2004 NORTH ZONE

WETLANDS MONITORING

May 31, 2004

KENNECOTT UTAH COPPER CORPORATION

MAGNA, UTAH

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Cover Photographs: Garfield Wetlands looking east from top of smelter stack, August 2004 (J. Lachowski); American Avocet (A. Neville)

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1.0 REGULATORY HISTORY

On January 17, 1994, the Environmental Protection Agency (EPA) proposed the Kennecott South Zone and Kennecott North Zone sites for listing on the National Priority List (NPL or Superfund). Within each of these sites, the EPA identified several source areas and potential source areas, including soils suspected of impacting the quality of groundwater on the northern end of Kennecott Utah Copper Corporation's (KUCC's) operations. EPA, Utah Department of Environmental Quality (UDEQ) and KUCC executed a Memorandum of Understanding (MOU) dated September 27, 1995, in which the NPL listing was deferred. KUCC entered into an Administrative Order on Consent (AOC) to excavate sludge from the waste water treatment plant ponds and other contaminated soils at the North Zone and place them in an on-site repository. KUCC also agreed to complete the following on the northern end of the property:

- "[t]he currently-defined ecological risk assessment studies and development of recommendations…
- start a remedial investigation/feasibility study (RI/FS) on the North Zone groundwater problems (i.e., originating at the refinery and smelter sites) within one year of completion of the ecological and human health risk assessment, if such an RI/FS is shown necessary based on ecological and human health risk assessments…
- complete environmental assessments of currently identified on-site historic facilities and their associated wastes and conduct cleanups of these wastes if shown necessary by the ecological and human health risk assessments," (This requirement is applicable to all KUCC property.)

Based on preliminary results of the ecological risk assessment (EcoRA) along the North Zone wetlands (also referred to as the Southshore wetlands) it was determined that an RI/FS for KUCC's North Zone groundwater should be implemented. The EcoRA indicated a small, but measurable threat to certain avian wildlife in the wetlands from dietary exposure to selenium, which can consequently effect reproductive success. The main source of selenium to the wetlands was artesian flows of contaminated groundwater (for more details see next section). The RI studied the nature and extent of contamination, the fate and transport of contamination (in both surface water and groundwater), the hydrology of the various aquifers, and hydrologic, geochemical and transport modeling (KUCC, 2000). The FS determined remedial action objectives and examined treatment options for the selenium-contaminated surface water and groundwater (KUCC, 2001).

During the RI/FS, additional EcoRA studies were completed. One of these studies involved selenium toxicity testing on the most common biological species in the Great Salt Lake (GSL). The data from this study were also used to develop a selenium concentration limit for KUCC's discharges to the GSL. KUCC's discharges to the GSL are UDEQ permitted Utah Pollution Discharge Elimination System (UPDES) outfalls. The EPA coordinated its CERCLA actions with the UDEQ UPDES program. The EPA's actions were designed to lower the contaminants in the waters being discharged to the GSL. KUCC has lowered its discharge of selenium to the GSL from 4,693 lb/yr in 1999 to 535 lb/yr in 2002. This decrease, coupled with the implementation of the UPDES discharge limits and the required monitoring of these limits, led the EPA to defer the GSL action's to another authority (UDEQ). Therefore, the GSL was not included in the monitoring plan for the North Zone wetlands.

The Record of Decision (ROD) for the North Zone Site was issued by the EPA in September 2002. The ROD presented the response objectives and actions for each operable unit within the North Zone. One of the response actions for the North Zone wetlands involved the development of a monitoring plan to determine the effectiveness of the various soil and sediment cleanups and water diversions. An outline of the draft wetlands monitoring plan was presented to the Technical Review Committee (TRC) on April 25, 2003. The group reached a consensus that the monitoring plan was adequate for meeting the requirements of the ROD. The monitoring plan consisted of three annual sampling events beginning in June 2003. This report documents the results of the North Zone Wetlands sampling in June 2004.

2.0 PURPOSE, OBJECTIVES AND GOALS

The purpose of the wetlands sampling was to comply with the selected remedy for North Zone wetlands as outlined in the ROD (EPA, 2002a). The objectives were to:

- determine concentrations of selenium, along with arsenic, cadmium, copper, lead and zinc, in surface water, sediments and macroinvertebrates in the KUCC wetlands,
- evaluate the effectiveness of the sediment and soil removals,
- evaluate the effectiveness of spring and well water diversions, and
- ensure that migratory birds are not at risk from selenium at the KUCC wetlands.

Evaluation of the results obtained during monitoring may lead to further actions, such as identifying/removing remaining sources, additional sampling, and/or the determination of a site-specific water quality goal for selenium, if possible. Results are presented in Section 6.0, and evaluated in Sections 8.0 and 9.0 of this document.

