located at the mouth of Black Rock Canyon. Ruins of a WW II airplane crash have recently been removed from the canyon.

The Erda airshed is comprised of the communities of Erda, Stansbury Park, and Lakepoint. At the time of sampling, these communities were small and were surrounded by agricultural lands used for alfalfa and hay. These communities are now growing with suburban-like character and now have the typical structures associated with suburbs including houses, gas stations, restaurants, and associated infrastructure.

3. Sampling strategy

The sampling strategies used for the earlier sampling events (1974, 1988) in the canyons are not recorded. For the CERCLA action, the studies in the canyon were performed as a part of the Ecological Risk Assessment for the site because the canyons do not have human populations but are used

as open space and wildlife habitat. In these studies a stratified random sampling grid was established with a 5 point composite sample collected at each random grid point. At each point, soils and vegetation were collected for chemical analysis and species of plants were counted and quantified for use in diversity calculations. Plants were characterized with regard to their native or non-native (introduced) status. Samples were collected only on the flatter areas of the canyon floors rather than the steep hillsides of the canyons. The sampling grid was stratified to account for elevation differences and the change of plant communities as a function of elevation. The results were then compared to nearby canyons which were not as severely impacted by smelter smoke emissions. A similar approach was used at the Erda airshed with a random grid laid out and then 5 point composite samples collected for each grid. For Erda, only soil samples were collected.

4. Known or suspected sources of contamination.

Historical literature documents that the early smelter complex emitted large amounts of sulfur gases which killed the vegetation in the nearby canyons. Metal particulates were emitted also, but the damage appeared to have come from the sulfur gases. Early smelter men monitored the stack emissions, not because they were concerned for the environmental impacts, but rather because the loss of metals via the stacks indicated a loss of metal recovery and a loss of profits. Each new smelter improved emissions controls. The current smelter has very little emissions of either sulfur gases or metals.

5. Types of contamination, quantities

The particulate emissions of the smelters at the site had the chemical composition of flue dust, which today is classified as a hazardous waste. The quantities of contaminants are highly uncertain because they are entirely dependent on very old emissions data and older metal assay techniques, but a gross estimate is possible if the monitoring is representative of the entire operational history of the smelters and refinery. If the data in Table 9.1 are projected over the operational history of each facility, the estimates of quantities in Table 9.4 are extrapolated.

TABLE 9.4
TOTAL MASS OF ATMOSPHERIC EMISSIONS OVER HISTORY OF FACILITY

Dates of operation	Facility	Emissions to the atmosphere via stacks (tons over the entire history of the facility)		
		Arsenic	Lead	Selenium
MILLS				
1936 - 1991?	Magna Molybdenite Heat Treater	6.83	298.1	0.10
1936 - 1966	Arthur Molybdenite Heat Treater	24.4	16.4	1.14
NORANDA SMELTER				
1979-1995	Main Stack	121.5	219.6	14.3
1979-1995	Dryer	0.88	13.1	0
REFINERY				
1950-1995	Refined furnaces	0	0.082	0.082
1950-1995	Anode furnaces	0.329	0.657	4.35
1950-1995	Sludge Roasters	65.8	1.48	340.7
1950-1995	Cooling Tower	37.1	2.21	85.0
1950-1995	Dore Precipitator	0.57	5.50	2.46
1950-1995	By-product retort	1.40	2.63	27.1
HISTORIC REVERBERATORY SMELTER				
1906-1979	Reverberatory Smelter	18,865	6,909	365
TOTAL STACK EMISSIONS				
1906-1995	Total stack emissions	19,123 tons	7,469 tons	840 tons

6. Location of contamination, exposures

The ultimate fate of the atmospheric emissions via fallout can not be determined. The largest proportion of arsenic and lead came from the older reverberatory smelter. Over the years, it is very likely that, because these atmospheric particulate emissions are typically small in size, they would have been subject to secondary transport during rain events. The particulates could have ended up in early mudflows which sent mud all the way to the Great Salt Lake, or in later mudflows which ended up behind the dams in the canyons. After a systematic chemical survey of the canyons, later investigators looked specifically in the sediments behind the dams to determine if significant concentrations of originally airborne material had collected there. The contamination that remains in the original location of deposition or in nearby gullies or behind dams may be only a small fraction, a residual, of the original contamination.

The exposures of concern in the canyons is the uptake of the contaminants from soil by plant and insect communities. The food chain progression starts first with small omnivorous mammals and herbivorous mammals, insectivorous mammals and insectivorous birds. Shrews, voles, mice, deer, elk, and theoretically, chickadees, swallows and bats (theoretically because none were observed during the sampling) were representative species investigated during the sampling. As these species ingest the plant material or insects containing the contaminants of concern, the contaminants tend to bioaccumulate or concentrate within certain body tissues. Next, as carnivorous mammals and birds ingest these species, they, too, are potentially exposed to elevated concentrations of the contaminants.

During the investigation, not all of the intended investigatory species were detected. This was attributed to the lack of habitat essential for these species. Increased predation caused by the reduction of vegetative cover may have reduced the amount of individuals potentially caught for each of the sampled species. Reduction of the vegetation in each of the canyons also reduced the available food source at the bottom of the food chain, causing potential pressure to herbivores and insectivores. Restriction of food and habitat certainly would have hindered the success of the investigated species in the canyons, and may be the primary hindrance to species prosperity, rather than the concentrations of the contaminants of concern.

D. Scope and Role of Operable Unit

This operable unit was created because of the known impacts of the smelter emissions to the plants of the canyons and because there was concern that residuals in the soils from those days might still be impacting the plants and animals of the canyon. This operable unit (OU 19) did not have sources of its own but received contamination from the area of the mills (OU 15), the refinery (OU 14) and the smelter (OU13). Secondary transport of contaminated soils and sediments downstream from OU 19 contributed to contamination of the Garfield Wetlands and Great Salt Lake (OU 22). Because the canyons were the largest areas of open space use in the North Zone, it was the site used for the upland terrestrial ecological risk studies.

Because it was unknown how far smelter smoke had traveled, the Erda Fallout was a part of OU 19. In this area, exposures to human residents were possible.

E. Current and potential Future Site and Resource Uses

The current zoning for the canyons is industrial/mining and the current land use is open space and buffer lands for Kessler Canyon and Little Valley. A sand and gravel mining operation occupies the lower part of Black Rock Canyon. Little Valley, near the Town of Magna, has been mentioned as a possible site for residential development. Other valleys in the Smelter Fallout OU could potentially be used for residential development or recreation after the smelter and refinery are close.

F. Summary of Site Risks

1. Chemicals of Concern

Table 9.5 demonstrates the concentration ranges found by various investigators in the canyons near the smelter.

TABLE 9.5
CONCENTRATIONS OF SELECTED CHEMICALS OF CONCERN IN CANYON SOILS
(Units are mg/Kg, or parts per million)

Location	Arsenic concentrations		Lead concentrations		Selenium concentrations	
	maximum	mean	maximum	mean	maximum	mean
Kessler Canyon (Above and below dams, 1988)	810	206	84	45.3	64	9.7
Kessler Canyon (above first dam only, 1988)	307	126	84	46.8	7	1.3
Kessler Canyon (1995)	109*	67	367*	155	3.4*	2.6
Kessler Canyon dam sediments (2001)	88.2	41.5	140	60.4	1.9	0.91
Little Valley (1974)	57.5	36	222	117	3.6	3.1
Little Valley (1988)	298	111	219	66.4	1	<1
Little Valley (1995)	70*	50	275*	155	4.5*	1.6
Black Rock (1974)	654	350	1126	689	4.5	2.5

Location	Arsenic concentrations		Lead concentrations		Selenium concentrations	
	maximum	mean	maximum	mean	maximum	mean
Black Rock (1988)	325	160	133	65.2	1	<1
Black Rock (1995)	118*	67	508*	161	4.8*	1.8
Black Rock Monroc area (1999)	76.6	24.9	218	64.9	<0.5	<0.5
Erda Fallout#	991	27.6	4860	287	Not determined	Not determined
Erda Fallout	112	8.4	1010	151	Not determined	Not determined
BACKGROUND SITES						
Coon (1974)	22.6	13.9	228	110	1.3	1.3
Harkers (1974)	40.2	23.6	230	100	<1	<1
Coon (1988)	34	19.4	40	27.5	<1	<1
Coon (1995)	57*	36	259*	109	4.3*	2.3

#includes samples close to (<1 mile) from International Smelter
* upper 95% confidence level.

G. Removal/Remedial Action Objectives

1. Reduce or eliminate unacceptable exposures of plants and wildlife to residual contaminants in the soils of the canyon.

2. Reduce or eliminate unacceptable exposures experienced by people who might use the canyon properties for recreational activities in the future, such as hiking and hunting.

3. Prevent migration of contaminants into sensitive habitats such as wetlands.

H. The Selected Remedy

As documented in the ecological risk assessment reports, the on-site concentrations of the chemicals of concern may currently pose a risk of exposure to some wildlife receptors. Though observable effects were not distinguished during the assessment, some risk quotients were exceeded for some of the contaminants. Currently, the main threat of exposure has been determined to come from palatable, selenium concentrating plants that are consumed by small herbivorous and omnivorous bird and mammals. There was a reported possibility of increased risk to carnivorous mammals and birds that consume the birds and mammals that feed primarily on these plants. Most other previous investigations determined that there were no current risks for exposure to on-site workers or potential future recreational users of the canyons.

Although the risk to various wildlife species in the canyon from exposures to chemicals can be calculated, remediation of the soils would result in massive destruction of habitat which is showing signs of recovery due to extensive revegetation efforts. In this case, a potential risk due to residual contamination is preferred over complete destruction of canyon habitat, and erosion problems which would follow.

However, the agencies understand that these canyons might not always be used for wildlife habitat and may undergo development in the future. The agencies agree that mapping where concentrations of chemicals of concern exceed developed land use standards or pose an increased risk of observable effects to either ecological or human receptors, will be performed. Areas that are currently capped will be delineated from areas that pose a threat but are not capped. Plant species, which can concentrate the chemicals of concern and pose a risk to herbivorous and omnivorous species, will not be used during revegetation efforts in the canyons. Areas that have a potential to pose a threat dependent upon future land use will be segregated and scheduled for appropriate remedial and reclamation activities in the future, pursuant to the chosen land use.

If the canyon areas are mined for sand, gravel and/or topsoil, none of these materials containing lead in excess of 500 ppm and/or arsenic in excess of 50 ppm shall leave the site. On-site use must be appropriate for the land use.

Section 10: Pine Canyon (Kennecott South Zone OU 20) and other Tooele County areas (Kennecott South Zone OU 18)

A. Site Name, Location and Description

1. Site Type and description of operable unit

Pine Canyon (OU 20) includes Kennecott owned properties on the western slopes of the Oquirrh Mountains in Tooele County. Several mining companies located their processing facilities on the western side of the Oquirrhs and transported their ores from Bingham Canyon on the eastern side via a tram over the mountain crest or through tunnels. Wastes included waste rock, tailings, and mine drainage. The majority of these wastes are located downstream of Kennecott properties and are being addressed as a part of the International Smelting and Refining NPL site.

Other Tooele County areas include mine drainage and waste rock associated with adits and tunnels which have at least one end daylighting on the western side of the Oquirrhs in Tooele County.

2. Facilities located within OU 20 and OU 18

The following facilities or areas are all located on the Tooele County, or western, side of the Oquirrh Mountains:

TABLE 10.1
LIST OF KENNECOTT-RELATED FACILITIES IN TOOELE COUNTY

Facility	Location	OU Designation
Anaconda Carr Fork	Pine Canyon (Kennecott property only)	OU20 (Kennecott property only) Most of the tailings from this operation are down gradient on the International Smelting and Refining NPL site.
Star Mill	Pine Canyon (Kennecott property only)	OU20, reclamation pending under supervision of DOGM
Pine Canyon	Pine Canyon (Kennecott property only)	OU 20, reclamation pending under supervision of DOGM

Facility	Location	OU Designation
Pine Canyon Tunnel	Upper Pine Canyon	OU 20, UPDES permit
Utah-Delaware Mill	Pine Canyon	NOT a part of the Kennecott Site. This is a part of the International Smelting and Refining NPL site.
International Mill	Pine Canyon	NOT a part of the Kennecott Site. This is a part of the International Smelting and Refining NPL site.
International Smelter	Pine Canyon and Tooele Valley	NOT a part of the Kennecott Site. This is part of the International Smelting and Refining NPL site.
Anaconda Carr Fork Tailings Pond	Tooele Valley, downgradient of Pine Canyon	NOT a part of the Kennecott Site. This is part of the International Smelting and Refining NPL site.
Elton Tunnel	mouth of Pine Canyon	NOT a part of the Kennecott Site. Outfall is on the International Smelting and Refining NPL site.
Water Supply Tunnel Dump	Middle Canyon	OU 18, site management plan needed
Water Supply Tunnel	Middle Canyon	OU18, site management plan needed
Other adits and tunnels including Bingham West Dip, Copper Boy, Spring Canyon, Upper Bruneau, Helen B.	Western Slope Oquirrhs	OU18
Other adits and tunnels, including Apex (Parvenu), Armstrong, Highland Boy	Near crest of Oquirrhs with drainage toward Bingham Pit	OU 18
Erda Airshed	Tooele Valley	See OU 19 (section 9)

B. Site History and Enforcement Activities

1. Activities at the site which led to contamination

Anaconda Carr Fork Mine: Several companies with mines in the Carr Fork area of Bingham Canyon found it convenient to set up milling and smelting operations outside Bingham Canyon due to the increasingly limited space there. While Kennecott's predecessors use the mills and smelter near the Great Salt Lake (see OU's 13, 14, and 15), the other mining companies in Bingham Canyon used the mills and smelter located on the western slope of the Oquirrhs just over the crest. The ores were shipped by an aerial tram from Bingham Canyon to the western facilities. The first smelter and mill, built by the International Smelting and Refining Company, became operational in 1911. Anaconda purchased the smelter and mill in 1915. These facilities, which were partially operational until 1971, are not the subject of this ROD. The International Smelter Site is now being addressed as a separate NPL site.

Later on, Anaconda began a new project in 1974 to develop its Carr Fork properties in Bingham Canyon which were accessed by a shaft in Pine Canyon. A large flotation mill was constructed near the former International Smelter site. ARCO bought Anaconda in 1981. The mine was closed in 1984 due to an accident. In 1985, Kennecott bought the land near the shaft and all the mining claims in Carr Fork. ARCO retained ownership of the mill and smelter sites and the lands on which the milling and smelter wastes are located. (The wastes on ARCO land are not covered in this ROD but are a part of another NPL site.)

Pine Canyon Tunnel: The Pine Canyon Tunnel, now on Kennecott land, was constructed in 1972 to provide ventilation and water drainage for the Carr Fork operations. During operations (1972 - 1985) the water drainage went to a series of settling ponds before it was used for ore processing and irrigation. The settling ponds were reclaimed by Kennecott in 1988. The mine water discharge was added to Kennecott's UPDES permit in 1995 (Outfall 9). A partially unreclaimed dump of waste rock near the entrance of the tunnel may have been associated with the tunnel construction.

Pine Canyon: Similar to the experiences in Kessler Canyon, the nearby International Smelter emitted high concentrations of sulfur gases which devastated the vegetation in Pine Canyon. Although there is little information about historical mudflows, major mudflow events occurred in 1984 and again in 1993. The mudflows were blamed on moving the channel of the creek and denuded canyon walls at the head of the canyon. Kennecott reclaimed and revegetated several sediment ponds in the valley floor shortly after they acquired the property.

Star Mill: Several references indicate the presence of a cyanide mill used for

processing gold bearing ores located at the mouth of Baltimore Gulch, a tributary of Pine Canyon, or close by. It was operating in 1898 with a capacity of 25 - 50 tons/day of gold ore.

Water Supply Tunnel and Dump (sometimes called Middle Canyon Dump): In nearby Middle Canyon is the Water Supply Tunnel and associated Waste Rock Dump. This tunnel was driven in 1913 to facilitate a water exchange between Tooele and Bingham City. It may have also been used to transport ores from the Carr Fork operations to the smelter on the Tooele side, and for generation of water power. One end daylights in the Bingham Pit and the other near Middle Canyon Creek. The water exchange is no longer in force. The tunnel is about 11,000 feet long and measures 8 feet by 9 feet. The waste rock dump is on the Middle Canyon side and is about 250 feet in diameter.

Other tunnels on Western Slope of Oquirrhs or near the crest of the Oquirrhs: In addition to the Elton Tunnel, which has a portal on the nearby International Smelting and Refining Site, there are numerous tunnels which were constructed to access Bingham Canyon claims but with portals on the western slope of the Oquirrhs. They include Apex (a.k.a. Parvenu), Armstrong, Highland Boy 700, Bingham West Dip, Adamson, Copper Boy, Spring Canyon Tunnels, Upper Bruneau, and Helen B. Kennecott owns the water rights associated with these tunnels, but most of the flows are very small.

> *Apex (Parvenu) Tunnel*: Apex Tunnel was probably constructed between 1905 and 1907 and was used for haulage and drainage from the Apex working above the 1000 foot level. The Apex Tunnel interconnects with the Pine Canyon Tunnel and are at the same elevation. It has also intersected with the Bingham Pit, and was proposed as a possible method to transport tailings should a tailings disposal area be needed in Tooele County. (This idea was ultimately rejected.)
>
> *Armstrong Tunnels:* The Upper and Lower Armstrong tunnels were apparently constructed to access the Mercer No. 2 mining claim and were operational between 1914 and 1978. Water in these tunnels drained toward the Bingham Pit. The tunnels did not have any connections with the Anaconda Carr Fork works. Today, only 30% to 50% of the tunnels still exist because the eastern portals have both been mined away by the pit.
>
> *Highland Boy 700 (Highland Tunnel):* This tunnel is located on the Lorena mining claim and was used for haulage and drainage. It is interconnected with all the other tunnels on the western slope. It has a portal near the crest in the Bingham Pit.

Bingham West Dip Tunnel (Levine Tunnel): The Bingham West Dip Tunnel was on the Angell Claim and may have been built prior to 1900. There is no evidence of any ore discoveries or extraction. By 1926, the tunnel had been converted to a water supply tunnel and the water was piped to the International Smelter. The tunnel was used for this purpose until 1985. The tunnel portal is caved in, but a steel pipe transects the tunnel and discharges to a cement sump near the portal and then to a storage tank outside of the tunnel. There is a waste rock dump near the tunnel portal. The tunnel is located in Pole Canyon, a tributary to Pine Canyon. The water now spills out of the tank into the creek.