Ecological risk assessments conducted for all of the North Zone concluded that the primary area of concern was the wetlands (mainly the Garfield Wetlands), where elevated selenium posed a potential risk to the reproductive success of shorebirds and insectivorous songbirds or waterfowl (ep&t and Parametrix, Inc., 1997). However, the data from these assessments did not support a relationship between water, sediment, and bird egg selenium concentrations for this site due to the wide variety of habitats, organic carbon and salinity gradients, and therefore a site-specific action level for selenium concentrations in water and sediment was not derived. Instead, the cleanup goal set by the EPA in the ROD for this site was based on the selenium concentrations in macroinvertebrates. It is assumed that protecting the food source from accumulating selenium also protects migratory birds. A direct relationship exists between selenium in the macroinvertebrates (primary diet of shorebirds) and the selenium that accumulates in the bird eggs. Therefore, the goals for wetlands cleanup and associated actions were determined and are summarized in Table 2-1.

TABLE 2-1 GOALS FOR WETLANDS CLEANUP PROJECT (EPA, 2002a)

CATEGORY	RANGE OF CONCENTRATIONS OF Se IN MACROINVERTEBRATES (ppm, dw)	ACTION
Acceptable	0 – 5 ppm Se	No action needed
Warning	5 – 10 ppm Se	Increased monitoring frequency and number of samplings locations
Unacceptable	> 10 ppm Se	Determine additional sources and abate sources, perform additional sediment removals, and/or provide cleaner water to wetlands.

The overall objective was to measure selenium concentrations available to wildlife in macroinvertebrates, water and sediment in the wetlands. Data on selenium concentrations in macroinvertebrates were compared to the goals listed in Table 2-1 and also compared to historical data, where available, to evaluate the potential for selenium exposure (see Section 8.0). Data were also examined to determine if a site specific water quality standard for selenium could be derived. Additionally, water, sediment and macroinvertebrates are analyzed for arsenic (As), cadmium (Cd), copper (Cu), lead (Pb) and zinc (Zn).

As stated in the ROD, the goals in Table 2-1 are meant to be a benchmark:

> “The goals for the 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 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.” (EPA 2002a, p.7.45)

Specific areas that were monitored included all North Zone wetlands within the approximately 1,100 acre triangle formed by Utah State Highway 201 (SH201), Utah State Highway 202 (SH202) and I-80, along with Spitz Springs, the Eastside Wetlands and the Japanese Springs Wetlands (see Figure 2-1 for locations and Section 3.3 for discussion of these areas). The GSL and all of KUCC’s discharges to the GSL were not included. KUCC discharges to the GSL through permitted outfalls that are monitored under the UPDES program of the UDEQ.

Figure 2-1

3.0 BACKGROUND

3.1 Ecological Risk Assessments

In 1993, KUCC initiated a EcoRA to ascertain the potential ecological risk from deposition of heavy metals in the environment as a result of past mining practices. One of the focal points of the EcoRA was the KUCC-owned wetlands along the southeastern shore of the GSL. The screening level risk assessment was completed in early 1995 focusing on the concentrations of metals and metalloids in soil, water, and vegetation of randomly selected sample points in the wetlands north of the smelter (Smelter Wetlands) and refinery areas (Garfield Wetlands). Relative to GSL Southshore Wetlands, it was concluded that the Garfield Wetlands, also referred to in the EcoRA as Sampling Unit 1 (SU1), may present a potential risk to shorebirds and insectivorous songbirds or waterfowl due to elevated concentrations of selenium.

During the final phase of the EcoRA in 1995-1996, sampling was conducted to quantify 1) the abundance and diversity of aquatic macroinvertebrates 2) the abundance and diversity of wildlife 3) the nesting success of birds and 4) the chemicals of concern (CoCs) concentrations in water, sediment, aquatic macroinvertebrates and bird eggs. Also, the assessment of wetlands was expanded to include KUCC-owned wetlands on the east side of the Magna tailings impoundment (SU2) and north of I-80 along the shore of the GSL (the Mitigation Site for the tailings expansion project). A comparison was made of the KUCC wetlands and two reference sites, based on the CoCs in the biota and the environment. Based on this comparison, it was concluded that selenium may pose a limited risk to successful reproduction of some shorebirds that feed in specific portions of SU1.

During the 1999 nesting season, ep&t sampled macroinvertebrates, bird eggs and water in SU1. They also conducted field surveys that measured bird use and habitat quality. The results showed the areas of concern to be 1) the Garfield well-field area where macroinvertebrate selenium concentrations were elevated and may present some risk to nesting birds, 2) the Kessler Springs area which could pose an elevated risk, although the bird eggs at that location indicated no risk, and 3) the I-80 Pond which had selenium concentrations in aquatic macroinvertebrates that may pose a marginal risk to birds, but where egg selenium concentrations were below toxicity levels (ep&t, 1999). Contaminated sediments had not yet been removed from either the Garfield well-field or the I-80 Pond at the time of this study.

3.2 Soil Removal, Water Diversions and Restoration

Through comprehensive agreements with the EPA and the State of Utah, and consultation with the U.S. Fish and Wildlife Service, remediation of contaminated soils and sediment was initiated in 1996 throughout the smelter-refinery-Garfield area. KUCC undertook extensive soils removals and constructed a high-capacity, lined repository in the Arthur Stepback area, on the southwest embankment of the Magna tailings impoundment, to dispose of the contaminated soils. Concurrently, KUCC has removed the sources of surface water and groundwater contamination, and has completed a remedial investigation/feasibility study to address long-term groundwater treatment options, especially for selenium removal.