Adamson Tunnel: International Smelter drove this tunnel in 1925 to collect water for its processing needs. Any excess not used by the smelter was sent down the creek for use as irrigation water. The tunnel was 319 feet long and transected the bottom of Pine Canyon. The water right associated with the tunnel is 413 gpm. The tunnel drains into Pine Canyon via a water storage tank. Because its reported location is close to Pine Canyon Tunnel, it may have been obscured by a mudflow. The tank overflows into Pine Canyon Creek.

Copper Boy Tunnel: Copper Boy Tunnel was located in Baltimore Gulch, a tributary to Pine Canyon. It is at 7700 feet elevation and has a water right of 200 gpm.

Spring Canyon Tunnels: Spring Canyon (located between Pine Canyon and Middle Canyon, had three water tunnels (Hardrock Tunnel, McBride Tunnel, and Main Tunnel). The waters (water right totaling 325 gpm) were used by the International Smelter for processing.

Upper Bruneau Tunnel: There is a Kennecott water right associated with a tunnel located up Pass Canyon (just north of Pine Canyon) for 54.8 gpm. It is also known as the Pass Canyon Tunnel.

Helen B Tunnel: There is a Kennecott water right associated with a tunnel located on the south fork of Swenson's Canyon (just north of Pine Canyon) for 20 gpm.

2. Investigations, cleanup activities, enforcement

A summary of investigations and cleanups is given in the following table. Note that this table does not include actions associated with the adjacent International Smelting and Refining Superfund site.

TABLE 10.2
INVESTIGATIONS AND CLEANUPS

DATE	ACTIVITY	PERFORMED BY:
1988	Reclamation of sediment ponds near Pine Canyon Tunnel	Kennecott, under supervision of DOGM (Utah Division of Oil Gas and Mining)
1993	Ecological risk assessment sample collections in Pine Canyon and along the crest of the Oquirrhs	Kennecott, under the supervision of EPA.
1995	Monitoring of Pine Canyon Tunnel effluent begins under the provisions of a UPDES permit	Kennecott, under supervision of UDEQ-Water Quality.
2001	Relaxed slopes of Water Supply Tunnel Dump, stabilized drainage channel, revegetated	Kennecott, under supervision of UDEQ-DERR
2000 - ongoing	Oquirrh Mountain Ground Water Plan monitoring program	Kennecott in cooperation with USGS and UDNR.

C. Site Characteristics

1. Size, topography

Pine Canyon is characterized by a small valley floor (about 230 acres) trending NW with steep mountain terrain on both sides. Although the valley floor has a 7.7% slope downward, the mountains on each side have slopes on the order of 35%. Pine Canyon Creek was relocated from its original location in the middle of the valley into a cement lined box on the north side of the valley. During most of the year, the entire flow of the creek originates from Pine Canyon Tunnel. Because the slopes in the upper part of the canyon are unstable, there have been several recent mudflows. The waste rock dump associated with the construction of the Pine Canyon Tunnel is about 1 acre in size; the waste rock dump associated with the Water Supply Tunnel in nearby Middle Canyon is about 1.4 acres in size.

2. Surface and subsurface features

At Pine Canyon, the major surface structure on site is the head shaft housing of the Anaconda Carr Fork Mine, built in the early 1970s. The portal of the Pine Canyon Tunnel discharges about 35 gpm into a concrete lined ditch. There is a water tank on site which is fed from a pipe exiting a nearby mountain slope. The waste rock dump near the Anaconda Carr Fork headframe is probably from construction of the mine.

At Middle Canyon, there is a waste rock dump associated with the Water Supply Tunnel. This tunnel has a water discharge of about 500 gpm which flows into Middle Canyon Creek. There is a water tank on site. The flat surface of the waste rock dump was used at one time as a baseball field.

3. Sampling strategy

There were a number of sampling activities performed in this area for different objectives, resulting in a variety of sampling strategies. A summary of the major sampling activities is given in the following table.

TABLE 10.3
INVESTIGATIONS AT TOOELE COUNTY SITES

Location	Objective	Sampling strategy	Media	Date
Pine Canyon Tunnel Discharge	UPDES permit	Routine monitoring, grab samples	Water	1995 and ongoing
Water Supply Tunnel Dump, Bingham West Dip Tunnel	Site Investigation	Grab samples	Soils, wastes, water	1996
Crest of the Oquirrhs, Pine Canyon drainage	Ecological risk assessment	Composites, line samples	Soils, vegetation	1995
Springs and Tunnels	Water supply model	Routine monitoring	water and ground water	2000 and ongoing

4. Known or suspected sources of contamination

The sources of contamination in the Pine Canyon and adjacent area are varied.

TABLE 10.4
SOURCES OF CONTAMINATION, TOOELE COUNTY KENNECOTT SITES

SOURCE	WASTE	MIGRATION PATHWAY	LOCATION OF WASTES
International Smelter	Stack emissions*	Airborne, fallout	Scattered about the canyonsides and mountains
Pine Canyon Tunnel	Mine drainage	Down creek channel	Sediment ponds and downstream water users
Pine Canyon Tunnel	Waste rock	Mechanical transport	Still near the portal entrance
Water Supply Tunnel	Tunnel drainage	Down creek channel	Near mouth of Middle Canyon, if any.
Water Supply Tunnel	Waste rock	Mechanical transport, erosion	Most of it still located near tunnel portal in Middle Canyon
Other tunnels	Mine drainage	Down the slopes, most onto eastern side	Bingham Pit, mostly

*other wastes associated with this facility are located on the nearby International Smelter site.

5. Types of contamination, quantities

Investigations have located the wastes associated with some of the operations in this area. (See Table 1.5)

TABLE 10.5
TYPES OF CONTAMINATION, TOOELE COUNTY KENNECOTT SITES

Facility	Years of Operation	Nature of wastes	Volume of wastes	Current status
International Smelter*	1911-1971	Smelter emissions	Unknown	Traces remain in soils of the canyon behind the smelter
Pine Canyon Tunnel	1972 - present	Mine drainage	35 gpm	UPDES permit
Pine Canyon Tunnel	1972 - present	Mine drainage sediments	Unknown	Sediment ponds capped and revegetated
Pine Canyon Tunnel	1972 - present	Waste rock	100 cy	At angle of repose near portal of tunnel
Water Supply Tunnel	1913 - present	Waste rock	30,000 cy	Slopes relaxed, flat surfaces revegetated
Water Supply Tunnel	1913 - present	Tunnel drainage	500 gpm	Flows to Middle Canyon
Bingham West Dip Tunnel	1926 - 1985	Waste rock	4150 cy	Near portal of tunnel
Bingham West Dip Tunnel	1926 - 1985	Tunnel drainage	150 - 200 gpm	Flows to Pole Canyon creek then to Pine Canyon

* Most of the smelter wastes and tailings associated with this facility are located on the adjacent International Smelter Superfund Site.

6. Location of contamination, exposures

The exposed contamination consists of waste rock dumps in Pine Canyon and Middle Canyon and mine drainage. In Pine Canyon, there are occasional visits by mine workers, but most of the exposures to the contaminants are to wildlife. In Middle Canyon, there are occasional visits by hikers and bikers and there is a popular campground nearby, but most of the exposures are to wildlife.

D. Scope and Role of Operable Unit

This operable unit is located in a fairly remote area of Kennecott property and, other than Pine Canyon Tunnel, is not associated with active mining operations. Pine Canyon Tunnel is used for access to underground workings in the vicinity of Bingham Pit. The facilities are grouped together because of their geographic location in Tooele County on the western slope of the Oquirrhs.

E. Current and potential Future Site and Resource Uses

The Pine Canyon area is zoned industrial/mining but its current land use is open space and a buffer zone to active mining operations just over the crest. The Middle Canyon area is frequented by visitors seeking recreation opportunities. Both areas are quite scenic and local governments are considering recreational and tourist attraction possibilities in the future.

F. Summary of Site Risks

1. Chemicals of Concern

TABLE 10.6
CONCENTRATIONS OF MAJOR CONTAMINANTS IN SOILS

Location	Lead in soils (mg/Kg)		Arsenic in soils (mg/Kg)		Selenium in soils (mg/Kg)	
	maximum	average	maximum	average	maximum	average
Water Supply Tunnel Dump	2110	2110	107	107	<0.5	<0.5
Pine Canyon Tunnel Dump	62.7	62.7	68.6	68.6		
Bingham West Dip Tunnel Dump	236	236	29.3	29.3	36.3	36.3
Crest of Oquirrhs behind smelter	632.5	592	95.8	76.6		

TABLE 10.7
WATER QUALITY OF TUNNEL DISCHARGES

Location	Arsenic (mg/l)	Lead (mg/l)	Selenium (mg/l)
Pine Canyon Tunnel(1995)	0.006	0.006	<0.004
Pine Canyon (2001)	0.007	<0.005	Not reported
Pine Canyon (2001)	<0.005	<0.005	Not reported
Pine Canyon (2001)	<0.005	<0.005	Not reported
Water Supply Tunnel	<0.005	<0.005	0.003
Bingham West Dip Tunnel	<0.005	<0.005	0.008
Bingham West Dip Tunnel (2001)	<0.005	<0.005	Not reported
Upper Bruneau Tunnel	<0.005	<0.005	Not reported

G. Removal/Remedial Action Objectives

1. Reduce or eliminate unacceptable levels of exposures to wildlife

2. Reduce or eliminate unacceptable levels of exposures to recreational and industrial workers.

H. The Selected Remedy

Most of the dumps had concentrations of contaminants well beneath the level of concern for human health of recreational and industrial workers at the site. However, one of the dumps (Water Supply Tunnel Dump) was actively eroding into Middle Canyon Creek which could have posed a threat to wildlife which use the creek water for drinking. Therefore, Kennecott, under UDEQ supervision, constructed various structures on top of the dump and along the toe of the dump to stabilized the the dump faces and prevent further erosion and impact to the main drainage of Middle Canyon. Two ditches in conjunction with a retaining berm were placed along the top of the dump to collect drainage water. Drainage water is routed via a pipe and ditch to the Middle Canyon drainage. At the toe of the dump, Kennecott removed waste rock from areas where the material had encroached into the main drainage of Middle Canyon. A berm was place between the toe of the waste rock dump and the drainage to prevent continued

encroachment. Additionally, a layer of rocks was placed in the drainage to prevent undercutting of the waste rock slope. Kennecott has also capped and revegetated the old sediment ponds associated with the Pine Canyon Tunnel discharges. This was done under the supervision of the Utah Division of Oil, Gas, and Mining. Additional reclamation work is ongoing under supervision of this state agency.

Most of the significant water discharges from the tunnels in the area were studied during the investigations of this area. The water was of drinking water quality, and therefore does not pose a threat to potential downstream human users. The streams are intermittent in nature and are not classified by the state.

Although there was ample evidence that smelter emissions had impacted the plant life in Pine Canyon and the residual metals were above background levels, the concentrations and extent of contamination did not rise to a level of concern for wildlife populations in the area.

In addition to the actions already taken, the Water Supply Tunnel Dump must be inspected on an annual basis to determine if the actions taken there are effective. A map, for the local authorities, must be produced which shows locations where contaminants are too high to allow unrestricted land use in the future.

Section 11: Precipitation Plant (Kennecott South Zone OU24)

A. Site Name, Location and Description

1. Site Type and description of operable unit

This site is physically located in the Kennecott South Zone Site, but is linked to the Kennecott North Zone site because, while operational, it provided a copper sludge product that was shipped to the smelter (OU 13) for further purification. The Precipitation Plant site is located just to the west of Copperton along Bingham Creek. It consists of large wooden tanks in which the reactions took place, associated channels for handling of solutions, and storage areas for scrap iron and product. A flow chart of the precipitation plant's role in copper production is given in Figure 11.1. A number of nearby historic and current facilities are also included in this operable unit.

2. Facilities located within OU24

There is one major facility within OU 24, the Kennecott Precipitation Plant, though there are a number of structures and buildings which are associated with this plant. The facility was built on the same site as used by several earlier operations, including the Lead Mine Mill, and several other former precipitation plants.

Other nearby facilities within OU24 include a number of historic and current railroad facilities including the Copper Belt Railroad, the portions of the Denver and Rio Grande Low Line within Bingham Canyon, Cuprum Yard, the Denver and Rio Grande High Line, Cuprum Heights, the Bingham and Garfield Railroad, the Kennecott Ore Haulage Railroad, the Ore Loading Area, the Copperton Railyard and the portion of the Bingham Canyon and Camp Floyd Railroad within Bingham Canyon. Current milling facilities include the Copperton Concentrator, and the Copperton Concentrator Process Water Ponds. Former waste areas include the Copperton Dumping Areas and the Revere Switch Pond. Nearby tunnels include the 5490 Tunnel, the 6040 Tunnel, and the unnamed 700 foot adit.

B. Site History and Enforcement Activities

1. Activities at the site which led to contamination

Precipitation Plant

Although the current structures on the site date back to 1965, there were a number of facilities located on the site prior to the current facility. The area was first used for the Lead Mine Mill and tailings pond, which operated from 1883 until the mill burned in 1896. With a capacity of about 50 tons/day of lead ore, it discharged its tailings to a nearby tailings pond. After the mill burned, a pyritic smelter which operated from 1896 to 1901, was erected on the site. The ruins of the smelter were then used in 1905 to house victims of smallpox and other infectious diseases. The first precipitating plant at this location was constructed in 1929 to be a central location for the treatment of acid leachate which had begun flowing from the toes of the dumps in the nearby gulches. Prior to this centralized approach, there were smaller (and cruder) launders at the mouth of each gulch in Bingham Canyon. All the tailwaters from these early operations were discharged into Bingham Creek. Shortly after the centralized facility was built, the miners built the Bingham-Magna ditch in 1930 to carry the precipitation plant tailwaters to the Magna Tailings Pond (OU15). Before construction of the ditch, the tailwaters were discharged to a settling pond "where they seeped away". Local sources have indicated that waste rock was used to level the site prior to construction of the 1929 plant.

The centralized precipitation plant, called the Lead Mine Precipitation Plant, consisted of concrete troughs and long settling tanks. The troughs (launders) were 4 feet wide by 4 feet deep by 960 feet long. The shed for storing scrap iron and unloading rail cars carrying scrap iron was 550 feet long. In 1965, the concrete launders were demolished and a new plant was built for the recovery of copper from the acid leachate. Prior to construction of the new plant, the site was partially cleaned up.

The "new" plant consisted of 2 modules with 13 redwood cones each which received acid solutions containing copper and scrap iron. A copper precipitate called "copper mud" was produced. The copper precipitate was slurried to a thickening tank, a surge mixing tank and then to filter presses where it was weighed, dried, loaded into railcars and then shipped to the smelter. The resulting tailwaters (copper now removed) went into two 140 foot diameter settling basins and then recycled through the leach water circuit. The acid waters were taken back to the top of the dumps and used for leaching again. When active leaching was discontinued in 2001, the precipitation plant became surplus and is slated for demolition as a part of this action.

Nearby Railroad Facilities

The Copper Belt Railroad was one of several shortline railroads which were built around 1900 to service the mines in Bingham Canyon. The Copper Belt Railroad was standard-gauged and had tracks between the Rio Grand Western Railroad terminus in the town of Bingham to the Old Jordan Mine, with branches to the Commercial Mine and the Telegraph Mine. The railroad was built on the bed of a very narrow gauge mule tramway laid out in 1874. The Railroad was about 4 miles in length. The line was sold to the Rio Grande in 1908. Today, the bed of this railroad has been mined away or is buried under the waste rock dumps and is no longer accessible.

The Denver and Rio Grande Low Line and Cuprum Yards was built in 1906 to capture the ore hauling business from the Utah Copper Mine (Bingham Pit) to the new Magna Mills. The railroad started at Lead Mine (the site of the Precipitation Plant), swung two miles to the south to gain elevation, continued high on the mountainside to a staging area (Cuprum Yard) and then jointed with the Copper Belt Railroad high in upper Bingham Canyon. The line was double tracked to handle the volumes of ore from Utah Copper and Boston Consolidated. The line from Welby Junction to Midvale had already been double-tracked, but the branch to the mills in Magna was only single tracked. Only the portion of the railroad line upgradient of Lead Mine is included in the site. The lower portions of the rail right-of-way (Lead Mine to Welby Junction, Welby Junction to Magna, and Welby Junction to Midvale) are currently owned by Union Pacific. The portion above Lead Mine has been buried by waste rock.

The Denver and Rio Grande High Line and Cuprum Heights was also built in 1906 to provide access to a new roundhouse facility at Cuprum Heights. The roundhouse was reached via winding stairs from Bingham City. The site is buried by waste rock.

Bingham and Garfield Railroad was constructed by Utah Copper in 1911 because the Denver and Rio Grande Low Line could no long handle the volume of ore going from the Bingham Pit to Magna for milling. When it was built, it was 20 miles long and included 4 tunnels and 3 major trestles in Bingham Canyon. The railroad featured 2 railyards, Bingham Yard and Auxiliary Yard. Although its sole customer was almost exclusively Utah Copper, it was a common carrier, ran occasional passenger trains and had a spur to the Hercules powder plant. The line was abandoned in 1948 and the rails removed. The railbed still exists between Bingham Canyon and Magna, but the portion in the canyon above Copperton has been buried by waste rock or subsumed by the pit.

Kennecott Ore Haulage Railroad (Copperton low line) was built in 1948. It featured a more gradual grade than the Bingham and Garfield. At first, it carried

Kennecott Utah Copper ore from the Copperton Yards to the Magna milling facilities. At first it was run using electric motors powered by overhead lines. The total length was 16 miles. In 1964, another branch of 9-miles was added to the Bonneville Crusher. Electrification of the Copperton Low Line was removed in 1979 and operations began to use diesel locomotives. Although the ore haulage operations have largely ceased due to the closure of the mills near Magna, the ore haulage road remains in service for occasional use in hauling supplies to the mine.

The Copperton Railyard, located just south of the town of Copperton and east of the precipitation plant, operated from 1948 until 2000 as a marshalling yard for ore cars going into and out of the pit. From the yard, the ore cars were then hauled to the Magna Mill and later the Bonneville Crusher via the Kennecott Ore Haulage Rail Line. The railyard had a dispatcher's office which communicated with the trains and controlled the switches in the yard and all the way to Magna. The equipment in the dispatcher's office was removed when ore haulage ceased.

The Ore Loading Station was a new facility that was built in 2000 and was used for loading ore into trains after the original railroad into the pit was buried by waste rock. Haul trucks would carry the ore via haul roads and dump it down an embankment. An electric shovel at the bottom of the embankment scooped up the ore and loaded it into rail cars moved sequentially into position by the shovels. The ore loading station was located just west of the precipitation plant. The station is now idle since the closing of the Magna Mill, Bonneville Crusher and most rail operations in January 2001.

The Bingham Canyon and Camp Floyd Railroad was originally constructed in 1873 to service the mines in Bingham Canyon with plans to extend to Mercur and Ophir as well. Only the Bingham Canyon portion was built. The line was narrow gauge. The purpose of the railroad was to haul ores from Bingham Canyon to the mills and smelters in Midvale and Murray. After the line was purchased by the Denver and Rio Grande in 1881, it was converted to standard gauge in 1890. Only the portion of this historic rail line in Bingham Canyon is a part of the site. The right-of-way in the valley in owned by Union Pacific and is not a part of the Kennecott Site.

Nearby milling facilities

Just to the north of Copperton is the Copperton Concentrator. Ores are sent from a crusher in the pit via conveyor belt where it is stored temporarily in a covered storage shed behind the concentrator. From there it is ground with rotary mills containing steel balls. The ground ore is then sent to flotation cells where reagents are added to separate the sulfide minerals from the host minerals. The sulfides adhere to the bubbles and collect in the froth and are skimmed from the

surface. The sulfide minerals or concentrates, containing copper, are then slurried to the smelter; the host minerals or tailings are slurried to the Magna Tailings Pond. The Copperton Concentrator was built in 1988, expanded in 1992, and has four grinding lines with four semi-autogenous Grinding Mills and eight ball mills.

The Copperton Concentrator Process Water Ponds serve as storage, mixing, and settling basins for the process waters used in the Copperton Concentrator. The process waters are a combination of waters recycled from the smelter and refinery and waters recovered from the decant pond at the Magna Tailings Pond. These process waters do not have to be pristine. It is likely that after closure, these ponds might be reused for water treatment purposes for the ground waters and acid leachate.

Waste areas

An area known as Copperton Dumps may have referred to a tailings pond formerly in the location now occupied by the precipitation plant. These dumps may have also referred to an area where the Large Bingham Reservoir is today.

The Revere Switch Tailings Pond is referred to as an area in which Utah Copper built a tailings pond in 1905 for use by Utah Copper's experimental mill in the Bingham Canyon. It is suspected that this tailings pond was located in the area where the Large Bingham Reservoir was later built. When the original Large Bingham Reservoir was retired, cleanup crews discovered a layer of tailings underneath the reservoir sludges. These tailings were removed from the area, mixed with sludges and soils, and buried underneath the relaxed slopes of the waste rock dumps at the northern end of the Eastside dumps.

Tunnels

The 5490 Tunnel was constructed by Kennecott in 1957 through an area then owned by USSRM. The tunnel was built to facilitate easier ore haulage from Kennecott's expanding pit, but USSRM retained ownership of any ores excavated during tunnel construction. The tunnel does not generate significant flows because it is grouted. Today, it is used for the conveyor belt between the pit and the Copperton Concentrator. The portal outside the pit is located near the precipitation plant site.

The 6040 Tunnel was a railroad tunnel which allowed ore trains to travel from Bingham Canyon into and out of the pit. At the time of construction, it was 4200 feet long, 24 feet high and 18 feet wide, using steel and timber supports. The canyon-side portal was buried by waste rock in 2000 when railroad service to the pit ceased, and the pit-side portal is being mined away. The tunnel may be used

again in the future to access the North Ore Shoot.

Listed as "unnamed adit" in EPA records, a 700 foot tunnel just north of Lark was discovered during the construction of the East Side Collection System. The flow from the tunnel has now been directed to the East Side Collection System.

2. Investigations, cleanup activities, enforcement

The precipitation plant was partially investigated in 1997 as part of the historic facilities assessment project (on-site environmental assessments) supervised by UDEQ. They reported that at the time the older plant was retired, 30,000 tons of thickener material and other high metal soils were sent to the top of the dumps, scrap metal was washed and sent to Atlas Steel for recycling, and other soils and debris were sent to the Trans Jordan Landfill. A cut-off wall called the Bingham Creek cut-off wall was constructed in 1995 just downstream of the site to collect any surface and subsurface flow which transected the site. The site will require further characterization after the current plant is demolished. The groundwater issues at the site are being investigated by the Utah Division of Water Quality Groundwater Program.

Occasionally, there have been reported spills at the precipitation plant or nearby. A list is given in Table 11.1.

TABLE 11.1
REPORTED SPILLS IN THE VICINITY OF THE PRECIPITATION PLANT

Date	Location	Spilled Substance	Volume	Cause
8-5-95	Bingham Canyon	Barren leach water (leach water with copper removed)	120,000 gal	Sump overflowed due to lightning induced power outage
10-3-96	Tunnel portal adjacent to p-plant	Leach water	250,000 gal	36" HDPE pipeline broken when a front-end loader ruptured the buried pipeline.

Date	Location	Spilled Substance	Volume	Cause
9-14-97	West of Copperton	Leach water	1,000,000 gal	24" pipeline ruptured due to corrosion
9-14-97	West of Copperton	Seach water	500,000 gal	Gasket failure on pipeline
9-22-97	West of Copperton	Low pH water (leach water)	30 lbs copper sulfate	4" valve on 36" pipeline leaked
11-17-97	West of Copperton	Leach water	3000 gal	24" pipeline fittings failed
12-22-97	West of Copperton	Leach water	650 lbs copper sulfate	Settling pond overflowed due to outlet valve clogged with tumbleweeds.
5-27-99	Copperton	Pyrite slurry	40,000 lbs	Tanker truck hit a ditch trying to avoid deer.

C. Site Characteristics

1. Size, topography:

The precipitation plant is located on a 20 acre industrial site located just upstream of the town of Copperton in a flat valley floor of Bingham Creek. The valley is probably flat because of addition of fill material. To the south is the Large East Side Waste Rock Dumps which have steep slopes at the angle of repose; to the east is Copperton which sits on a bluff overlooking the p-plant and the railyard; to the West is what is left of Bingham Creek and Dry Fork; and to the north is the county road along the side of the valley floor.

2. Surface and subsurface features

The surface of the site is composed of several structures including the reaction cones (built of redwood), building with filter presses, railroad loading and unloading areas, open channels built of concrete, two large settling tanks, storage areas for scrap iron with gantries for moving the iron, and concrete covered

operational areas. Piles of concrete debris from prior facilities are buried in some locations on the site. The subsurface situation is largely unknown, but is theorized to contain remnants of former precipitation plants, waste rock fill, and perhaps a tailings pond left from the Lead Mine Mill. Characterization of the subsurface has not been possible to date because of the presence of an operational facility at the surface. Under the various man made structures and fill, is the alluvial channel of Bingham Creek. A substantial stream flows underground in these gravels. The underground stream eventually flows to the Bingham Creek Cut off Wall where it is captured and diverted into Kennecott's process water circuit. The degree to which there is flow through the bedrock under the site is unknown, but is under investigation by Kennecott and the Utah Division of Water Quality Groundwater Program.

3. Sampling strategy

The sampling, thus far, has been limited to a few grab samples from selected areas of the site and one 10 foot borehole through the fill material. The sampling was limited at the time because the area was covered with operational facilities and concrete. Further sampling will be necessary following demolition of the structures and removal of the concrete to determine lateral and vertical extent of the contamination.

4. Known or suspected sources of contamination

The sources of contamination at the Precipitation Plant area are varied. Underneath the site is the alluvial channel of Bingham Creek which receives waters captured from the Bingham Canyon and Dry Fork Waste Rock dumps from rainwater and snowmelt which percolates into the dumps. It receives stormwater runoff as well which sinks from the surface into the alluvial channel. These waters are typically acidic and metal laden. The degree to which the waters contaminate the solid alluvium materials is unknown.

Suspected to be underneath the site on top of the native alluvium are tailings from the Lead Mine Mill, and above that, perhaps as much as 20 feet of waste rock which was used for fill. Historic operations were known to have contaminated that fill with spills of acid leach waters which contained high concentrations of metals, especially copper. Because of soils which contain over 20% copper near the former launders, EPA concludes that there must have been spills of product (copper mud) in the vicinity.

More recent site inspections have found several dumping areas used when the launders were cleaned out, and high concentrations of metals in the soils from numerous spills of acid leachate over the years.

The sources of contamination impacting Kennecott's historic and operating railroad corridors are inadvertent spills of products (ore, concentrate, acids), diesel locomotive related contaminants (fuel and lubricants), rail maintenance contaminants (flange grease, solvents), and slag ballast.

5. Types of contamination, quantities

It is possible only to estimate the quantities of contamination because the site has not been characterized fully. At the bottom of the area are the wastes left from the Lead Mine Mill. The wastes from this operation have been previously estimated (based on production rates) to be about 47,000 tons. If prior to precipitation plant construction, 20 feet of waste rock fill were used to create a large flat area, this could amount to a volume of 645,000 cubic yards. The borehole through this fill material indicates that spills of copper solutions have contaminated the fill, which would be a unknown proportion of the fill volume. Just the reported spills could have amounted to 600 tons of solid materials in the soils and about a ton of copper alone. In addition, unknown quantities of cell cleanout material, scrap iron, rubblized concrete and rebar are present on the site. These are in addition to whatever materials might be underneath the current facilities from spills and leaks over the years.

The types and quantities of contamination associated with rail operations are unknown.

6. Location of contamination, exposures

The contamination is located in several layers reflecting the use and reuse of the land over the years. The two layers of contamination of significance for humans and wildlife exposures are the top and bottom layers. The bottom layer is the alluvial channel of Bingham Creek through which a mixture of stormwater and acid leachate flows. All wells at the site are contaminated. Exposures are prevented because waters extracted in this area are used in Kennecott's industrial process circuit. Humans and wildlife would be exposed to the top layer which contains a variety of waste piles and fill contaminated by spills of contaminated waters and products. Exposure to layers beneath would occur only in the event of construction activities. The contamination associated with railroad operations is probably located within the rail corridors.

D. Scope and Role of Operable Unit

The current action at this operable unit involves demolition and cleanup of a former industrial facility located near the Town of Copperton. Although physically located in the Kennecott South Zone, it has characteristics in common with the heavy industrial sites in

the North Zone in the varied kinds of wastes produced. The remedy will use the same strategy previously used at the smelter, refinery, and mill sites. Previously, the operations here had links to both the North Zone and the South Zone. At the South Zone, it was a source of groundwater contamination contributing to the leach waters in the Bingham Creek plume (OU2).. The former operation at the Lead Mine Mill may have contributed to the contamination found in the Bingham Creek neighborhoods in West Jordan and South Jordan (OU1). Intermediate products were shipped from this site to the North Zone via rail, particularly to the smelter (OU13) and its unloading facilities behind the smelter. The alluvial ground water issues near the precipitation plant and Copperton Railyard have already been addressed through the provisions of the NRD settlement and a state ground water permit. The evaluation of the role of bedrock transport under the site is being evaluated by Kennecott, the USGS, and the Utah Division of Water Quality Groundwater Program. In addition, Kennecott was required to complete the Eastside Collection System under the provisions of the South Zone NRD settlement with the State of Utah. The Bingham Creek Cut-Off Wall, which stops any ground water flow through the Bingham Creek alluvium is a part of the Eastside Collection System and is located just downstream of the precipitation plant. Maintenance of the Eastside Collection System was also part of the OU2 Record of Decision. The demolition of the old structures, the characterization of the contaminated soils underneath the structures and in the surrounding yard, and the cleanup of the surface areas are the foci of this action at the Precipitation Plant. Rail and rail infrastructure cleanups will proceed after mine closure, if the rails and facilities are no longer needed for future development.

E. Current and potential Future Site and Resource Uses

Until recently, the site was occupied by an active mineral processing facility which had the problems of a heavy industrial site. In 2001, when active leaching of the waste rock dumps ceased, the facility and associated infrastructure became unneeded. Only maintenance staff are left. Kennecott has announced its desire to demolish the plant. Future plans for the reclaimed site remain uncertain at this time, but they are considering using the site as the location of an experimental molybdenum recovery area or they may leave the land vacant and use it as a buffer area between the waste rock dumps in Bingham Canyon and the town of Copperton. Because the site is equipped with piping which used to service the leaching operations, it is possible to use this area as a water management area for both clean waters and "process" waters. If redevelopment does not occur, it would serve as a wildlife habitat area. (Its former use as riparian habitat would not be possible due to lack of surface water at the site.)

F. Summary of Site Risks

1. Chemicals of Concern

The primary chemicals of concern at the site are given in Table 11.2.

TABLE 11.2
CONCENTRATIONS OF HEAVY METALS IN SOILS AND WASTES AT THE FORMER PRECIPITATION PLANT

Area	Arsenic Conc (ppm)		Copper Conc (ppm)		Lead Conc (ppm)		Selenium Conc (ppm)	
	max	ave	max	ave	max	ave	max	ave
Scav Cells	61	42	84,100	78,130	540	383	7	5
Fill	18	15	49,500	22,100	680	502	<0.5	<0.5
Old launder	553	553	132,000	132,000	835	835	190	190
Surface berm	265	265	39,400	39,400	1303	1303	138	138
Old iron storage	22	22	70,500	70,500	1400	1400	<0.5	<0.5
Under former launder	167	35.9	211,000	68,920	10,200	2728	202	83.4
2001 samples	378	57.4	Not given	not given	14,100	1492	9.9	2.2
Indus-trial land use action levels		261		103,000		4414		13,972

G. Removal/Remedial Action Objectives

1. Reduce or eliminate unacceptable exposures to industrial workers and future visitors to the site.

2. Reduce or eliminate unacceptable exposures of site contaminants to wildlife.

3. Prevent movement of contaminants from the site into ground water or downstream.

H. The Selected Remedy

1. A number of the historic facilities near the precipitation plant do not require any further action as a part of this project. A summary of these areas is given in Table 11.3

TABLE 11.3
HISTORIC AREAS WHERE NO FURTHER ACTION IS REQUIRED

SITE	PREVIOUS ACTIONS	NOTES
Copper Belt Railroad	None	Site is mined away and/or buried by waste rock
Denver and Rio Grande Low Line and Cuprum Yards	None	Kennecott ROW buried by waste rock
Denver and Rio Grande High Line and Cuprum Heights	None	Kennecott ROW buried by waste rock
Bingham Canyon and Camp Floyd Railroad	None	Kennecott ROW buried by waste rock.
Copperton Concentrator	None	Active facility with state ground water permit
Copperton Concentrator Process Water Pond	None	Active facility which may be used for water management following mine closure
Copperton Dumps (a)	Cleaned up as part of the Large Bingham Reservoir removal and reconstruction	Historic dump formerly underneath the Large Bingham Reservoir
Revere Switch Tailings Pond	Cleaned up as part of the Large Bingham Reservoir removal and reconstruction	This tailings pond may have been known by the general term Copperton Dumps
5490 Tunnel	Grouted	This small discharge is captured by the Bingham Creek Cutoff Wall

6040 Tunnel	none	The Bingham Creek end of the tunnel is now buried with waste rock. The small discharge is captured by the Bingham Creek Cutoff Wall.
Unnamed Adit	Flow redirected	The flow has been redirected to the Eastside Collection System. The portal is secured with a metal gate.

(a) There were two Copperton tailings areas. This one was under the Large Bingham Reservoir. The other is reportedly underneath the Precipitation Plant. The second will be addressed as part of the Precipitation Plant cleanup.

2. Additional activities and cleanups required.

The Precipitation Plant and underlying contamination:

a. Demolish unneeded buildings and infrastructure and decontaminate construction debris, as needed, prior to disposal.

b. Fully characterize the site so that future users will know where layers of contamination may be found subsurface. Construction of future facilities may encounter buried wastes. Provide maps indicating where buried and surface wastes are located for use in future redevelopment of the site. Redevelopment for residential purposes is inappropriate.

c. At a minimum, remove contaminated materials to an appropriate repository or landfill or down to a depth of 18 inches, whichever comes first. The wastes may go to the Arthur Stepback Repository, if appropriate.

d. Cap any remaining wastes and revegetate, to minimize infiltration of rain water into underlying wastes.

e. Provide run-off and run-on controls to minimize erosion to capped surfaces and prevent migration of wastes downstream.

f. Depending on the post-removal confirmation results, institutional controls may be necessary.

Bingham and Garfield Railroad corridor:

a. Determine the location of the historic rail bed between Bingham Canyon and Magna

b. Characterize the rail bed soils and any other impacted media.

c. Remove soils with concentrations of the contaminants of concern above the standards for the intended land use. Remedial activities can follow the same protocols as outlined in the North Facilities Soils Work Plan.

d. Any waste capped in place must be mapped for use by future land use managers and planners.

Operating railroads on Kennecott property (including Kennecott Ore Haulage, Ore loading area, Copperton Yard, Smelter Railyard, Railroad line between the smelter and refinery to the UP line, and the Industrial railroad and infrastructure servicing the North Facilities).

a. Remove site infrastructure pursuant to chosen land use

b. Characterize to determine extent of impact from ore and other material shipment operations.

c. Remove soils with concentrations of contaminants of concern above standard for the intended land use. Remedial activities can follow the protocols outlined in the North Facilities Work Plan. Soils with elevated concentrations of the contaminants of concern that remain in place because of infrastructure use will be capped to prevent unwanted exposures. Mapping of the capped areas is required.

SECTION 12: SUMMARIES

A. Technical Management Strategy of the Kennecott Sites

The technical management of the Kennecott Sites was designed to facilitate streamlined decisions, consistent remedial approaches, and efficient response. A step-wise approach was used. The first step was called an "environmental assessment" which was designed to be similar to a combination Preliminary Assessment/Site Investigation (PA/SI) and a Removal Assessment. All facilities on the property of Kennecott Utah Copper were investigated by Kennecott; and all facilities or drainages downstream of Kennecott property were investigated by the Utah Department of Environmental Quality. If the facility did not pose a risk as determined in the human health and ecological risk assessments (see p. 1.15 and p. 1.19), it was immediately dropped from further investigation. If the investigation indicated that there was a current or potential risk, the site was scheduled for a Removal Action or, if further study was needed, a Remedial Investigation/Feasibility Study (RI/FS).