Within the Garfield area, soil removal actions focused on five major sites:

- Pond A, near the Saltair interchange of SH202 with I-80
- I-80 Pond, a large, elongated pond next to I-80
- Slag Lagoon, located between I-80, the I-80 Pond and the smelter area
- Garfield well-field, southwest of the intersection of SH202 with old UP Railroad corridor
- Pond D, northwest of the SH202-UP Railroad (old corridor) intersection.

All soil removal projects were completed by 2001. Post removal data are summarized in Table 3-1 for each site. For all post removal data for the wetlands, see the Wetlands (WL03), Smelter (S16) and Refinery (W01 Pond A and W01 Pond D) Areas Post Removal Reclamation reports.

TABLE 3-1 GARFIELD AREA SOILS SUMMARY: AVERAGE (as collected) CONCENTRATIONS OF ALL POST REMOVAL SAMPLES

SITE	# of samples	As (ppm)	Cd (ppm)	Pb (ppm)	Se (ppm)
Pond A	222	7.6	0.4	1.5	0.5
Pond D	146	26	0.8	20	<0.5
Garfield Well-field	77	10.4	0.9	3.9	3.8
I-80 Pond	189	32	1.0	15.5	1.8
Slag Lagoon	102	17.4	1.0	14.9	2.4

Surface water is present in varying amounts throughout the year north of SH201 in the Garfield wetlands. A site-wide surface water quality survey was conducted several times during the RI field studies and showed elevated concentrations of selenium in the surface water (KUCC, 2000). Although some of this selenium was leached from locally-contaminated soils, the majority of elevated selenium concentrations in the wetlands were the direct result of selenium-contaminated artesian flows. Kessler Springs, located down gradient from the refinery, flows at a rate of approximately 200 to 500 gpm and contains approximately 1.2 mg/L selenium. Until Kessler Springs was identified during the RI, the artesian flow meandered through the wetlands until it flowed into the smelter return canal. The flow is currently captured and used in KUCC's process water system.

Another source of selenium-contaminated artesian flow to the wetlands was well NEG485. This well is also know as Garfield Well Number 5 and flows at approximately 200 gpm with a selenium concentration that has decreased from a high of over 1.2 mg/L to its current concentration of 0.052 mg/L (4Q04). As a requirement of the Section 404 permit for the tailings modernization project, the artesian flow from this well was captured and hard piped to Outfall 008, which discharged to the GSL. This was completed in 1998. Because of concerns associated with discharging elevated selenium concentrations to the GSL, the artesian flow from NEG485 was repiped into KUCC's process water system in April 2000 (KUCC, 2001).

After the soil removal and the water diversion projects were completed, the wetlands were restored and the habitat improved. The goal of the reclamation and restoration activities was to create areas that were consistent with typical GSL south shore wetland habitat, including saline playas, limited marshes and areas of open water. After contaminated soil and sediment were removed from each site, other physical improvements were made before the equipment was demobilized. These improvements included the creation of islands and shoreline, optimization of hydrological features (i.e., water level control features), and revegetation with native wetland plants. Most of these activities were completed by the end of the 2001 construction season.

3.3 Site Setting

The Eastside Wetlands are located on the east side of the Magna tailings impoundment in an area where numerous creeks and ditches merge together (Figure 2-1). Habitat consists of saline playas with scattered ephemeral wetlands covering approximately 2,600 acres. The area has been impacted in the past by tailings spills from breaches in the nearby tailings pond. This area was studied in the EcoRA and was called Sample Unit 2 (SU2). The main focus within this area was two locations that showed elevated selenium concentrations in the 1995 EcoRA data.

Spitz Springs, a bedrock contact spring, forms a wetland area measuring approximately one acre. The western area contains water at a depth of approximately one foot, and is overgrown with phragmites. The eastern area is deep water (> 6 feet) surrounded by phragmites on the north and a rock cliff to the south. Spitz Springs is located along the southwestern base of the Magna tailings impoundment, north of Pond C, and south of Pond B (Figure 2-1). These ponds historically stored sludge produced by the waste water treatment plant.

Japanese Springs wetlands are located west of the smelter and consist a small ponded area surrounded by phragmites (Figure 2-1). The area covers less than one acre, and is of concern due to its proximity to the smelter.

The Garfield Wetlands down gradient of the smelter and refinery cover approximately 1,100 acres and are topographically flat. The area has a variety of habitats, including perennial and ephemeral ponds, marsh areas, saline playas, and other wetland areas that are wet only during periods of high precipitation, and dry the rest of the year. The area has been used for a variety of industrial purposes in the past, including a mine for oolitic sands, a railroad corridor, a slag storage and disposal area, and a storage and collection area for process and storm waters. Because of the size of the Garfield Wetlands the main areas of interest are described separately below.