Because the site is large (by CERCLA standards) and the history of mining and industrial operations date back to 1863, the number of facilities present on the site during this time period was large and varied in function and types of wastes produced. At this time, there are about 386 historic and current facilities at one time associated with this site. (For a full list, see Table 12.3.) A description of each of these facilities is available in the Site Background Document and a summary is given in each Record of Decision.

Operable Units were based on geographic area where a number of individual facilities in the same area were grouped together for response or study. For convenience, sometimes several Operable Units were grouped together for purposes of Administrative Orders on Consent and the final Consent Decrees. There were a total of 24 Operable Units combined into 4 Records of Decision with 4 Consent Decrees (already in place or planned for the near future). This North Zone Record of Decision addresses OU's 8, 9, 13, 14, 15, 18, 18, 20, 22, 23, and 24, and is the fourth and final Record of Decision in the series.

A summary of the various units and sub-units of the site are given in Table 12.1.

TABLE 12.1
UNITS AND SUB-UNITS OF THE KENNECOTT SITES

Records of Decision	Sites	Operable Units	Historic and Current Facilities
September 1998 (Bingham Creek ROD)	1 (South Zone)	6	87
December 2000 (South End Ground Water ROD)	1 (South Zone)	1	5
September 2001 (Lark ROD)	1 (South Zone)	3	76
This Record of Decision (Sept 2002) (North End ROD)	2 (North Zone and South Zone)	11	201
Deleted from Site - Other PRP	Portion of 1 (North Zone)	1	14
Deleted from Site - Other Environmental Authorities used	Portion of 1 (South Zone)	2	10

During this process, there were some facilities which were dropped from further consideration as a part of this site because they were owned and operated by others. In several of these cases, a separate CERCLA action was initiated. Examples of this include the Cobalt Leaching Plant (near the Kennecott smelter) and the International Smelting and Refining Site. A few of these non-Kennecott sites were not investigated as a part of this action, but may warrant further action in the future.

Other facilities were deleted from the site as well because they are still active mining, milling, or processing facilities and are regulated under the auspices of other environmental statutes and authorities. In general, EPA and UDEQ decided not to use CERCLA authorities to address environmental problems related to current operations. These facilities are typically fully regulated under other environmental statutes. Even so, all parties recognize that CERCLA action is possible should a release of hazardous substances from the site occur in the future. Requirements for closure are provided by state statute and bonding requirements for mining and milling-related sites, but not for mineral processing areas. These, too, could be addressed in a separate action should it become necessary to do so in the future.

However, there were some instances where operating facilities were formally left within this CERCLA site. This occurred for two situations. (1) There are suspected hazardous substances underneath the existing structures which might require removal to the Arthur

Stepback Repository in the future. Examples include the smelter and the refinery. (2) The operating facility might have future use as part of post-closure remedial actions. An example of this is the Copperton Concentrator process water reservoir which might find a new life after closure as part of the South Zone ground water treatment system infrastructure.

To summarize the subject matter and coverages in various Records of Decision, Table 12.2 lists the operable units and the Records of Decision; Table 12.3 lists the various facilities and the Records of Decision in which they are discussed.

TABLE 12.2
LIST OF OPERABLE UNITS AND RECORDS OF DECISION

List of Operable Units	Bingham Creek ROD (Sept. 1998)	South End Ground Water ROD (Dec. 2000)	Lark ROD (Sept 2001)	North End ROD (Sept 2002)
OU1 Bingham Creek (South Zone)	✓			
OU2 South End Ground Water (South Zone)		✓		
OU3 Butterfield Mine and Herriman (South Zone)			✓	
OU4 Large Bingham Reservoir (South Zone)	✓			
OU5 Anaconda Tailings (South Zone)	✓			
OU6 Lark Waste Rock and Tailings (South Zone)			✓	
OU7 South Jordan Evaporation Ponds (South Zone)			✓	
OU8 Waste Water Treatment Plant and Sludge Ponds (North Zone)				✓
OU9 Magna Soils (North Zone)				✓
OU10 Copperton Soils (South Zone)	✓			

List of Operable Units	Bingham Creek ROD (Sept. 1998)	South End Ground Water ROD (Dec. 2000)	Lark ROD (Sept 2001)	North End ROD (Sept 2002)
OU11 Bingham Canyon (South Zone)	✓			
OU12 Eastside Collection System	NOT A PART OF THIS KENNECOTT SITE, operates under the authority of the Utah Ground Water Program			
OU13 Smelter and Acid Plant (North Zone)				✓
OU14 Refinery (North Zone)				✓
OU15 Magna Tailings Pond (North Zone)				✓
OU16 Bingham Creek Underflow	NOT A PART OF THIS KENNECOTT SITE, under investigation as part of the Utah Ground Water Program			
OU17 Bastian Area (South Zone)	✓		✓	
OU18 Acid Mine Drainage (South Zone)				✓
OU19 Smelter Fallout (North Zone)				✓
OU20 Pine Canyon (South Zone)				✓
OU21 Cobalt Ponds	NOT A PART OF THE KENNECOTT SITE, owned by others; Emergency Response Action			
OU22 Great Salt Lake and Wetlands (North Zone)				✓
OU23 North End Ground Water (North Zone)				✓
OU24 Precipitation Plant (South Zone)				✓

TABLE 12.3
LIST OF HISTORIC FACILITIES AND RODS

Historic facilities (from Site Background as of 5-31-2002)	Bingham Creek ROD	South End Ground Water ROD	Lark ROD	North End ROD
1. Lead Mine Mill	✓			
2. Utah Copper Company Mill	✓			
3. Winnamuck Mill	✓			
4. Markham Mill	✓			
5. Wall's Mill	✓			
6. Shawmut Mill	✓			
7. Utah-Apex Mill	✓			
8. Roger's Mill	✓			
9. Boston Consolidated Mill	✓			
10. Stewart No. 2 Mill	✓			
11. Highland Boy Mill	✓			
12. Bingham-New Haven Copper and Gold Company Mill	✓			
13. Columbia Copper Company Mill	✓			
14. Last Chance Mill	✓			
15. New England Gold and Copper Company Mill	✓			
16. Jordan Mill	✓			
17. Stewart Mill	✓			
18. Spanish Mill	✓			
19. Telegraph Mill	✓			
20. Bemis Mill	✓			

Historic facilities (from Site Background as of 5-31-2002)	Bingham Creek ROD	South End Ground Water ROD	Lark ROD	North End ROD
21. West Mountain Mining Company Concentrator	✓			
22. Silver Shield Mill	✓			
23. Bingham Mining and Milling Company Mill	✓			
24. Utah Consolidated Gold Mine Mill	✓			
25. Bingham Gold Mining Company	✓			
26. Utah Concentrator	✓			
27. Heaston Concentrator Jigs	✓			
28. Massasoit Mill	✓			
29. Queen Mill			✓	
30. Utah Mill	✓			
31. Brooks Mill	✓			
32. Durrant Mill	✓			
33. Eagan and Bates Mill	✓			
34. Bingham-New England Mill	✓			
35. Robbe Cells	✓			
36. Proler			✓	
37. What Cheer Mill	✓			
38. Murphy Mill	✓			
39. Utah Metal and Tunnel			✓	
40.01 Boston Mine Precipitation Launder	✓			
40.02 Apex Yard Precipitation Launder	✓			

Historic facilities (from Site Background as of 5-31-2002)	Bingham Creek ROD	South End Ground Water ROD	Lark ROD	North End ROD
40.03 Ohio Copper Mine Precipitation Launders	✓			
40.04 Ute Copper Tiewaukee Dump Launder	✓			
40.05 McGuires Gulch Launder	✓			
40.06 Galena Gulch Launder	✓			
40.07 Copper Center Gulch Plant	✓			
40.08 Main Canyon Launder	✓			
40.09 "A" Pit Precipitation Launder	✓			
40.10 Drain Tunnel Precipitation Launder	✓			
40.11 Ingersoll Gulch Precipitation Plant	✓			
40.11a Starless Precipitation Plant	✓			
40.11b McGregor Plant	✓			
40.11c Utah Copper Winamuck Precipitation Plant	✓			
40.12 Copper Placer Plant	✓			
40.13 Cuprum Yard Precipitation Plant	✓			
40.14 C. W. Watson's Jig	✓			
40.15 Darrenugue Jig	✓			
40.16 Verona Uranium Plant	✓			
40.17 New York and Utah Mill	✓			
40.18 Zinc Concentrator	✓			

Historic facilities (from Site Background as of 5-31-2002)	Bingham Creek ROD	South End Ground Water ROD	Lark ROD	North End ROD
40.19 Barneys Canyon Historic Facilities	NOT A PART OF THIS KENNECOTT SITE, was owned by a different division at the time the negotiations began.			
40.20 Bingham Canyon and Camp Floyd Railroad	Now owned by UP. NOT A PART OF THE KENNECOTT SITE			
40.21 Dalton and Lark Railroad			✓	
40.22 Copper Belt Railroad				✓
40.23 Denver and Rio Grande Low Line and Cuprum Yard				✓, canyon only, rest not a part of the site, ROW owned by UP
40.24 Denver and Rio Grande High Line and Cuprum Heights				✓
40.25 Bingham and Garfield RR, Bingham Yard, Auxiliary Yard				✓
41. Utah Smelter	✓			
42. Winnamuck Smelter	✓			
43. Revere Smelter	✓			
44. Yampa Smelter	✓			
45. Anaconda Tailings	✓			
46. Mixed Tails	✓			
47. South Jordan Evaporation Ponds			✓	
47.01 Pond AO			not specific, but a part of SJEP	
48. Cemetery Pond	✓			

Historic facilities (from Site Background as of 5-31-2002)	Bingham Creek ROD	South End Ground Water ROD	Lark ROD	North End ROD
49. Copperton Dumps	✓			
49a. Copperton Residential Soils	✓			
49b. Other Copperton Dumping Areas				✓
50. Revere Switch Tailings Pond				✓
51. Ohio Copper Company Mills			✓	
52. Revere Mill			✓	
52.01 Yosemite Mill			✓	
52.02 Brooklyn Mine and Mill			✓	
53. Fortune Mill			✓	
54. New Mammoth Mill			✓	
55. Dalton and Lark Mill			✓	
56. Holt Mill			✓	
57.01 Mascotte Tunnel		mentioned as a source, source control required	✓	
57.02 Mascotte Ditch			✓	
57.03 Mascotte Pond			✓	
57.04 Mascotte Tailings			✓	
57.05 Midas Creek Silo Area			✓	
57.06 Experimental Wetlands			✓	
58. Butterfield Mine Waste Rock			✓	
58.01 Butterfield Canyon			✓	
58.02 Butterfield Creek and Herriman Soils			✓	

Historic facilities (from Site Background as of 5-31-2002)	Bingham Creek ROD	South End Ground Water ROD	Lark ROD	North End ROD
58.03 Herriman Irrigation Company			not specific, in Herriman	
59. State Motorcycle Park			✓	
59.01 Lone Tree Tailings			✓	
60. Lark Waste Rock			✓	
61. Copper Gulch Mines and Pond			✓	
62. Anaconda Carr Fork				✓
63. Star Mill				✓
64. Utah-Delaware Mill	NOT A PART OF THE KENNECOTT SITE, owned by others			
64.01 Utah Metal Co.				✓
65. International Mill	NOT A PART OF THE KENNECOTT SITE, owned by others			
66. International Smelter	NOT A PART OF THE KENNECOTT SITE, owned by others			
67. Water Supply Tunnel Dump			✓	✓
68. Anaconda Tailings Pond	NOT A PART OF THE KENNECOTT SITE, owned by others			
69. Magna Leaching Facility				✓
70. Cobalt Leaching Facility	NOT A PART OF THE KENNECOTT SITE, owned by others			
71. Boston Consolidated Mill (Arthur Mill)				✓
71.01 Reagent Stills				✓
71.02 Lime Kilns				✓
71.03 Lime Slacking Plant				✓

Historic facilities (from Site Background as of 5-31-2002)	Bingham Creek ROD	South End Ground Water ROD	Lark ROD	North End ROD
71.04 Iron Foundry				✓
71.05 West Debris Site				✓
71.06 Railroad Debris Site				✓
71.07 Crucible Site				✓
71.08 Arthur Second Line Ditch				✓
71.09 Leak in Pipeline Soils				✓
72. Black Rock Tailings Pond				✓
73. Smelter Slag				✓
74. Last Chance Pond				✓
75. Flue Dust Disposal Area				✓
76. Railroad Flue Dust Area				✓
76.01 Standby Fuel Station				✓
77. Refinery Evaporation Ponds				✓
77.01 Chevron Fertilizer Plant				✓
77.02 Morton Salt Ponds				✓
77.03 Wetlands Mitigation Area				✓
77.031 Wetlands Mitigation Area - Morton Salt land				✓
77.032 Wetlands Mitigation Area - Bothwell and Swaner land				✓
77.033 Wetlands Mitigation Area - Heughs Creek Associates land				✓
77.034 Wetlands Mitigation Area - Blackhawk Pond				✓
77.035 Wetlands Mitigation Area - North Point Consolidated Canal				✓

Historic facilities (from Site Background as of 5-31-2002)	Bingham Creek ROD	South End Ground Water ROD	Lark ROD	North End ROD
77.036 Wetlands Mitigation Area - Goggin Drain				✓
78. Utah Copper Power Plant				✓
79. Bingham Mine and Bingham Canyon	excluded from Bingham Creek ROD, NOT A PART OF THE KENNECOTT SITE, Operational Facility with permits			
79.01 Bingham Pit Rail Operations	excluded from Bingham Creek ROD, NOT A PART OF THE KENNECOTT SITE, Operational Facility with permits			
79.01a New Ore Loading Area				✓
79.02 Copperton Railyard	excluded			✓
80. Barneys Canyon Gold Mine	NOT A PART OF THE KENNECOTT SITE, Operational Facility with permits			
81. Precipitation Plants in Copperton	excluded			✓
82. Copperton Concentrator	excluded			✓
83. Yellow Cake Plant	✓			
84. Trans Jordan Landfill	NOT A PART OF THE KENNECOTT SITE			
85. Sludge Farm	NOT A PART OF THE KENNECOTT SITE			
86. Large Bingham Reservoir	✓			
87. Small Bingham Reservoir	✓			
88. East Side Dumps and Collection System	excluded	mentioned as a source, source control required	✓	
89. West Side Disposal Area (Dry Fork)	excluded, mentioned as a source of ground water contamination, source control required in 2nd ROD. NOT A PART OF THE KENNECOTT SITE, Active dumping area operating under state permits			

Historic facilities (from Site Background as of 5-31-2002)	Bingham Creek ROD	South End Ground Water ROD	Lark ROD	North End ROD
89.01 Solvent Extraction and Electrowinning Pilot Plant	NOT A PART OF THE KENNECOTT SITE, Operational facility with state permits			
90. Bluewater I North Repository	✓		✓	
91. Bluewater II Repository	✓		✓	
92. Midas Pond			✓	
93. Eastside Reservoir			✓	
93.01 Copperton Concentrator Process Water Reservoir				✓
94. North Concentrator (Magna Mill)				✓
94.01 Railroad Slope Site				✓
94.02 Concentrate Loading Site				✓
94.03 East Debris Site				✓
95. Bonneville Crusher				✓
95.01 Scrap Yard				✓
95.02 Bonneville Gate Hillside				✓
95.03 Little Valley Settlement Ponds				✓
95.04 North Slope Site				✓
96. American Smelting and Refining Company Smelter (Reverberatory Smelter)				✓
96.01 Slag crushing facility				✓
96.02 Modernized smelter footprint (Outokumpu Smelter)				✓
96.03 East Yard Site				✓
96.04 Old (Noranda) Smelter Soils				✓

Historic facilities (from Site Background as of 5-31-2002)	Bingham Creek ROD	South End Ground Water ROD	Lark ROD	North End ROD
96.05 Return Canal				✓
96.06 Slag Tailings Pipeline				✓
96.07 Railroad Yard Soils				✓
96.08 Smelter Power House				✓
96.09 Smelter Demolition Projects				✓
96.10 Roundhouse				✓
96.11 Row 5 Screening Plant				✓
96.12 Slag Mill Concentrate and Filter Building and Thickener				✓
96.13 Station 17 Pumphouse				✓
96.14 Section 12 Reverse Osmosis				✓
96.15 Pump Stations				✓
96.16 Praxair Plant	NOT A PART OF THE KENNECOTT SITE, operating facility not owned by Kennecott			
96.17 East and West Process Water Ponds				✓
96.18 Smelter Hydromet Plant				✓
96.19 East Stormwater Pond				✓
96.20 West Stormwater Pond				✓
96.21 Reverberatory Smelter Mixing Chambers (catacombs)				✓
96.22 Thaw Shed				✓
96.23 Smelter Process Water Pipeline				✓
96.24 Slag Point Cooling Area				✓
96.25 Materials Handling Facility (Dryer and Hopper bldgs)				✓

Historic facilities (from Site Background as of 5-31-2002)	Bingham Creek ROD	South End Ground Water ROD	Lark ROD	North End ROD
96.26 Cooling Towers				✓
96.27 Overhead Flues				✓
96.28 Shot coolers				✓
96.29 Cherry Bowl				✓
96.30 RR crossing				✓
96.31 Misc. smelter buildings				✓
96.31a. Converter annex bldg.				✓
96.31b Egg Crate Bldg				✓
96.31c. Uphill Stacks				✓
96.31d. Reverb Bypass Flue				✓
97. Garfield Acid Plants				✓
97.01 Weak Acid Corridor				✓
97.02 Weak Acid Lift Station				✓
97.03 Acid Plant Demolition Projects				✓
97.04 West weak acid lift station				same as 97.02
97.05 Concentrate Storage Pad				✓
98. Acid Storage Facility (tank farm)				✓
99a. Old Refinery				✓
99b. New Refinery				✓
99.01 Old Precious Metals Bldg.				✓
99.02 East Rail Yard Site				✓
99.03 Electrolyte Purification Bldg.				✓