Pond A

Pond A (7) has an approximate surface area of 25 acres, and is located near the SH202/I-80 interchange. It is separated on the northwest by a dike shared with the I-80 Pond. Influenced heavily by GSL salt evaporates, Pond A is primarily playa in hydrological and geochemical characteristics, and the water is ephemeral. Pond A stored sludge produced from the neutralization of acidic blow-down from the “green-feed” smelter prior to 1978. This area was filled before the initiation of the Clean Water Act, and is therefore considered an upland area. The removal of 145,842 cy of sludge was completed in September 1998. During restoration, culverts were installed for water control, islands and sinuous shorelines were constructed, and vegetation was planted.

Pond D

Pond D (5) is located northwest of the SH202/UP Railroad (old corridor) intersection and covers approximately 20 acres. Sludge produced by the neutralization of acid from the Noranda smelter was stored in Pond D. In contrast to Pond A, Pond D was considered a filled wetland area that required mitigation because it was filled after the Clean Water Act was implemented. The mitigation of Pond D was accomplished in 1996, when KUCC received an after-the-fact permit from the U.S Army Corp of Engineers. Approximately 235,492 cy of sludge was removed from Pond D during the 1999 and 2000 construction seasons. After the sludge was removed, an additional foot was excavated to reach the water table so that the uncontaminated, shallow aquifer in this area would be the source of water to the pond. A large island was constructed in the middle of the pond using the excavated material. The island and the shoreline of the pond were contoured for optimal macroinvertebrate and shorebird habitat. Native vegetation was planted on the south end of the pond, and water control structures were installed.

Garfield Well-field

Located southwest of the SH202/UP Railroad (old corridor) intersection, the Garfield Well-field (4) covers approximately 100 acres. The first production wells constructed on the north end of the Oquirrh Mountains to supply additional water for smelter and concentrator operations in 1937 were collectively called the Garfield well-field, and the majority of these wells were located in the Garfield wells area. Due to high salinity the failure rate was high for these wells and they were frequently abandoned and replaced. The Garfield wells area was affected by selenium contaminated artesian flow from Garfield Well Number 5. An estimated 49,780 cy of soil was removed from this area in 2001. Shallow, uncontaminated groundwater has filled in the excavated area.

I-80 Pond

The I-80 Pond (8A, 8B, 8C) covers 105 acres and its dimensions are approximately 1,000 feet by 4,550 feet. Nearly a mile in length, I-80 Pond extends southwestward along the east side of I-80 from the SH202/I-80 interchange. Historically, the I-80 Pond was known as the East Slag Pond and was used to collect storm water from Kessler Canyon and overflow of smelter process water from the West Slag Pond. Removal of 176,576 cy of contaminated sediment was completed in April 2001. During restoration, culverts were installed for water control, islands and sinuous shorelines were constructed, and vegetation was planted to enhance the open water habitat.

Slag Lagoon

The Slag Lagoon (8D) is located north of the smelter and south of I-80. Mining of naturally occurring oolitic sands for use as smelter process flux created the Lagoon, which covers approximately 77 acres. Historical sources to the Slag Lagoon are similar to those described above for the I-80 Pond. The slag in the adjacent slag pile has been found to be non-leachable during numerous studies in the 1990s (USACE, 1995; KUCC, 2000). Sediment removal was completed in fall 2001, with over 246,000 cy excavated. During the removal activities at the Slag Lagoon, the berm that separated the Lagoon from the I-80 Pond was removed, joining the two into one large water body. The source of water to this large pond is non-contact, excess storage water for smelter operations, which originates in the Tooele Valley. During restoration, culverts were installed for water control and islands were constructed to enhance the open water habitat.

Kessler Springs

Kessler Springs (2) is located north of the refinery under SH201, and discharges to the Garfield Wetlands via an old storm water culvert at a rate of 200 to 500 gpm. The springs are bedrock contact springs that bring selenium-contaminated water from the principal aquifer to the surface. The water is collected in a sump, where it is pumped into the KUCC process water circuit. The area where the springs surface is usually referred to as Kessler Springs, and the wetlands areas to the east and to the west are called East Kessler Springs and West Kessler Springs, respectively, all of which cover approximately 75 acres. There is no open water in the Kessler Springs area. In the west and east areas, there are areas of uplands mixed with wetland areas consisting of shallow, ephemeral standing water with dense phragmite growth.

Oolitic Ponds

The Oolitic Ponds (6)are located in the Garfield Wetlands between the slag pile and Pond D. Oolitic sands were mined in this area, creating a cluster of shallow ponds, which cover approximately 50 acres. Removal of sediments/soils was not necessary in this area. The ponds are surrounded with low-lying vegetation, with good shoreline habitat. The water in the ponds is ephemeral.

Smelter Wetlands

The Smelter Wetlands (9) are located to the west of the slag pile from SH201 to I-80. They cover an area of approximately 180 acres. Removal of sediments/soils was not necessary in this area, except in the southeast portion (Hazelton area). Historically, portions of the site have been used for industrial activities. Habitat is mainly phragmites in standing water. There are a few large ponds; however, the ponds have minimal to no shoreline, dense phragmites along the shore, and the sediments are extremely reducing, all of which minimize macroinvertebrate populations.