Historic facilities (from Site Background as of 5-31-2002)	Bingham Creek ROD	South End Ground Water ROD	Lark ROD	North End ROD
99.04 Lead Shop				✓
99.05 Electrolyte Pipeline Corridor				✓
99.06 West Laydown Yard				✓
99.07 Kessler Spring Dump				✓
99.08 Oil Storage Site				✓
99.09 Boiler Bldg. footprint				✓
99.10 Assay Lab footprint				✓
99.11 Bridge Crane Removal				✓
99.12 R1-R2 Containment Area				✓
99.13 Bosh Pond				✓
99.14 Santa Fe Basin				✓
99.15 Refinery Storm Water Canal				✓
100. New Power Plant				✓
100.01 Power Station				✓
101. South Tailings Impoundment (Magna Tailings Pond)				✓
101.01 North Tailings Impoundment				✓
101.02 Arthur Stepback Repository				✓
101.03 Ragtown and Snaketown				✓
101.04 Historic Roads				✓
101.05 Riter				✓
101.06 Historic Rail Routes				✓
102. Smelter Lagoon				✓

Historic facilities (from Site Background as of 5-31-2002)	Bingham Creek ROD	South End Ground Water ROD	Lark ROD	North End ROD
102.01 Tooele Canal Ditch				✓
102.02 Smelter Return Canal				✓
102.03 East Hazelton				✓
102.04 West Hazelton				✓
102.05 I-80 Pond				✓
102.06 Wetlands Landfill				✓
102.07 Wooden Bridge Site				✓
103. Rail Graveyard				✓
104. Diving Board Tails				✓
105. Waste Water Treatment Plant Sludge				✓
105.01 WWTP Soils				✓
105.02 New Sewage Treatment Plant	NOT A PART OF THE KENNECOTT SITE, operating facility under state permits			
106. Kennecott Tailings Pond Landfill				✓
107. Smelter Landfills				✓
108. Tailings Slurry Pipeline				✓
108a. Magna Mill (North Concentrator) Flume				✓
109. Concentrate Slurry Pipeline				✓
110. Bingham Creek	✓			
110.01 Historic Mine Drainage	major sources of water to Bingham Creek			
111. West Valley Highway	✓			

Historic facilities (from Site Background as of 5-31-2002)	Bingham Creek ROD	South End Ground Water ROD	Lark ROD	North End ROD
112. Kern Valley Gas Pipeline	✓			
113. Residential Property in West Jordan	✓			
114. Bastian Sink	✓			
115. Bingham Flats	✓			
116. Tailwater Ditches	✓			
117. 3200 West Crossing of Bingham Creek	✓			
117.01 Holy Cross Hospital	✓			
118. Bastian Ditch	✓			
119. Evaporation Ponds Canal	✓			
120. Water Pipeline Crossing	✓			
121. Redwood Road Pond	✓			
121.01 Lower Bingham Creek Channel	✓			
121.02 Railroad Right of Way (UP)	excluded, NOT A PART OF THE KENNECOTT SITE, now owned by Union Pacific			
122. Jordan River	NOT A PART OF THE KENNECOTT SITE, the river was used as the eastern site boundary			
122.01 Mine Wash Areas	addressed as a part of specific areas		addressed as a part of specific areas	
122.02 Butterfield Creek			✓	
122.03 Copper Creek, Copper Gulch and Mines			✓	
Antelope Mine			✓	
Blue Jay Mine			✓	

Historic facilities (from Site Background as of 5-31-2002)	Bingham Creek ROD	South End Ground Water ROD	Lark ROD	North End ROD
Dalton and Lark Mine			✓	
Evergreen Mine			✓	
Lead Mine			✓	
Mayflower			✓	
Miners Dream			✓	
Olympia			✓	
Richmond			✓	
Sampson			✓	
Union Flag			✓	
Vanderbilt			✓	
Wasatch			✓	
Yosemite #2			✓	
122.04 Midas Creek			✓	
122.05 Herriman Soils			✓	
123. SW Jordan Valley Ground Water Plume		✓		
124. Upper Bingham Creek Ground Water Contamination		mentioned as a source, source control required.		
125. Bingham Tunnel		mentioned as a source, source control required	✓	
125.01. 5490 Tunnel				✓
125.02. 6040 Tunnel				✓

Historic facilities (from Site Background as of 5-31-2002)	Bingham Creek ROD	South End Ground Water ROD	Lark ROD	North End ROD
126. Old Bingham Tunnel			✓	
127. Unnamed adit				✓
128. Queens Adit and other Black Jack Gulch Mines			✓	
128 Queens Mine			part of 128	
128.01 Eagle Bird			part of 128	
128.02 Northern Chief Tunnel			part of 128	
128.03 Bemis Tunnel			part of 128	
128.04 Lucky Boy Tunnel			part of 128	
128.05 St. James Mine			part of 128	
128.06 Other Black Jack Mines			part of 128	
Bunker Hill Tunnel			part of 128.06	
Mobile Tunnel			part of 128.06	
Osceola Tunnel			part of 128.06	
El Dorado Tunnel			part of 128.06	
129. St. Joes Tunnel and other Yosemite Gulch and Saints Rest Gulch Mines			✓	
129.01 Yosemite Mine and Mill			✓	
129.02 Paradox Mine			part of 129	
129.03 Daylight Extension Tunnel			✓	
129.04 Lenox Tunnel			✓	
129.05 Yes You Do Tunnel			✓	

Historic facilities (from Site Background as of 5-31-2002)	Bingham Creek ROD	South End Ground Water ROD	Lark ROD	North End ROD
129.06 Saints Rest Gulch and Yosemite Gulch			✓	
Badger Mine			part of 129.06	
Chicot Mine			part of 129.06	
Gladstone Mine			part of 129.06	
No You Don't Mine			part of 129.06	
Revere Mine			part of 129.06	
130. Elton Tunnel	NOT A PART OF THE KENNECOTT SITE, portal owned by others			
131. Pine Canyon				✓
132. Pine Canyon Tunnel				✓
133. Erda Airshed				✓
134. Water Supply Tunnel				✓
135.01 Apex (Parvenu) Tunnel				✓
135.02 Two Armstrong Tunnels				✓
135.03 Highland Boy Tunnel				✓
135.04 Bingham West Dip Tunnel				✓
135.05 Adamson Tunnel				✓
135.06 Copper Boy Tunnel				✓
135.07 Spring Canyon Tunnels				✓
Hardrock Tunnel				✓
McBride Tunnel				✓

Historic facilities (from Site Background as of 5-31-2002)	Bingham Creek ROD	South End Ground Water ROD	Lark ROD	North End ROD
Main Tunnel				✓
135.08 Upper Bruneau Tunnel				✓
135.09 Helen B Tunnel				✓
136. Kessler Canyon Drainage				✓
136.01 Garfield Townsite				✓
136.02 Wooden Flume Site				✓
137. Magna Soils				✓
138. Little Valley				✓
139. Black Rock Canyon				✓
140. C-7 Ditch				✓
140.01 Lee Creek				✓
140.02 Great Salt Lake				✓
140.03 Great Salt Lake Shore				✓
140.04 East Lake				✓
140.05 Kersey Creek				✓
140.06 East C-7 Ditch				✓
140.07 Riter Canal				✓
140.08 Utah-Salt Lake Canal				✓
140.09 Right of Way Canal				✓
140.10 Adamson Springs				✓
140.11 Saltair and other Beach Resorts				✓
140.12 South Shore Boating and Ports				✓

Historic facilities (from Site Background as of 5-31-2002)	Bingham Creek ROD	South End Ground Water ROD	Lark ROD	North End ROD
140.13 New Kennecott Outfall 012				✓
140.14 I-80 Off Ramp				✓
140.15 West C-7 Ditch				✓
140.16 East Side Wetlands (SU2)				✓
140.17 Smelter Wetlands				✓
141. North End Ground Water Plumes				✓
141.01 Garfield Wetlands				✓
141.011 Marsh Area 1				✓
141.012 Marsh Area 2				✓
141.013 Marsh Area 3				✓
141.014 Pond 1				✓
141.015 Pond 10a and 10b				✓
141.016 Pond 2				✓
141.017 Pond 3				✓
141.018 Pond 4				✓
141.019 Sample Unit 1				✓
141.019a Wetlands Landfill				✓
141.02 Garfield Wells				✓
141.03 Springs				✓
141.031 Spitz Springs				✓
141.032 Japanese Springs				✓
141.033 Springs 3 - 5				✓
141.034 No Name Springs				✓

Historic facilities (from Site Background as of 5-31-2002)	Bingham Creek ROD	South End Ground Water ROD	Lark ROD	North End ROD
141.035 Kessler Springs				✓
142. Road Construction	NOT A PART OF THE KENNECOTT SITE, mine waste locations only partially known at this point			
143. Miscellaneous Spills	Covered in geographic sites, as appropriate			
144. Demolition Debris	Covered in geographic sites, as appropriate			
145. Railroad Right of Ways	excluded			✓
146. Truck and Rail Maintenance Yards	excluded, NOT A PART OF KENNECOTT SITE, Operational facilities with state and local permits.			
146b. Smelter Area Employees Parking Lot.				✓

B. Summary of Remedies Associated with this Record of Decision

This Record of Decision is divided into several chapters describing different geographic areas of the Kennecott North Zone and South Zone. This is to facilitate documentation of the various cleanups performed in the past and then describe any future needed activities. For quick reference, Table 12.4 lists only the needed remedies to be carried out in the future.

TABLE 12.4
COMPILATION OF REMEDIES

Location	Remedy	Logic
Site-wide	Mapping of areas exceeding industrial land use standards, and unrestricted land use standards. Map locations of buried wastes.	For use in future land use planning at time of facility closures.

Location	Remedy	Logic
Magna Mills and Tailings	Demolition of unneeded facilities, disposal of haz waste and asbestos, characterization of underlying soils, clean up to industrial standards. (Bonneville Crusher and North Concentrator)	Protect current industrial workers, Prepare for redevelopment in the future.
Wetlands	Monitor macroinvertebrates for selenium, locate and remediate any additional sources, develop site-specific water quality standards, re-characterize East Side wetlands.	Wetland sediments have been cleaned up and contaminated spring water and well water diverted. Currently, it is unknown if this is sufficient to protect wildlife (birds).
North End Ground Water	Alternative 4B - injection of selenate reducing microbes into aquifer, collection of contaminated spring and well water	May cleanup aquifer much faster than natural attenuation estimate of 30 years. The hope is to get the groundwater cleaned up before mine closure.
Precipitation Plant	Demolition of plant, disposal of haz waste and asbestos, characterization of underlying soils, clean up to industrial standards.	Protect current industrial workers, Prepare for site redevelopment.

For aid in data compilation, Table 12.5 gives an estimate of the volumes already addressed at these sites through a seven-year long Non-Time Critical Removal Action

TABLE 12.5
VOLUMES OF KENNECOTT WASTES

Location	Removed to on-site repository	Removed to off-site repository	On-site wastes	Spills	Other
Magna Mills and Tailings Pond	27,343 cy	27 tons	2.1 billion tons (Magna Tailings), 6 million tons of phosphogypsum tails buried by tails, 2,165,065 tons in Arthur Stepback R.	5583 tons	237 tons non-haz debris, 211 tons asbestos, 251 tons recycled reagents, 150 gals PCBs 405,000 cy spilled tails
Smelter	325,111 cy	27,654 tons	434,000 cy (Black Rock Tailings), 20 million tons (slag)	1,366,947 gals + 540,051 pounds	155.4 tons asbestos, 53.5 tons transite, 252 tons copper recycled, 11 million gallons acid water recovered, 25,000 cy petroleum soils.
Refinery	23,281 cy	-	>16,700 cy under caps	1720 gals + 20 pounds	7140 tons recycled to Barneys, 950 tons recycled to smelter, 1500 cy petroleum soils.
Waste Water Treatment Plant	1,021,013 cy	-	-	75,000 gals	150 tons recycled to Bingham Mine

Location	Removed to on-site repository	Removed to off-site repository	On-site wastes	Spills	Other
Wetlands	819,305 cy	-	35,000 cy left in place - Slag Pond	-	-
Ground Water	-	-	-	-	>144,600 acre feet of contaminated ground water
Atmospheric Fallout	-	-	27,432 tons estimated As, Pb, Se of smelter fallout	-	-
Pine Canyon	-	-	34,250 cy left in place, mainly waste rock	-	-
Precipitation Plant	-	-	-	600 tons	as high as 645,000 cy of wastes on site.

C. Hazardous Substances Removed to Off-Site Locations

A wide variety of wastes were discovered in the process of facilities demolition and cleanup. Wastes that were characteristic RCRA wastes were disposed of in a licensed off-site facility. Other wastes were disposed off-site in specialty landfills as appropriate. A listing of wastes that were transported off-site, volumes, and destinations are given in Tables 12.6, 12.7, and 12.8.

TABLE 12.6
WASTES DISPOSED OFF-SITE DURING ARTHUR MILL DEMOLITION (1990 - 1991)

Waste composition	Hazard	Quantity	Location
320 Crushed Drums	Non-hazardous	Not given	Grassy Mtn, UT
250 Crushed Drums	Non-hazardous	Not given	Grassy Mtn, UT
Crushed Drums	Non-hazardous	6960 pounds	Grassy Mtn, UT
Crushed Drums	Non-hazardous	8440 pounds	Grassy Mtn, UT
Crushed Drums	Non-hazardous	20 cy	Grassy Mtn, UT
Crushed Drums	Non-hazardous	20 cy	Grassy Mtn, UT
Crushed Drums	Non-hazardous	20 cy	Grassy Mtn, UT
Waste Gear Grease	Non-hazardous	43680 pounds	Grandview, ID
Waste Gear Lubrication	Non-hazardous	42240 pounds	Grandview, ID
Xylene and Toluene	Flammable liquid	3200 gallons	Fredonia, KS
Xylene and Toluene	Flammable liquid	4700 gallons	Fredonia, KS
Mercury Ignition Tubes	ORM - E	85 gallons	Grandview, ID
Sampling materials and PPE	Non-hazardous	7020 gallons	Grandview, ID

Waste composition	Hazard	Quantity	Location
Waste Gear Lubrication	Non-hazardous	3820 gallons	Grandview, ID
Waste Liquid NOS	ORM - E	400 gallons	Henderson, CO
Waste Solid NOS	ORM - E	13550 pounds	Henderson, CO
Waste Paint Related	Flammable Liquid	660 gallons	Henderson, CO
Waste liquid NOS (oil, tar)	Flammable Liquid	100 gallons	Henderson, CO
Containers	Non-hazardous	39420 pounds	Grandview, ID
Waste Liquid NOS	ORM - E	850 gallons	Henderson, CO
Waste Solid NOS	ORM - E	13200 pounds	Henderson, CO
Waste paint related	Flammable Liquid	420 gallons	Henderson, CO
Waste Gear Grease	Non-hazardous	39200 pounds	Grandview, ID
Cresylic Acid	Corrosive liquid	115 gallons	Grandview, ID
Waste Gear Grease	Non-hazardous	38400 pounds	Grandview, ID
Waste solidified acids	Non-hazardous	1 gallon	Grandview, ID
Waste Laboratory chemicals	Non-hazardous	165 pounds	Grandview, ID
Waste ORM	ORM - A	15 pounds	Grandview, ID
1,1,1 -trichloroethane	ORM - A	50 pounds	Baton Rouge, LA

Waste composition	Hazard	Quantity	Location
Alcohol	Flammable Liquid	25 pounds	Baton Rouge, LA
Methyl alcohol	Flammable Liquid	249 pounds	Baton Rouge, LA
Acetone	Flammable Liquid	40 pounds	Baton Rouge LA
Liquid, NOS	Flammable Liquid	951 pounds	Baton Rouge, LA
liquid, NOS	Combustible liquid	880 pounds	Baton Rouge, LA
ORM-A, NOS	ORM - A	136 pounds	Baton Rouge, LA
Solid NOS	Flammable Solid	27 pounds	Baton Rouge, LA
Sodium sulfide, anhydrous	Flammable Solid	30 pounds	Baton Rouge, LA
Phosphorus pentasulfide	Flammable Solid	5 pounds	Baton Rouge, LA
Water reactive solid	Water reactive solid	4 pounds	Baton Rouge LA
Paint-related material	Flammable Liquid	692 pounds	Baton Rouge, LA
Paint-related material	Flammable Liquid	130 pounds	Baton Rouge, LA
Barium Peroxide, potassium chlorate	Oxidizer	15 pounds	Baton Rouge, LA
Potassium nitrate, bismuth nitrate	Oxidizer	22 pounds	Baton Rouge LA
Benzyl Chloride developer	Corrosive liquid	313 pounds	Baton Rouge, LA
Epoxy with methylenedian	Poison B	120 pounds	Baton Rouge, LA

Waste composition	Hazard	Quantity	Location
Toluene	Flammable Liquid	32 pounds	Baton Rouge, LA
Enamel paint with chrome and lead pigment	Flammable Liquid	320 pounds	Baton Rouge, LA
Arsenic trioxide	Poison, solid	200 pounds	Baton Rouge, LA
Waste fuel oil	Combustible liquid	40 pounds	Baton Rouge, LA
Allyl alcohol	Flammable liquid, poison	3 pounds	Baton Rouge, LA
HCL in isopropanol	Flammable liquid, corrosive	2 pounds	Baton Rouge, LA
Nickel powder, charcoal	Flammable solid	69 pounds	Baton Rouge, LA
Hydrogen peroxide solution	Oxidizer	40 pounds	Baton Rouge, LA
Potassium nitrate	Oxidizer	6 pounds	Baton Rouge, LA
Phenyl hydrazine, benzidrine acetate, aniline, methyl iodide	Poison B liquid	23 pounds	Baton Rouge, LA
Thiourea, thioacetamide, thiosemicarbazide	ORM - E	Not given	Baton Rouge, LA
Bromine	Corrosive	10 pounds	Baton Rouge, LA
Cresylic acid, sodium hydroxide	Corrosive solid	19 pounds	Baton Rouge, LA
Oxidizer NOS	Corrosive solid	1 pound	Baton Rouge, LA
Corrosive NOS	Corrosive liquid	2 pounds	Baton Rouge, LA
Waste liquid	Flammable liquid	9 pounds	Baton Rouge, LA