Wetland Delineation

A jurisdictional wetlands delineation for this area was completed in October 1999 and submitted to the United States Army Corps of Engineers for concurrence in January 2000.[1] The jurisdictional delineation reported a total of 88 acres of uplands, 450.3 acres of jurisdictional wetlands, 132.1 acres of jurisdictional water, 36.1 acres of playa, 41.7 acres of CERCLA sites, 3 acres disturbed, 117.9 acres of slag, 34.4 acres of railroad, and 13.5 acres of roads. The total acreages listed represent conditions in the Garfield Wetland area at the time of the delineation. Each of the sites described in this plan were evaluated as part of the jurisdictional delineation: Pond A and Pond D were classified as uplands, the I-80 Pond and the Slag Lagoon are jurisdictional open water, and the Garfield wells area is considered jurisdictional wetlands. As a result of KUCC's reclamation and restoration activities, it was estimated that approximately 40 to 50 acres of new wetland habitat was created (Pond A and Pond D), and approximately 150 to 160 acres of wetland and open water habitat was enhanced to better quality habitat.

[1] Note that the jurisdictional delineation was conducted prior to the Supreme Court's decision in Solid Waste Agency of Northern Cook County v. Army Corps of Engineers (2001). No formal determination has been made whether the holding in that case would result in a modification to the jurisdictional determinations.

4.0 SAMPLE LOCATIONS

Areas listed in Table 4-1 and shown on Figures 2-1 were selected for macroinvertebrates, water, and sediment sampling in 2004. Some of the larger areas were divided into subareas (denoted A, B, C etc. on Figure 2-1) based on remediated versus nonremediated areas, different habitats, or areas where selenium exceeds 5 ppm in the sediment (based on results of post removal/remediation samples, and characterization samples in non-removal areas).

In June 2004, co-located samples were collected at 30 sites for macroinvertebrates, water and sediment. Figures 2-1 show the locations of these samples. Table 4-2 provides a description of each sample location that was able to be sampled for these three media. Every effort will be made to sample at the same locations each year. However, the number of samples may vary from year to year at a particular site due to variations in the surface area that is covered by water.

Areas that were dry at the time of sampling were the wetlands east of the tailings impoundment, west of Pond A, East Kessler Springs, West Kessler Springs, small ponds on northern edge of smelter return canal. No aquatic macroinvertebrates were found in Spitz Springs. The water at Spitz Springs was deep with no observed shallow areas for macroinvertebrate habitat.

Sampling methodologies, analytical procedures and QA/QC data quality objectives are outlined in Section 4 of the Monitoring Plan (Appendix A). Section 5 of this report describes deviations from the monitoring plan. Field notes can be found in Appendix B.

TABLE 4-1 WETLAND AREA SITES TO BE MONITORED DURING THE NESTING SEASON

# ON FIGURES	AREA NAME	DESCRIPTION OF AREA
1	Kessler Springs West	habitat is phragmites in standing water, some uplands; water is ephemeral
2	Kessler Springs	two ditches drain the area to sump; no standing water except ditches
3	Kessler Springs East	habitat is phragmites in standing water, some uplands; water is ephemeral
4	Garfield Well-field	majority is open water habitat; few smaller ephemeral ponds with shorebird habitat
5	Pond D	shorebird habitat; water is ephemeral
6	Oolitic Sand Ponds	shorebird habitat; water is ephemeral
7	Pond A	shorebird habitat; water is ephemeral
8	I-80 Pond/Slag Lagoon/Hazelton Pond	majority is open water habitat; some shorebird and songbird habitat
9	Smelter Wetlands	phragmites in standing water habitat, along with few large ponds; however the ponds have minimal to no shoreline and the sediments are extremely reducing, both of which minimize invertebrate populations
10	Japanese Springs	small ponded area surrounded by phragmites
11	Spitz Springs	phragmites in standing water
12	Eastside Wetlands and Lee Creek	Saline playas and ephemeral wetlands; area of concern are two areas that showed elevated Se in EcoRA. Lee Creek: riverine area discharging to GSL.
13	Saltair Ponds south I-80/SH202 interchange	standing water little to no vegetation.