Waste composition	Hazard	Quantity	Location
Lead peroxide, chromium nitrate	Oxidizer	5 pounds	Baton Rouge, LA
Ammonium fluoride, sodium meta-bisulfite	ORM - B	18 pounds	Baton Rouge, LA
Lead nitrate	Oxidizer	5 pounds	Baton Rouge, LA
Benzedrine, resourcinol, dinitrophenol, phenyl thiourea, arsenic sulfide, ammonium meta-vanadate	Poison B	16 pounds	Baton Rouge, LA
Sodium cyanide, potassium cyanide, xylencyanole	Poison B	8 pounds	Baton Rouge, LA
Potassium chromate, lead acetate	ORM - E	9 pounds	Baton Rouge, LA
Organic peroxide catalyst	Hazardous	1 pound	Baton Rouge, LA
Arsenic trioxide, thallium sulfate, mercuric chloride, selenium chunks	Poison B	32 pounds	Baton Rouge, LA
Corrosive NOS	Corrosive solid	7 pounds	Baton Rouge, LA
Asbestos	ORM - C	3 pounds	Baton Rouge, LA
Potasssium dichromate	ORM - A	3 pounds	Baton Rouge, LA
Potassium xanthate	Non hazardous	1162 pounds	Baton Rouge LA
Nickel-copper alloy shot	Non hazardous	136 pounds	Baton Rouge LA
Flammable liquid	Flammable liquid	440 pounds	Baton Rouge, LA
Combustible liquid	Combustible liquid	550 pounds	Baton Rouge, LA

Waste composition	Hazard	Quantity	Location
Paint related	Flammable liquid	240 pounds	Baton Rouge, LA
Corrosive	Corrosive liquid	55 pounds	Baton Rouge, LA
Waste adhesive	Flammable liquid	65 pounds	Baton Rouge, LA
Waste cyanide	Poison B	10 pounds	Baton Rouge, LA
Waste cyanide	Poison B	15 pounds	Baton Rouge, LA
Flammable liquid	Flammable liquid	160 pounds	Baton Rouge, LA
Phosphorus pentasulfide	Flammable solid	15 pounds	Baton Rouge, LA
Red lead powder	Haz solid	280 pounds	Baton Rouge, LA
Corrosive solid	Corrosive solid	Not given	Baton Rouge, LA
Organic peroxide liquid	Haz liquid	Not given	Baton Rouge, LA
Corrosive solid	Corrosive solid	5 pounds	Baton Rouge, LA
Waste	Non-hazardous	305 pounds	Baton Rouge, LA
Cs-137 sources of various activities	Radioactive	19 sources	Texas Nuclear
Th-232	Radioactive	0.25 pound	Texas Nuclear
U-238	Radioactive	0.25 pound	Texas Nuclear
Am-241-Be	Radioactive	2 sources	Texas Nuclear

Waste composition	Hazard	Quantity	Location
Ra-226-Be	Radioactive	1 source	Texas Nuclear
Pu-238	Radioactive	1 source	Texas Nuclear
Pm-147	Radioactive	1 source	Texas Nuclear

TABLE 12.7
LIST OF MATERIALS RECYCLED WHEN MAGNA MILL WAS CLOSED

Material	Weight	Recycled to
Reco (flotation reagent)	8432 pounds	Copperton Concentrator
MIBC (solvent)	8282 pounds	Copperton Concentrator
Cyanide	6020 pounds	Copperton Concentrator
Lime from grind silo	183 tons	Copperton Concentrator
Lime from dumper silo	57 tons	Copperton Concentrator

TABLE 12.8

OFF-SITE DISPOSAL OF HAZARDOUS WASTE
CLEANUPS AT SMELTER

Flue Dust Contaminated Debris - GM92-1846
Flue Dust Contaminated Soil - GM 92-1060
RQ, Hazardous Waste solid, NOS. 9, NA3077, PG III, (D004, D006, D008)

Manifest	Date	Weight (Tons)	Disposal Location
EP001	8/6/97	3.72	Grassy Mtn RCRA landfill
EP003	8/7/97	3.40	Grassy Mtn RCRA landfill

Manifest	Date	Weight (Tons)	Disposal Location
EP004	8/15/97	4.38	Grassy Mtn RCRA landfill
EP006	8/19/97	7.62	Grassy Mtn RCRA landfill
EP007	8/19/97	4.85	Grassy Mtn RCRA landfill
EP008	8/19/97	5.72	Grassy Mtn RCRA landfill
EP009	8/20/97	3.06	Grassy Mtn RCRA landfill
EP010	8/20/97	8.61	Grassy Mtn RCRA landfill
EP011	8/21/97	4.60	Grassy Mtn RCRA landfill
EP012	8/21/97	11.44	Grassy Mtn RCRA landfill
EP013	8/21/97	6.92	Grassy Mtn RCRA landfill
EP014	8/27/97	9.82	Grassy Mtn RCRA landfill
EP016	8/27/97	9.68	Grassy Mtn RCRA landfill
EP017	8/27/97	6.24	Grassy Mtn RCRA landfill
EP019	9/5/97	8.01	Grassy Mtn RCRA landfill
EP024	9/8/97	1.74	Grassy Mtn RCRA landfill
EP025	9/12/97	6.61	Grassy Mtn RCRA landfill
EP026	9/12/97	1.02	Grassy Mtn RCRA landfill

Manifest	Date	Weight (Tons)	Disposal Location
EP027	9/12/97	3.93	Grassy Mtn RCRA landfill
EP028	9/12/97	18.40	Grassy Mtn RCRA landfill
EP029	9/24/97	13.25	Grassy Mtn RCRA landfill
EP030	9/25/97	7.72	Grassy Mtn RCRA landfill
EP031	9/26/97	8.78	Grassy Mtn RCRA landfill
EP032	9/22/97	2.76	Grassy Mtn RCRA landfill
EP033	9/22/97	11.55	Grassy Mtn RCRA landfill
EP036	10/16/97	12.85	Grassy Mtn RCRA landfill
EP037	10/21/97	7.19	Grassy Mtn RCRA landfill
EP038	11/14/97	6.64	Grassy Mtn RCRA landfill
EP041	9/29/97	7.46	Grassy Mtn RCRA landfill
EP048	10/3/97	4.23	Grassy Mtn RCRA landfill
EP055	10/9/97	12.66	Grassy Mtn RCRA landfill
EP056	10/13/97	16.01	Grassy Mtn RCRA landfill
EP059	10/15/97	7.64	Grassy Mtn RCRA landfill
EP060	10/15/97	11.31	Grassy Mtn RCRA landfill

Manifest	Date	Weight (Tons)	Disposal Location
EP061	10/15/97	6.71	Grassy Mtn RCRA landfill
EP062	10/15/97	10.62	Grassy Mtn RCRA landfill
EP066	10/21/97	10.57	Grassy Mtn RCRA landfill
EP067	10/15/97	1.52	Grassy Mtn RCRA landfill
EP068	10/21/97	1.91	Grassy Mtn RCRA landfill
EP069	10/21/97	10.91	Grassy Mtn RCRA landfill
EP070	10/22/97	24.30	Grassy Mtn RCRA landfill
EP076	10/24/97	14.23	Grassy Mtn RCRA landfill
EP077	10/24/97	10.09	Grassy Mtn RCRA landfill
EP078	10/24/97	1.77	Grassy Mtn RCRA landfill
EP088	10/30/97	16.13	Grassy Mtn RCRA landfill
EP089	10/30/97	1.75	Grassy Mtn RCRA landfill
EP090	10/30/97	9.61	Grassy Mtn RCRA landfill
EP102	11/10/97	1.89	Grassy Mtn RCRA landfill
EP103	11/10/97	12.58	Grassy Mtn RCRA landfill
EP106	11/14/97	9.39	Grassy Mtn RCRA landfill

Manifest	Date	Weight (Tons)	Disposal Location
EP107	11/17/97	2.49	Grassy Mtn RCRA landfill
EP108	11/17/97	9.99	Grassy Mtn RCRA landfill
EP109	11/17/97	7.25	Grassy Mtn RCRA landfill
EP110	11/17/97	11.45	Grassy Mtn RCRA landfill
EP116	11/19/97	15.45	Grassy Mtn RCRA landfill
EP117	11/19/97	14.92	Grassy Mtn RCRA landfill
EP119	11/20/97	12.98	Grassy Mtn RCRA landfill
EP129	12/17/97	7.30	Grassy Mtn RCRA landfill
EP130	12/18/97	3.13	Grassy Mtn RCRA landfill
EP131	12/18/97	10.27	Grassy Mtn RCRA landfill
EP132	12/18/97	8.49	Grassy Mtn RCRA landfill
EP133	1/6/98	5.31	Grassy Mtn RCRA landfill
EP134	1/6/98	5.22	Grassy Mtn RCRA landfill
EP135	1/8/98	8.34	Grassy Mtn RCRA landfill
EP136	1/8/98	6.09	Grassy Mtn RCRA landfill
EP139	1/8/98	10.89	Grassy Mtn RCRA landfill

Manifest	Date	Weight (Tons)	Disposal Location
EP140	1/8/98	10.39	Grassy Mtn RCRA landfill
EP143	1/12/98	3.44	Grassy Mtn RCRA landfill
EP144	1/12/98	2.71	Grassy Mtn RCRA landfill
EP146	1/21/98	4.90	Grassy Mtn RCRA landfill
EP147	1/21/98	3.00	Grassy Mtn RCRA landfill
EP155	1/29/98	17.49	Grassy Mtn RCRA landfill
EP156	1/29/98	15.50	Grassy Mtn RCRA landfill
EP157	1/29/98	13.74	Grassy Mtn RCRA landfill
EP158	1/29/98	19.28	Grassy Mtn RCRA landfill
EP159	1/30/98	13.46	Grassy Mtn RCRA landfill
EP160	1/30/98	0.10	Grassy Mtn RCRA landfill
EP165	2/3/98	10.63	Grassy Mtn RCRA landfill
EP166	2/3/98	13.76	Grassy Mtn RCRA landfill
EP167	2/3/98	17.03	Grassy Mtn RCRA landfill
EP168	2/3/98	15.88	Grassy Mtn RCRA landfill
EP169	2/3/98	13.69	Grassy Mtn RCRA landfill

Manifest	Date	Weight (Tons)	Disposal Location
EP173	2/6/98	2.49	Grassy Mtn RCRA landfill
EP174	2/6/98	1.75	Grassy Mtn RCRA landfill
EP175	2/6/98	1.08	Grassy Mtn RCRA landfill
EP176	2/9/98	16.77	Grassy Mtn RCRA landfill
EP177	2/9/98	16.09	Grassy Mtn RCRA landfill
EP178	2/9/98	16.88	Grassy Mtn RCRA landfill
EP179	2/9/98	16.05	Grassy Mtn RCRA landfill
EP182	2/9/98	19.52	Grassy Mtn RCRA landfill
EP183	2/13/98	10.95	Grassy Mtn RCRA landfill
EP184	2/13/98	20.90	Grassy Mtn RCRA landfill
EP185	2/13/98	20.10	Grassy Mtn RCRA landfill
EP186	2/13/98	23.29	Grassy Mtn RCRA landfill
EP187	2/13/98	4.57	Grassy Mtn RCRA landfill
EP191	3/12/98	18.69	Grassy Mtn RCRA landfill
EP192	3/12/98	20.68	Grassy Mtn RCRA landfill
EP193	3/12/98	13.76	Grassy Mtn RCRA landfill

Manifest	Date	Weight (Tons)	Disposal Location
EP194	3/12/98	4.55	Grassy Mtn RCRA landfill
EP195	3/17/98	14.79	Grassy Mtn RCRA landfill
EP196	3/17/98	15.59	Grassy Mtn RCRA landfill
EP197	3/17/98	15.12	Grassy Mtn RCRA landfill
EP198	3/17/98	12.87	Grassy Mtn RCRA landfill
EP199	3/17/98	9.86	Grassy Mtn RCRA landfill
EP200	3/19/98	17.11	Grassy Mtn RCRA landfill
EP201	3/19/98	16.08	Grassy Mtn RCRA landfill
EP202	3/19/98	17.54	Grassy Mtn RCRA landfill
EP203	3/19/98	16.02	Grassy Mtn RCRA landfill
EP204	3/19/98	13.77	Grassy Mtn RCRA landfill
EP205	3/20/98	18.53	Grassy Mtn RCRA landfill
EP206	3/20/98	11.34	Grassy Mtn RCRA landfill
EP207	3/20/98	9.58	Grassy Mtn RCRA landfill
EP208	3/20/98	14.31	Grassy Mtn RCRA landfill
EP209	3/20/98	13.07	Grassy Mtn RCRA landfill

Manifest	Date	Weight (Tons)	Disposal Location
EP211	3/25/98	13.22	Grassy Mtn RCRA landfill
EP212	3/25/98	16.27	Grassy Mtn RCRA landfill
EP213	3/25/98	12.43	Grassy Mtn RCRA landfill
EP214	3/25/98	13.70	Grassy Mtn RCRA landfill
EP215	3/25/98	15.03	Grassy Mtn RCRA landfill
EP219	3/26/98	14.27	Grassy Mtn RCRA landfill
EP220	3/26/98	9.85	Grassy Mtn RCRA landfill
EP221	3/26/98	14.18	Grassy Mtn RCRA landfill
EP222	3/26/98	15.37	Grassy Mtn RCRA landfill
EP223	3/26/98	14.23	Grassy Mtn RCRA landfill
EP229	4/3/98	14.19	Grassy Mtn RCRA landfill
EP230	4/3/98	14.47	Grassy Mtn RCRA landfill
EP231	4/3/98	15.18	Grassy Mtn RCRA landfill
EP232	4/3/98	17.75	Grassy Mtn RCRA landfill
EP233	4/3/98	10.49	Grassy Mtn RCRA landfill
EP237	4/14/98	10.05	Grassy Mtn RCRA landfill

Manifest	Date	Weight (Tons)	Disposal Location
EP238	4/6/98	13.81	Grassy Mtn RCRA landfill
EP239	4/6/98	13.11	Grassy Mtn RCRA landfill
EP240	4/6/98	10.36	Grassy Mtn RCRA landfill
EP241	4/6/98	5.80	Grassy Mtn RCRA landfill
EP242	4/6/98	10.33	Grassy Mtn RCRA landfill
EP243	4/8/98	13.27	Grassy Mtn RCRA landfill
EP244	4/8/98	11.66	Grassy Mtn RCRA landfill
EP245	4/8/98	20.39	Grassy Mtn RCRA landfill
EP246	4/8/98	16.82	Grassy Mtn RCRA landfill
EP247	4/8/98	12.50	Grassy Mtn RCRA landfill
EP248	4/14/98	15.08	Grassy Mtn RCRA landfill
EP249	4/14/98	11.63	Grassy Mtn RCRA landfill
EP250	4/14/98	20.50	Grassy Mtn RCRA landfill
EP251	4/14/98	16.33	Grassy Mtn RCRA landfill
EP252	4/21/98	10.73	Grassy Mtn RCRA landfill
EP253	4/21/98	11.74	Grassy Mtn RCRA landfill

Manifest	Date	Weight (Tons)	Disposal Location
EP254	4/21/98	10.31	Grassy Mtn RCRA landfill
EP255	4/21/98	15.69	Grassy Mtn RCRA landfill
EP257	4/22/98	13.24	Grassy Mtn RCRA landfill
EP258	4/22/98	15.53	Grassy Mtn RCRA landfill
EP259	4/29/98	10.81	Grassy Mtn RCRA landfill
EP260	4/29/98	16.18	Grassy Mtn RCRA landfill
EP261	4/29/98	11.67	Grassy Mtn RCRA landfill
EP262	4/29/98	10.83	Grassy Mtn RCRA landfill
EP290	6/8/98	9.61	Grassy Mtn RCRA landfill
EP291	6/8/98	8.11	Grassy Mtn RCRA landfill
EP292	6/8/98	10.88	Grassy Mtn RCRA landfill
EP293	6/8/98	12.87	Grassy Mtn RCRA landfill
EP294	6/8/98	9.26	Grassy Mtn RCRA landfill
EP295	6/8/98	11.33	Grassy Mtn RCRA landfill
EP296	6/24/98	12.19	Grassy Mtn RCRA landfill
EP297	6/24/98	13.51	Grassy Mtn RCRA landfill

Manifest	Date	Weight (Tons)	Disposal Location
EP298	6/24/98	12.64	Grassy Mtn RCRA landfill
EP299	8/12/98	12.23	Grassy Mtn RCRA landfill
EP300	8/12/98	9.90	Grassy Mtn RCRA landfill
EP301	8/12/98	12.94	Grassy Mtn RCRA landfill
EP304	1/13/99	13.14	Grassy Mtn RCRA landfill
EP305	1/13/99	7.41	Grassy Mtn RCRA landfill
EP306	1/13/99	11.33	Grassy Mtn RCRA landfill
EP307	1/13/99	13.14	Grassy Mtn RCRA landfill
EP308	2/10/99	11.32	Grassy Mtn RCRA landfill
EP309	2/10/99	14.40	Grassy Mtn RCRA landfill
EP310	2/18/99	20.23	Grassy Mtn RCRA landfill
EP311	2/25/99	7.21	Grassy Mtn RCRA landfill
EP312	2/25/99	15.64	Grassy Mtn RCRA landfill
EP313	2/25/99	15.95	Grassy Mtn RCRA landfill
EP256	4/21/98	15.64	Grassy Mtn RCRA landfill
EP005	8/15/97	8.48	Grassy Mtn RCRA landfill

Manifest	Date	Weight (Tons)	Disposal Location
Subtotal	178 loads	1990.43	All to Grassy Mtn RCRA landfill

Flue Dust, GM88-0554

RQ Waste arsenical dust, 6.1, UN1562, PG II, (EPA D004, D006, D008), Poison

Manifest	Date	Weight (tons)	Disposal location
EP002	8/27/97	15.00	Grassy Mtn RCRA landfill
EP015	8/27/97	2.06	Grassy Mtn RCRA landfill
EP018	9/5/97	7.52	Grassy Mtn RCRA landfill
EP020	9/5/97	11.52	Grassy Mtn RCRA landfill
EP021	9/5/97	10.90	Grassy Mtn RCRA landfill
EP022	9/8/97	15.06	Grassy Mtn RCRA landfill
EP023	9/8/97	6.03	Grassy Mtn RCRA landfill
EP042	9/29/97	9.91	Grassy Mtn RCRA landfill
EP046	10/3/97	8.65	Grassy Mtn RCRA landfill
EP047	10/3/97	6.83	Grassy Mtn RCRA landfill
EP053	10/9/97	15.10	Grassy Mtn RCRA landfill
EP054	10/9/97	11.66	Grassy Mtn RCRA landfill

Manifest	Date	Weight (tons)	Disposal location
Subtotal	12 loads	120.24	All to Grassy Mtn RCRA landfill