TABLE 4-2 SAMPLE LOCATION DESCRIPTIONS

SITE 1D	SAMPLE IDs	DESCRIPTION
2	2	Kessler Springs – channel north of collection sump
4A	4A-1, 4A-2, 4A-3	Garfield Well-field – north, near well NEG485
4B	4B-1, 4B-2, 4B-3	Garfield Well-field – south
4C1	4C1-1, 4C1-2, 4C1-3	Pond west of well NEG486
4C2	4C2-1, 4C2-2	Horseshoe Pond
4C3	4C3	Pond east of well NEG488
5	5-1, 5-2, 5-3	Pond D
6A1	6A1-1, 6A1-2	Small, shallow pond east of Oolitic Pond area
6A2	6A2-1, 6A2-2	Small pond near the railroad tracks in the northeast area of the Oolitic Sand Ponds
6A3	6A3	Old landfill excavation area east of Oolitic Pond area
6B	6B-1, 6B-2, 6B-3	South east Oolitic Pond
6C	6C-1, 6C-2, 6C-3	South west Oolitic Pond
6D1	6D1-1, 6D1-2, 6D1-3	North Oolitic Pond
6D2	6D2	Pond east of slag pile
7A	7-1, 7-2, 7-3	Pond A
8A1	8A1-1, 8A1-2, 8A1-3	I80 Pond: east portion, northwest side
8A2	8A2-1, 8A2-2, 8A2-3	I80 Pond: east portion, northeast side
8B	8B-1, 8B-2, 8B-3	I80 Pond: east portion, south central side
8C	8C-1, 8C-2, 8C-3	I80 Pond: west portion, south side
8D1	8D1	Slag Pond: southeast side
8D2	8D2	Slag Pond: northwest side
8E	8E	Hazelton fresh water pond, southwest side
9A	9A	Smelter Wetlands: east pond
9B	9B	Smelter Wetlands: large central pond
9C	9C	Smelter Wetlands: pond south of I80
9D	9D	SH201 Ponds
10	10	Japanese Springs
11	11	Spitz Springs
12	12	Lee Creek
13	13-1, 13-2, 13-3	Saltair Ponds (I-80/SH202 interchange ponds)

5.0 DEVIATIONS FROM THE MONITORING PLAN

As described in the 2003 Wetlands Monitoring Report (KUCC, 2004), sampling methods were modified to allow for use of light traps at locations where sweep netting was difficult due to deep water or thick vegetation. Two of the 57 macroinvertebrate samples gathered in 2004 (4C3 and 6A3) were collected using light traps. Light traps were used unsuccessfully at the smelter wetlands south of I-80 (9C) and Spitz Springs, therefore macroinvertebrates were not collected at these locations.

Following discussions with EPA and the Technical Review Committee prior to the 2004 wetlands sampling, Kennecott implemented modifications to the sampling plan. These adjustments were intended to allow for better statistical analysis of the data as well as allow analysis of other conditions controlling selenium occurrence and uptake and included:

- Splitting 1 in 10 water samples and submittal to outside lab for Se analysis
- Increasing number of samples in areas where macroinvertebrate tissue Se > 10 ppm in 2003
- Adding analysis of major ions, TDS, DOC, TOC to analytical suite for water samples
- Adding TOC to analytical suite for sediment samples

6.0 RESULTS

6.1 Water Sample Results

Table 6-1 shows the total and dissolved metals analytical results for the water samples. Only the dissolved results are discussed in this report.

Dissolved selenium concentrations ranged from less than the method detection limit (<2 µg/L) to 32 µg/L. The highest concentration was measured in samples from a small pond near the railroad tracks in the northeast area of the Oolitic sand ponds (6A2). The lowest concentrations detected were measured in samples from the North Oolithic pond and in the SH201 ponds. Nine of the samples collected were below the method detection limit for selenium. It should be noted that dissolved selenium and total selenium analytical results generally agreed except at Kessler Spring (2) where dissolved selenium was 5 µg/L and total selenium was 186 µg/L.

Arsenic concentrations ranged from 6 to 623 µg/L. The highest concentration was measured in samples from the southeast Oolitic pond (6B). The lowest concentrations were measured in samples from Spitz Springs (11). None of the samples collected were below the method detection limit for arsenic.

Cadmium concentrations ranged from less than the method detection limit (<1 µg/L) to 9 µg/L. The highest concentration was measured in samples from a small pond near the railroad tracks in the northeast area of the Oolitic sand ponds (6A2). Eighteen of the samples collected were below the method detection limit for cadmium.

Copper concentrations ranged from less than the method detection limit (<20 µg/L) to 546 µg/L. The highest concentration was measured in samples from the southwest Oolitic pond (6C). Thirty of the samples collected were below the method detection limit for copper.

Lead was detected at a concentration of 37 µg/L measured in samples from the southwest Oolitic pond (6C). The remaining samples collected were below the method detection limit (<5 µg/L) for lead.