Process Flues, GM97-0042

RQ, Hazardous Waste Solid, NOS 9, NA3077, PG III, (D004, D006, D008)

Manifest	Date	Weight (tons)	Disposal Location
EP034	9/24/97	44	Grassy Mtn RCRA landfill
EP035	9/24/97	53	Grassy Mtn RCRA landfill
EP039	9/25/97	27.21	Grassy Mtn RCRA landfill
EP040	9/26/97	23.38	Grassy Mtn RCRA landfill
EP043	10/1/97	39	Grassy Mtn RCRA landfill
EP044	10/2/97	40	Grassy Mtn RCRA landfill
EP045	10/2/97	54	Grassy Mtn RCRA landfill
EP049	10/3/97	24.5	Grassy Mtn RCRA landfill
EP050	10/3/97	16.9	Grassy Mtn RCRA landfill
EP051	10/10/97	57	Grassy Mtn RCRA landfill
EP052	10/14/97	22.5	Grassy Mtn RCRA landfill
EP057	10/14/97	12.5	Grassy Mtn RCRA landfill

Manifest	Date	Weight (tons)	Disposal Location
EP058	10/16/97	50	Grassy Mtn RCRA landfill
EP063	10/20/97	54	Grassy Mtn RCRA landfill
EP064	10/21/97	34	Grassy Mtn RCRA landfill
EP065	10/21/97	50	Grassy Mtn RCRA landfill
EP071	10/22/97	31	Grassy Mtn RCRA landfill
EP072	10/23/97	13	Grassy Mtn RCRA landfill
EP073	10/23/97	10	Grassy Mtn RCRA landfill
EP074	10/24/97	55	Grassy Mtn RCRA landfill
EP075	10/27/97	12	Grassy Mtn RCRA landfill
EP079	10/27/97	15	Grassy Mtn RCRA landfill
EP080	10/28/97	12	Grassy Mtn RCRA landfill
EP081	10/28/97	10	Grassy Mtn RCRA landfill
EP082	10/29/97	11	Grassy Mtn RCRA landfill
EP083	10/29/97	10	Grassy Mtn RCRA landfill
EP084	10/29/97	12	Grassy Mtn RCRA landfill
EP085	10/29/97	10	Grassy Mtn RCRA landfill

Manifest	Date	Weight (tons)	Disposal Location
EP086	10/30/97	55	Grassy Mtn RCRA landfill
EP087	10/30/97	13	Grassy Mtn RCRA landfill
EP091	10/30/97	9	Grassy Mtn RCRA landfill
EP092	10/31/97	8	Grassy Mtn RCRA landfill
EP093	10/31/97	26	Grassy Mtn RCRA landfill
EP094	11/3/97	7	Grassy Mtn RCRA landfill
EP095	11/3/97	12	Grassy Mtn RCRA landfill
EP096	11/4/97	12	Grassy Mtn RCRA landfill
EP097	11/5/97	6	Grassy Mtn RCRA landfill
EP098	11/6/97	16	Grassy Mtn RCRA landfill
EP099	11/7/97	21	Grassy Mtn RCRA landfill
EP100	11/7/97	27	Grassy Mtn RCRA landfill
EP101	11/10/97	10	Grassy Mtn RCRA landfill
EP104	11/12/97	4	Grassy Mtn RCRA landfill
EP105	11/12/97	4	Grassy Mtn RCRA landfill
EP111	11/14/97	51	Grassy Mtn RCRA landfill

Manifest	Date	Weight (tons)	Disposal Location
EP112	11/16/97	56	Grassy Mtn RCRA landfill
EP113	11/18/97	24	Grassy Mtn RCRA landfill
EP114	11/19/97	12	Grassy Mtn RCRA landfill
EP115	11/20/97	18	Grassy Mtn RCRA landfill
EP118	11/21/97	9	Grassy Mtn RCRA landfill
EP120	11/21/97	30	Grassy Mtn RCRA landfill
EP121	12/2/97	45	Grassy Mtn RCRA landfill
EP122	12/3/97	46	Grassy Mtn RCRA landfill
EP123	12/4/97	43	Grassy Mtn RCRA landfill
EP124	12/5/97	19	Grassy Mtn RCRA landfill
EP125	12/7/97	52	Grassy Mtn RCRA landfill
EP126	12/10/97	7	Grassy Mtn RCRA landfill
EP127	12/10/97	6	Grassy Mtn RCRA landfill
EP128	12/11/97	8	Grassy Mtn RCRA landfill
EP141	1/19/98	15	Grassy Mtn RCRA landfill
EP145	1/20/98	15	Grassy Mtn RCRA landfill

Manifest	Date	Weight (tons)	Disposal Location
EP148	1/21/98	15	Grassy Mtn RCRA landfill
EP149	1/22/98	15	Grassy Mtn RCRA landfill
EP150	1/23/98	6	Grassy Mtn RCRA landfill
EP151	1/23/98	24	Grassy Mtn RCRA landfill
EP152	1/27/98	8	Grassy Mtn RCRA landfill
EP153	1/27/98	8	Grassy Mtn RCRA landfill
EP154	1/28/98	12	Grassy Mtn RCRA landfill
EP161	1/29/98	6	Grassy Mtn RCRA landfill
EP162	1/29/98	19	Grassy Mtn RCRA landfill
EP163	2/2/98	6	Grassy Mtn RCRA landfill
EP164	2/3/98	10	Grassy Mtn RCRA landfill
EP170	2/4/98	10	Grassy Mtn RCRA landfill
EP171	2/5/98	10	Grassy Mtn RCRA landfill
EP172	2/6/98	10	Grassy Mtn RCRA landfill
EP180	2/9/98	10	Grassy Mtn RCRA landfill
EP181	2/10/98	10	Grassy Mtn RCRA landfill

Manifest	Date	Weight (tons)	Disposal Location
EP188	2/20/98	9	Grassy Mtn RCRA landfill
EP189	2/23/98	11	Grassy Mtn RCRA landfill
EP190	2/24/98	10	Grassy Mtn RCRA landfill
EP210	3/24/98	32	Grassy Mtn RCRA landfill
EP216	3/25/98	18	Grassy Mtn RCRA landfill
EP217	3/26/98	31	Grassy Mtn RCRA landfill
EP218	3/27/98	26	Grassy Mtn RCRA landfill
EP224	3/30/98	20	Grassy Mtn RCRA landfill
EP225	3/31/98	26	Grassy Mtn RCRA landfill
EP226	4/1/98	28	Grassy Mtn RCRA landfill
EP227	4/2/98	16	Grassy Mtn RCRA landfill
EP228	4/3/98	32	Grassy Mtn RCRA landfill
EP234	4/6/98	31	Grassy Mtn RCRA landfill
EP235	4.7.98	25	Grassy Mtn RCRA landfill
EP236	4/8/98	25	Grassy Mtn RCRA landfill
Subtotal	91 loads	2007.99	All to Grassy Mtn RCRA landfill

Concentrate contaminated debris - GM97-0856

Hazardous Substance Solid NOS, NA3077, not RCRA hazardous waste.

Manifest	Date	Weight (tons)	Disposal Location
EP137	1/7/98	5	Grassy Mtn RCRA landfill
EP138	1/7/98	2	Grassy Mtn RCRA landfill
EP142	1/19/98	2	Grassy Mtn RCRA landfill
EP302	12/4/98	4.38	Grassy Mtn RCRA landfill
EP303	12/4/98	4.56	Grassy Mtn RCRA landfill
SM385	10/6/98	2.12	Grassy Mtn RCRA landfill
SM386	10/6/98	2.09	Grassy Mtn RCRA landfill
SM387	10/6/98	0.60	Grassy Mtn RCRA landfill
SM388	10/6/98	2.85	Grassy Mtn RCRA landfill
Subtotal	9 loads	25.60	All to Grassy Mtn RCRA landfill

Weak Acid Contaminated Debris - GM92-1847

RQ, Hazardous Waste Solid, NOS. 9, NA3077, PG III, (D004, D006, D008, D010)

Manifest	Date	Weight (tons)	Disposal Location
EP263	5/6/98	15.54	Grassy Mtn RCRA landfill
EP264	5/6/98	15.80	Grassy Mtn RCRA landfill

Manifest	Date	Weight (tons)	Disposal Location
EP265	5/6/98	13.73	Grassy Mtn RCRA landfill
EP266	5/8/98	9.41	Grassy Mtn RCRA landfill
EP267	5/8/97	9.26	Grassy Mtn RCRA landfill
EP268	5/8/98	10.21	Grassy Mtn RCRA landfill
EP269	5/8/98	8.44	Grassy Mtn RCRA landfill
EP270	5/8/98	13.79	Grassy Mtn RCRA landfill
EP271	5/8/98	10.36	Grassy Mtn RCRA landfill
EP272	5/12/98	11.31	Grassy Mtn RCRA landfill
EP273	5/12/98	8.85	Grassy Mtn RCRA landfill
EP274	5/12/98	9.63	Grassy Mtn RCRA landfill
EP275	5/12/98	13.53	Grassy Mtn RCRA landfill
EP276	5/12/98	13.25	Grassy Mtn RCRA landfill
EP277	5/12/98	12.62	Grassy Mtn RCRA landfill
EP278	5/15/98	15.24	Grassy Mtn RCRA landfill
EP279	5/15/98	14.69	Grassy Mtn RCRA landfill
EP280	5/15/98	14.20	Grassy Mtn RCRA landfill

Manifest	Date	Weight (tons)	Disposal Location
EP281	5/15/98	16.19	Grassy Mtn RCRA landfill
EP282	5/15/98	13.19	Grassy Mtn RCRA landfill
EP283	5/15/98	13.59	Grassy Mtn RCRA landfill
EP284	5/20/98	10.76	Grassy Mtn RCRA landfill
EP285	5/20/98	11.74	Grassy Mtn RCRA landfill
EP286	5/20/98	19.72	Grassy Mtn RCRA landfill
EP287	5/20/98	11.98	Grassy Mtn RCRA landfill
EP288	5/20/98	11.39	Grassy Mtn RCRA landfill
EP289	5/20/98	11.82	Grassy Mtn RCRA landfill
Subtotal	27 loads	340.24	All to Grassy Mtn RCRA landfill

Process Dust Contaminated Debris - GM98 0021-5
RQ Hazardous Waste Solid, NOS, HC 9, PG III, (D004, D006, D008, D010)

Manifest	Date	Weight	Disposal Location
EP314	7/27/99	22.79	Grassy Mtn RCRA landfill
EP315	7/27/99	29.12	Grassy Mtn RCRA landfill
EP316	7/27/99	29.96	Grassy Mtn RCRA landfill

EP317	7/27/99	22.25	Grassy Mtn RCRA landfill
EP318	8/2/99	10	Grassy Mtn RCRA landfill
EP319	8/2/99	11.72	Grassy Mtn RCRA landfill
EP320	8/2/99	10.83	Grassy Mtn RCRA landfill
EP321	8/2/99	10	Grassy Mtn RCRA landfill
SM405	12/4/98	3.12	Grassy Mtn RCRA landfill
Subtotal	9 loads	149.79	All to Grassy Mtn RCRA landfill

Contaminated Aluminum desiccant - GM98-0315
Hazardous Waste Solid, NOS, HC 9, PG III, (D004, D006, D008, D010)

Manifest	Date	Weight	Disposal Location
SM406	12/4/98	9.41	Grassy Mtn RCRA landfill
Subtotal	1 load	9.41	All to Grassy Mtn RCRA landfill

Grand Total = 4643.60 tons 327 loads

APPENDIX A: RESPONSIVENESS SUMMARY

(questions are paraphrased)

A. Written comments

Lynn de Freitas, President
Friends of the Great Salt Lake

1. Recommends that there be a North End Technical Review Committee meeting to address the benchmarks and what they mean in terms of protection of wildlife.

   EPA agrees.

2. Recommends that there be a monitoring plan for the North End Wetlands to ensure that post remediation has been and will be protective of the wildlife.

   EPA agrees and has included this requirement in the Record of Decision

3. Recommends that the monitoring plan also assess reclamation activities to ensure than maximum habitat function is attained.

   Although reclamation to enhance wildlife values is not allowed as a part of the remedy, the settlement between the USFWS and Kennecott may be used as a vehicle to accomplish this goal. This recommendation will be forwarded to the USFWS.

4. Applauds EPA's systematic approach to mitigate environmental impacts, especially the triage system to deal with the worst situations first.

   EPA has used a mixture of authorities at this site including Emergency Response Authorities, especially for the worst parts of the site. This allows the cleanups to proceed more quickly.

5. Likes EPA's consideration for the long term future of the Kennecott properties.

   This has been a concern for EPA, UDEQ and Kennecott. If at all possible, it makes sense to clean up the sites so that they can be used for different purposes should the mine close in the future.

6. Likes EPA's aggressive approach to ground water cleanup to speed the rate of cleanup.

   It makes sense to clean up the aquifer as soon as possible while the mine is still operating and the infrastructure is still available. This will result in some cost-savings and avoid the logistics of long term maintenance (which will clearly be more difficult after mine and

facility closure).

7. Likes EPA's suggestion that the Arthur Stepback Repository remain open for later use when facilities are demolished. It keeps the wastes consolidated.

   It makes sense to consolidate the wastes in one place. This allows the rest of the property to be redeveloped after mine closure.

8. Likes EPA's requirement of maps of known existing wastes for use by future land use planners.

   Because mine closure may not occur in the near future, maps will be needed so that future environmental scientists and land use planners can take advantage of our current knowledge and will not have to start over to re-locate the wastes and characterize the site. They will know what to look for and where as they evaluate their redevelopment plans.

9. Likes EPA's recommendation that UDEQ continue to monitor and enforce the Kennecott discharge limits to the Great Salt Lake

   The discharge limits to the Great Salt Lake are an important part of the remedy. It is not desirable to clean up one place only to transfer the problem to the Great Salt Lake. The discharge limits to the Great Salt Lake were derived from experiments done under this program.

10. The state should make an effort to establish numeric water quality standards for the Great Salt Lake and conduct the necessary scientific research needed to set such standards. Then permits could be based on the standards and make effective monitoring and enforcement possible.

    EPA agrees.

Jon Cherry, PE, Project Engineer
Kennecott Utah Copper Corporation

1. The Magna Tailings Pond is also referred to as the "South Tailings Impoundment".

   Nomenclature is a particularly vexing problem because of the long operating history of these properties. EPA met with Kennecott prior to issuance of the ROD to determine what each facility should be called as primary names. Names used in the past will only be listed as aliases.

2. The Proposed Plan suggests that phosphogypsum wastes are in the tailings pond. These

wastes were buried underneath the new tailings pond. The tailings pond is not a part of the site.

Yes, the phosphogypsum wastes (also known as the "gypstack") are buried under the new North Tailings Impoundment. Other facilities underneath the North Tailings Impoundment are the Morton Salt Ponds, historic rail lines and canals. EPA believes that burial of these wastes is protective of human health and the environment and this burial has become an integral part of the selected remedy. The Magna Tailing Ponds are a part of the site. CERCLA staff cooperated with the Army Corps of Engineers in evaluation of the CWA 404 permit application and Environmental Impact Study. The requirements in the CWA 404 permit also included the concerns of CERCLA and thus became an integral part of the selected remedy for the site. No separate or duplicative action was needed to accomplish the goals of both programs under one project.

3. Both the Arthur Mill and the Magna Mill (North Concentrator) are now closed, but the tailings pond continues to receive tailings from the Copperton Concentrator

Noted.

4. ASARCO smelter was built in 1906, not 1905.

According to EPA research, construction started in 1905, but the first furnace was lit on Labor Day 1906. EPA agrees that the operational history goes from 1906 to present.

5. Kennecott suggests that the original smelter be referred to as the reverberatory smelter and the new smelter be referred to as the Outokumpu smelter.

See Kennecott Question 1. This is particularly important - the term "new" smelter could mean different things depending on the date of the article.

6. The old tailings pond should be referred to as the South Tailings Impoundment.

See Kennecott Question 1.

7. The Magna Mill should also have a parenthetical indicating that it has been referred to recently as the North Concentrator.

See Kennecott Question 1.

8. All of the vegetation in the canyons were not killed by the smelter. Logging, overgrazing, and fires also contributed to the damage of the vegetation before the smelter was built.

EPA has not researched this issue or made any determination on the severity of

vegetation damage. All four causes (smelter smoke, logging, overgrazing, and fire) are known to affect vegetation. The degree to which each played a part was not evaluated.

9. Reclamation of the dumps is regulated by DOGM; reclamation is not necessarily required.

   Reclamation may or may not be required as dictated in each DOGM permit.

10. Kennecott would like to see the remaining historic sites included in this ROD.

    EPA agrees.

11. EPA should formally issue a replacement document authorizing the Repository and Staging Area CAMU's in the Record of Decision and in the Consent Decree. The CAMU is designated in the ROD and the operating requirements should go into the Work Plan under the CD.

    EPA agrees.

Henry R. Maddux
Field Supervisor
U. S. Fish and Wildlife Service
Salt Lake Office

1. Several portions of the Garfield Wetlands including the Garfield Well area, a portion of Pond A, the entire Smelter Wetlands, and the oolitic sand mining area were not cleaned up during the removal action and it is the belief of the Service that these areas will continue to impact migratory birds. These areas have high selenium in the water, invertebrates or bird eggs, or are notable for a lack of bird use.

   EPA does not yet know the effectiveness of the various cleanups in the wetlands or the impact of eliminating the major selenium water sources. The impact on migratory birds was uncertain and controversial before cleanup, and, now that conditions have been improved, the impacts, if any, are unstudied and unevaluated.

2. Monitoring should not be for the purposes of monitoring the impacts of the cleanup, but rather to determine the impacts of leaving contamination in place in the wetlands.

   The monitoring program should keep both issues in mind. EPA wants to know how far we have come, but also needs to know how far we have yet to go. There is a formal evaluation of the "how far we have yet to go" in the five-year review process.

3. Studies of risk to migratory (rather than resident) birds should continue to determine

when the risks are eliminated.

With USFWS concurrence, EPA identified resident birds to be the ecological sub-population most at risk due to selenium exposure. The theory was that the resident birds would be more likely to be impacted at the site than the occasional visitors which just pass through the site yet do not nest there. The impacts of selenium occur during reproduction. Therefore, it is EPA's view that protection of the birds that nest at the site will also protect the migratory birds that visit the site occasionally but nest elsewhere.