TABLE 6-1 SUMMARY OF LABORATORY RESULTS FOR WATER SAMPLES COLLECTED JUNE 2004
TOTAL (T) AND DISSOLVED (D) METALS

Sample	Date	pH	Cond.	Alkalinity	TDS	TOC	Calcium	Chloride	Potassium	Magnesium	Sodium	Sulfate	Arsenic		Cadmium		Copper		Lead		Selenium		Zinc	
													total	dissolved	total	dissolved	total	dissolved	total	dissolved	total	dissolved	total	dissolved
ID			umhos/cm	(mg/L) as CACO3	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(ug/L)	(ug/L)	(ug/L)	(ug/L)	(ug/L)	(ug/L)	(ug/L)	(ug/L)	(ug/L)	(ug/L)	(ug/L)	(ug/L)
2	Jun-03	7.49	3,500	--	--	--	--	--	--	--	--	--	160	68	1	<1	946	<20	60	<5	25	17	104	11
2	Jun-04	6.73	3,420	399	2,280	2	167	750	19.3	64	537	259	71	62	<1	<1	27	<20	<5	<5	186	5	11	<10
4A	Jun-03	7.7	20,300	--	--	--	--	--	--	--	--	--	91	84	1	<1	79	<20	<5	<5	17	15	11	<10
4A-1A [a]	Jun-04	7.41	17,480	134	9,820	11	272	5,570	85.7	170	3,800	428	90	80	<1	<1	20	<20	<5	<5	12	11	15	12
4A-1B [b]	Jun-04	7.41	17,480	135	9,940	9	216	5,490	67.7	135	2,940	440	88	80	<1	<1	<20	<20	<5	<5	12	11	41	12
4A-2 [c]	Jun-04	7.89	17,760	124	9,900	11	222	5,550	71.6	142	3,100	450	86	84	<1	<1	<20	<20	<5	<5	13	13	14	14
4A-3 [d]	Jun-04	7.87	18,100	124	10,400	1	223	5,650	72.6	143	3,080	495	85	85	<1	<1	<20	<20	<5	<5	14	13	<10	<10
4B	Jun-03	7.86	19,700	--	--	--	--	--	--	--	--	--	101	98	2	2	35	21	<5	<5	15	15	11	<10
4B-1	Jun-04	8.09	15,120	150	9,030	8	207	4,790	71.8	156	2,950	560	110	104	2	1	34	28	<5	<5	11	10	12	12
4B-2	Jun-04	7.97	14,270	170	8,020	2	190	4,450	65.6	144	2,650	542	98	92	2	1	35	30	<5	<5	11	11	255	17
4B-2 dup	Jun-04	7.97	14,270	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	11.3	--	--	--
4B-3	Jun-04	7.97	15,340	153	8,850	10	203	4,970	72.5	154	2,880	553	92	89	2	2	41	41	<5	<5	12	11	<10	<10
4C1	Jun-03	8.31	16,850	--	--	--	--	--	--	--	--	--	15	15	<1	<1	<20	<20	<5	<5	60	30	<10	<10
4C1-1	Jun-04	9.08	14,850	66	8,500	8	206	4,860	64.5	90	2,930	200	25	25	<1	<1	<20	<20	<5	<5	7	6	<10	<10
4C1-2	Jun-04	8.68	14,880	74	8,090	10	197	4,610	59	83	2,720	215	26	25	<1	<1	2	<20	6	<5	6	6	<10	<10
4C1-3	Jun-04	8	15,510	183	8,290	8	255	4,770	62.2	92	2,890	236	22	22	<1	<1	27	<20	<5	<5	6	6	<10	<10
4C2	Jun-03	7.23	50,900	--	--	--	--	--	--	--	--	--	115	104	1	<1	39	<20	<5	<5	7	5	11	<10
4C2-1	Jun-04	7.55	24,000	276	15,100	14	295	8,250	95.9	302	4,490	816	97	80	3	2	62	29	<5	<5	<2	<2	31	21
4C2-2	Jun-04	7.49	22,200	264	14,100	14	244	7,780	87.5	248	4,190	552	84	76	<1	<1	35	27	<5	<5	<2	<2	152	24
4C3	Jun-03	7.8	23,600	--	--	--	--	--	--	--	--	--	277	249	<1	<1	79	45	<5	<5	9	9	46	21
4C3	Jun-04	7.47	17,690	466	10,800	24	377	5,110	90.6	305	3,070	1,280	237	237	5	5	28	28	5	<5	8	8	26	18
5	Jun-03	7.64	22,000	--	--	--	--	--	--	--	--	--	50	42	5	5	21	<20	<5	<5	11	11	<10	<10
5-1	Jun-04	7.87	19,930	92	12,500	5	440	6,090	118	208	3,850	954	50	38	3	3	87	25	6	<5	10	10	48	48
5-2	Jun-04	7.92	20,100	78	12,300	5	443	6,120	119	209	3,910	927	42	42	4	3	34	34	<5	<5	11	10	12	12
5-2 dup	Jun-04	7.92	20,100	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	9.35	--	--	--
5-3A	Jun-04	7.99	20,200	77	12,300	5	446	6,600	117	207	4,550	919	43	41	4	3	44	24	<5	<5	10	10	22	22
5-3B	Jun-04	7.99	20,200	76	12,400	9	425	6,100	117	203	4,190	907	46	44	6	5	<20	<20	<5	<5	10	10	<10	<10
6A1	Jun-03	7.83	25,700	--	--	--	--	--	--	--	--	--	359	356	5	4	125	105	<5	<5	35	30	11	<10