4. The Service would like to help EPA develop a monitoring plan for the ROD which includes long-term migratory bird species management goals, final physical design components, water and vegetation management, water sources, spill and storm water management and control, and performance measures to ensure success has been reached and maintained.

EPA continues to appreciate the help of the USFWS and supports the need for a monitoring plan in the wetlands. The monitoring plan has become an element of the Record of Decision.

5. Effects of selenium in water are unlikely if the water quality is 2 ug/L or less. Class 3D water quality standard in Utah is 5 ug/L. The performance goal for water in the wetlands should be 5 ug/L or less.

EPA has determined that the current scientific data at the site does not support establishment of specific water quality goal for this site. Although data are available from other sites, this particular area is unique with saline playas, quiet waters, marshland and other habitats different than other fresh waters. It is not classified by the state, so no regulatory standards are applicable. However, during the course of the monitoring program, EPA hopes that a sufficient database can be generated which could allow calculation of a specific water quality goal for these unique waters. Until such a water quality goal can be established, EPA will use the macroinvertebrate selenium concentrations as a benchmark, and an interim goal of 5 µg/L Se until the site specific water quality goal is established.

6. Because Tooele Canal water is the main source of water to the wetlands and it has a concentration greater than 5 ug/L, water treatment of this water should be investigated, including blending, elimination of springs which feed into the Tooele water sources or biological treatment.

Tooele Canal water has no known anthropogenic sources of selenium and therefore represents a local background for selenium. EPA has no authority to treat waters at or below background concentrations. Background concentrations often create some risk, but EPA's authority is limited in this regard.

7. The geometric mean of the macroinvertebrate selenium concentrations should not exceed 6 ug/g dw. A performance goal of 10 ug/g dw Se should be the goal and the threshold at which action is required to perform additional Se control actions. The performance goal for remediated wetlands should not exceed a mean of 6 ug/g dw Se in invertebrates, and the goal for unremediated wetlands should not exceed a mean of 10 ug/g dw Se in invertebrates.

EPA supports the overall goal of this statement, although does not prefer use of a geometric or arithmetic mean. The use of a mean is subject to the number of samples collected and where they are collected and can be too easily manipulated. EPA prefers that any samples which contain more than 10 ug/gm dw Se two years in a row trigger an investigation of that particular area to determine what Selenium sources might still be influencing this uptake. Further cleanup work may be needed to abate the source.

8. The fate of selenium in the Great Salt Lake has not been determined. Long-term monitoring is necessary and further evaluation on the effects on migratory birds is warranted.

EPA also believes that scientific research on the fate and impacts of most lake contaminants is rather minimal. Future management of this valuable ecological resource would become easier if more were known about how the lake operates. Because the Great Salt Lake is the terminal basin for a huge watershed, this should be done in a holistic manner. EPA is pleased that the FWS is interested enough in this issue to start a research program on the Great Salt Lake.

9. FWS monitoring indicates that there are more instances of bird eggs exceeding 6 ug/g Se dw than in other parts of the lake. Continued monitoring of bird eggs near the Great Salt Lake is warranted to evaluate that the situation is stable or improving.

Again, EPA continues to advocate studies of the Great Salt Lake and is pleased that the FWS is interested in this topic.

10 Discharges to Lee Creek should have a performance goal of 5 ug/L, not the 12 ug/l used by the Army Corps of Engineers in the 404 permit. Kennecott discharges to Lee Creek should be eliminated if they are found to occur. A monitoring program should determine if there is a residual problem in Lee Creek.

Although the pollutant sources from Kennecott to Lee Creek have been diverted elsewhere, a monitoring program to determine if these changes have improved the water quality of the creek is warranted, especially since Lee Creek was implicated as a problem in some of the initial ecological findings. Lee Creek does not originate on Kennecott property. Upstream selenium sources may be implicated.

11. Selenium concentrations in mice are quite high in Kessler and Black Rock Canyons, and these areas had the highest concentrations of mice. These concentrations may represent a potential threat to prey species and avian predators. Because of the high populations of mice, it should not be assumed that these areas represent a small portion of the diet. Hot spot removals may be needed.

It is EPA's view that the impacts of bulldozers in the canyons would do actual damage to the ecosystem and the habitat of all the plants and animals. This is too high a price to pay for remediation of a theoretical and unknown risk. The high population of mice in the "impacted zones" indicates that the prey population hasn't been negatively impacted.

12. Long term monitoring of the canyons is needed to determine if long term impacts to terrestrial resources are occurring. Prey concentrations of selenium should not exceed 12 ug/g dw Se.

The whole body burden of selenium average 15.27 µg Se/g dry weight and 13.26 µg Se/g dry weight in Kessler Canyon and 10.65 µg Se/g and 11.21 µg Se/g in Black Rock Canyon. These concentrations are indeed significantly higher in selenium than other nearby canyons. Although the NOAEL for carnivorous birds is 10 µg Se/g, the LOAEL (the level at which effects have been observed in the literature) is 30 µg Se/g. The concentrations are 2 to 3 times lower than the LOAEL. The problem with hot spot removal is that the concentrations in the mice do not correlate well with concentrations in the soil. It is not clear if soil removal would help especially if the mice are receiving the selenium from selenium concentrating plants such as white top.

13. Artesian flow to the wetlands will continue to degrade parts of these wetlands, including the remediated wetlands.

All known artesian flows tainted with selenium are now being diverted away from the wetlands into the process water circuit. Should additional artesian flow sources be found, they should be diverted as well.

14. FWS supports the choice of 4B over 3, but would like to see development of contingency plans if the selenium thus treated begins to remobilize after facility closure.

If monitoring during execution of the remedy suggests that the elemental selenium produced by the microbes is beginning to remobilize, this would indicate a failure of the selected remedy and a new remedy would have to be chosen.

15. Pumping of shallow ground water may be needed in localized areas where artesian flow still surfaces in the Garfield Well Area.

The artesian flow currently entering the wetlands is not contaminated, but if conditions

change and additional contaminated flows are found, they must be diverted.

16. EPA has asked for help in establishing performance goals, and the FWS would like to continue to participate as this project moves forward.

    EPA continues to appreciate the help of the FWS in these matters.

B. Questions at the Public Hearing in Magna, June 12, 2002

Greg Schulz
Magna Area Council

1. The Magna Area Council should have been notified by mail at our P.O. Box that this meeting was occurring.

   Over April and May of 2002, UDEQ staffers tried in vain to contact the Magna Area Council through its environmental contact. They were unsuccessful. The late Jim Brusatto was the Magna Area Council's representative on the North End Technical Review Committee and he was very active in behalf of the council for a large number of years. EPA would be pleased if the Magna Area Council would send us another representative to serve on this work group. That person could also serve as an interface between the agencies and the Council, keeping the Council informed of upcoming issues and options being considered.

2. According to Kennecott's 50-year development plan, Kennecott plans to put heavy to medium industries all along the impoundment. What are the impacts to Magna from this?

   Virtually any future development in this area would have to undergo county and town scrutiny. Many issues are involved, not just environmental. Transportation and utility infrastructure, increased (or decreased) population impacts, drainage, water supply, etc. EPA encourages Magna and Kennecott to work together in their planning for future development.

3. Some of the contamination could impact the Great Salt Lake in the future.

   Any development along or near the shoreline of the Great Salt Lake is going to have an impact on the Great Salt Lake. There are two questions: What happens in the Great Salt Lake with increasing pollution loads? (How much is too much?) And how much pollution should each source be allowed to add? The scientific knowledge about the Great Salt Lake is nowhere close to answering even these two basic questions. EPA encourages further study of the Great Salt Lake and the potential impacts. Then we can all make better decisions about what is prudent for the future.

4. What would be the impacts of development in Little Valley? Would it impact the ground water?

Development could impact the ground water at the very least by adding additional nutrients to the water (if septic systems are used). Commercial and industrial development could add other contaminants as well. Stormwater runoff is a particular problem for Little Valley. In the past, mudflows came down Little Valley because the vegetation had been damaged by smelter smoke and the soil could not hold the water. Pavement doesn't hold the water well either, and increasing development in Little Valley puts Magna more at risk (unless design precautions for storm water management are included).

5. With all the rail connections, Kennecott indicates that southern California-style development is possible in areas that are not a great deal higher than the floodplain. We need to think about impacts.

See question #2.

Lynn de Freitas, President
Friends of the Great Salt Lake

1. I am duly impressed with the amount of progress and the work accomplished by EPA and Kennecott.

Thank you.

2. What should the performance standards be? How clean is clean?

As noted in your question, the performance standard issue was controversial among the scientists on the Technical Review Committee. The Record of Decision will implement an interim goal, and use a monitoring program to develop a site-specific standard which will be specific for the wildlife and birds at this location, not just for some captive birds in the literature. EPA is not satisfied with the information it has on this issue today.

APPENDIX B
FEDERAL ARARs FOR NORTH END REMEDIATION

Standard, Requirement, Criterion or Limitation	Citation	Type of ARAR/Description	Applicable/ Relevant and Appropriate	Remedy	Comment
Safe Drinking Water Act					
National Primary Drinking Water Standards	40 C.F.R. 141.61 - 141.63				See State ARARs
Maximum Contaminant Level Goals (MCLGs)	40 C.F.R. 141.50-141.53	Chemical specific. Health goals	No/No		The water is not a current or future drinking water source, because it is naturally high in Total Dissolved Solids.
National Secondary Drinking Water Standards	40 C.F.R. 143				See State ARARs
Underground Injection Control Regulations	40 C.F.R. 144 - 147				See State ARARs
Clean Water Act					
Water Quality Criteria	40 C.F.R. 131	Chemical specific. Goals used by states to set water quality standards.	No/No	Ground water	Actual limits are set by states as a function of location and water usage by humans and wildlife. See State ARARs
Dredge and Fill Criteria	40 C.F.R. 230	Location specific. Regulates disposal and handling of fill and dredge material into wetlands	Probably not	Ground water	Wetlands will not be used as disposal locations in this action. Dredging activities have already taken place.
Clean Air Act					See State ARARs

Standard, Requirement, Criterion or Limitation	Citation	Type of ARAR/Description	Applicable/ Relevant and Appropriate	Remedy	Comment
Resource Conservation and Recovery Act	40 C.F.R. §254.552(a)(1), 40 C.F.R. §264.550(b)	Action Specific. Regarding continued use of an official CAMU within general scope of the original approval	Yes/No	Arthur Stepback Repository	Arthur Stepback Repository was approved for use in AOC, CERCLA VIII-95-04 in 1995. Public comment prior to this ROD supported continued use of the repository for cleanups. Also see State ARARs
Archaeological and National Historic Preservation Act	16 USC§ 469, 40 C.F.R. 6.301(c)	Location-specific. Procedures to preserve historical and archaeological data	Yes/No	Ground water, mill and plant demolition	Unlikely to encounter archaeological sites in the future remediation projects
Historic Site, Buildings, and Antiquities Act	16 USC§ 461, 40 C.F.R. 6.301(a)	Location-specific. Requires agencies to avoid undesireable impacts on historic landmarks	Yes/No	Ground water, mill and plant demolition	Unlikely to encounter historic landmarks in the future remediation projects
Fish and Wildlife Coordination Act	16 USC§ 1531-66, 40 C.F.R. 6.302(g)	Location-specific: Requires notification to USFWS if structural modifications or controls are added to waterbodies	Yes/No	Ground water	It is unlikely that any modifications will be made to waterbodies as a part of this project.
Floodplain Management	40 C.F.R. 6.302(b), and Appendix A, Executive Order 11988	Location-specific. Requires evaluation of effects of projects on flood plains, regulates activities in floodplains.	Yes/No	Ground water	It is unlikely that there will be any impacts to floodplains due to this project.
Protection of Wetlands	40 C.F.R. 6.302(a) and Appedix A, Executive Order 11990	Location-specific. Avoid adversely impacting wetlands.	Yes/No	Ground water	No wetland activities anticipated except monitoring

Standard, Requirement, Criterion or Limitation	Citation	Type of ARAR/Description	Applicable/ Relevant and Appropriate	Remedy	Comment
Endangered Species Act	16 USC §§1531-1543, 40 C.F.R 6-302(h), 50 C.F.R.200, 50 C.F.R. 402	Location-specific. Conserve endangered species within critical habitats	Yes/No	Ground water, mill and plant cleanup	Unlikely impacts, because habitats not critical and no endangered species present.
Occupational Safety and Health Act	20 USC§§ 651-678, 29 C.F.R. 1910 and 1926	Action-specific. Standards necessary to provide safe places of employment	Yes/No	All	All worker activities during cleanups regulated by OSHA, inspections occur when complaints received.
Superfund Amendments and Reauthorization Act	40 C.F.R. 302	Action-specific. Notification requirements for releases to the environment	Yes/No	All	All releases and spills (above reportable quantities) must be reported.

STATE ARARs FOR THE NORTH END REMEDIATION

Standard, Requirement, Criterion or Limitation	Citation	Type of ARAR/Description	Applicable/ Relevant and Appropriate	Remedy	Comment
Utah Public Drinking Water					
Water Quality Maximum Contaminant Levels (MCLs)	UAC R309-103-2	Chemical-specific. Establishes drinking water standards	No/No	Ground Water	The aquifer in question is not a current or future drinking water source due to high content of Total Dissolved Solids
Water Quality Regulations					

Standard, Requirement, Criterion or Limitation	Citation	Type of ARAR/Description	Applicable/ Relevant and Appropriate	Remedy	Comment
Water Quality Standards	UAC R317-2-3	Action specific. Anti-degradation policy	Yes/No	Ground Water	Maybe at closure, but already have a permit for process and other waters discharged to Great Salt Lake.
Water Quality Standards	UAC R317-2-5	Action specific. Mixing Zone - prohibits acute concentrations in mixing zone	Yes/No	Ground Water	Maybe at closure, but already have a permit for process and other waters discharged to Great Salt Lake.
Water Quality Standards	UA C R317-2-7	Action-specific. Numeric standards for each water quality class of state waters	Yes/No	Ground Water	Great Salt Lake does not have numeric standards but could have them in the future.
Design Requirements for Wastewater Collection, Treatment and Disposal Systems	UAC R317-3	Action-Specific. Design requirements for domestic wastewater	No/No	Ground Water	Water to be treated not in anyway similar to domestic sewage.
Groundwater Quality Protection Regulations	UAC R317-6-2	Chemical specific - typically drinking water standards	No/No	Ground Water	Aquifer is not useful for drinking water.
Groundwater Quality Protection Regulations	UAC R317-6-4	Action specific - for the operations of facilities that discharge to groundwater	No/No	Ground Water	Applies to facilities requiring a permit. This may be an ARAR if post closure treatment requires a facility.
Groundwater Quality Protection Regulations	UAC R317-6-6	Action specific - substantive requirements for facilities that require a groundwater permit	No/No	Ground Water	Only if a treatment facility requiring a permit is built.
Groundwater Quality Protection Regulations	UAC R317-6-6.15	Chemical specific - corrective action concentration limits - cleanup standards	No/No	Ground Water	Aquifer is not useful for drinking water. These limits are not ARARs, according to the regulations.

Standard, Requirement, Criterion or Limitation	Citation	Type of ARAR/Description	Applicable/ Relevant and Appropriate	Remedy	Comment
Underground Injection Control Program	UAC R317-7	Action specific - conditions under which wastes or fluids can be injected underground	Yes/No	Ground Water	Applicable because microbes will be injected into the aquifer
UPDES (Utah Pollutant Discharge Elimination System)	UAC R317-8	Action specific - limits discharges into surface waters	Yes/No	Ground Water	If discharges are made to the Great Salt Lake, they are subject to requirements in Kennecott's UPDES permit.
Utah Air Conservation Regulations					
Air Quality Standards for Control of Installations	UAC R307-1-3	Action specific. Regulates new installations with air pollution potential	Yes/No	Ground Water	If a new treatment facility might cause air pollution
Fugitive Dust and Emission Standards	UAC R307-12	Action specific. Requires dust control during construction and demolition	Yes/No	Demolition and cleanup of closed facilities	If cleanups generate dusts. (They do.)
National Emission Standards for Hazardous Air Pollutants	UAC R307-10	NESHAP standards	No/No	Ground Water	Remedy does not have one of the source categories regulated
State Engineer, Department of Natural Resources					
Drilling standards	UAC R655-4	Action specific. Drilling standards, abandonment of wells	Yes/No	Ground Water	Applicable to all well installations and abandonment
Salt Lake Valley Interim Ground Water Management Plan		Action specific. Limits water withdrawals from principal aquifer	Yes/No	Ground Water	Applicable to all ground water withdrawals.

Standard, Requirement, Criterion or Limitation	Citation	Type of ARAR/Description	Applicable/ Relevant and Appropriate	Remedy	Comment
Hazardous Waste Regulations					
Definition of Solid and Hazardous Waste	UAC R315-2	Action Specific. Standards for identifying solid and hazardous wastes	Yes/No	Demolition and cleanup of closed facilities	If cleanups encounter hazardous wastes
Operation of TDS facilities	UAC R315-3 and R315-8	Action specific. Operation and design standards for owners of TSD facilities	No/Yes	Management of Arthur Stepback Repository	The Repository was originally built incorporating these standards. The wastes in the repository are either soils or Bevill exempt.
Hazardous Waste Generators	UAC R315-5	Action specific. Hazardous waste generator standards	Yes/No	All	If hazardous wastes are generated during remedial actions
Spills	UAC R315-9	Action specific. Requires notification and response to spills of hazardous wastes	Yes/No	All	If spills occur, they must be reported and cleaned up
Land Disposal Restrictions	UAC R315-13	Action specific. Land Disposal Restriction Standards	Yes/No	All	However, no new land disposal facilities will be needed in the remedial actions
Closure Standards	UAC R315-101	Chemical specific. Closure standards	No/No	All	No on-site RCRA TDS facilities will be needed. Risk-based standards already calculated
Solid Waste Regulations					
Industrial solid waste facility	UAC R315-304	Action specific. Industrial solid waste facility requirements	No/No		Remedial actions will not involve construction of a new industrial solid waste facility

Standard, Requirement, Criterion or Limitation	Citation	Type of ARAR/Description	Applicable/ Relevant and Appropriate	Remedy	Comment
State OSHA Rules	UAC R574	Adopts federal OSHA standards for safe and healthful employment	Yes/No	All	Applicable to all worker activities related to remedial actions at Kennecott.