6A1-1	Jun-04	7.86	26,700	204	18,000	22	666	8,940	206	356	4,960	1,600	227	222	5	5	256	223	<5	<5	12	12	36	36
6A1-2	Jun-04	7.88	27,000	204	17,700	20	647	9,100	199	346	4,890	1,720	231	226	5	5	239	216	<5	<5	13	12	42	24
6A2	Jun-03	7.7	67,800	--	--	--	--	--	--	--	--	--	146	146	33	31	65	65	<5	<5	160	159	18	17
6A2-1	Jun-04	7.89	33,800	159	23,500	15	593	12,000	296	470	6,850	2,260	263	254	9	9	153	122	<5	<5	32	32	27	27
6A2-2	Jun-04	7.9	34,200	163	23,100	15	626	12,300	320	503	7,400	2,340	262	256	9	9	149	135	12	<5	33	30	28	28
6A3	Jun-03	7.68	54,500	--	--	--	--	--	--	--	--	--	81	80	3	2	63	40	<5	<5	30	26	16	12
6A3	Jun-04	8.03	40,700	86	27,200	3	628	14,700	183	483	8,250	2,120	89	85	2	2	48	38	<5	<5	14	14	25	25
6B	Jun-03	8.05	77,800	--	--	--	--	--	--	--	--	--	1090	1020	7	6	725	667	<5	<5	53	49	12	11
6B-1	Jun-04	8.37	31,400	193	19,500	26	374	10,200	259	420	6,760	1,180	589	542	2	2	353	310	<5	<5	19	18	56	14
6B-2	Jun-04	8.28	31,400	195	19,400	24	389	10,600	269	430	6,900	1,200	636	618	21	2	380	334	<5	<5	20	20	86	13
6B-3	Jun-04	8.32	31,100	194	19,600	25	386	10,400	263	425	7,080	1,080	652	623	3	2	411	344	<5	<5	22	20	18	18
6C	Jun-03	8.05	52,300	--	--	--	--	--	--	--	--	--	974	928	5	4	1120	488	46	<5	27	26	34	<10
6C-1	Jun-04	8.07	23,900	264	15,100	20	386	7,390	201	326	5,170	1,950	313	275	2	2	633	423	16	<5	7	6	29	29
6C-2	Jun-04	8.24	25,800	197	16,500	28	442	8,190	230	368	5,590	2,030	323	313	2	2	546	546	37	37	6	5	27	27
6C-3	Jun-04	8.21	26,100	195	16,600	30	440	8,120	229	365	5,580	2,020	299	285	2	2	48	48	<5	<5	5	<2	171	34
6D1	Jun-03	8.5	23,100	--	--	--	--	--	--	--	--	--	256	248	2	2	174	148	<5	<5	10	9	<10	<10
6D1-1	Jun-04	8.1	17,900	203	11,000	14	359	5,140	156	257	3,720	1,680	196	179	2	2	144	144	<5	<5	3	2	114	18
6D1-1 dup	Jun-04	8.1	17,900	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2.96	--	--	--
6D1-2	Jun-04	8.28	15,670	231	9,520	19	315	4,320	130	220	3,190	1,500	182	170	2	1	188	175	7	<5	3	3	13	13
6D1-3	Jun-04	8.22	15,690	245	9,300	21	307	4,350	125	212	3,120	1,440	180	169	2	2	269	180	13	<5	3	3	22	18
6D2	Jun-03	7.57	8,260	--	--	--	--	--	--	--	--	--	11	8	<1	<1	38	<20	<5	<5	2	2	36	<10
6D2-A	Jun-04	7.14	7,150	171	4,060	25	185	1,710	38.4	86	1,230	594	13	6	1	<1	95	<20	14	<5	<2	<2	24	<10
6D2-B	Jun-04	7.14	7,150	173	4,050	27	173	1,730	35.7	79	1,140	629	15	6	1	<1	122	23	16	<5	<2	<2	62	14
7A	Jun-03	8.16	20,600	--	--	--	--	--	--	--	--	--	351	342	4	2	110	95	<5	<5	10	10	<10	<10
7-1	Jun-04	8.11	18,400	168	11,600	13	351	5,350	141	257	3,370	1,790	402	389	3	2	162	142	<5	<5	6	6	25	25
7-1 dup	Jun-04	8.11	18,400	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	6.21	--	--	--
7-2	Jun-04	8.06	17,800	188	11,000	12	339	5,070	128	233	2,960	1,720	421	416	2	2	145	119	<5	<5	5	5	68	18
7-3	Jun-04	8.12	17,900	230	11,300	19	343	5,160	142	253	3,330	1,640	154	142	2	2	245	206	<5	<5	3	3	18	16
8A1	Jun-03	8.07	8,020	--	--	--	--	--	--	--	--	--	196	166	2	1	<20	<20	<5	<5	8	7	19	<10
8A1-1	Jun-04	8.31	7,170	160	3,830	7	140	1,900	39.9	84	1,160	491	106	91	1	1	32	<20	<5	<5	7	7	52	13
8A1-2	Jun-04	8.15	7,230	162	3,890	4	153	1,820	43.9	92	1,270	500	108	100	2	1	21	<20	<5	<5	7	6	27	10
8A1-3	Jun-04	8.3	7,270	156	3,880	5	155	1,910	44.1	94	1,310	499	135	103	2	1	26	<20	<5	<5	7	7	50	12

TABLE 6-1 SUMMARY OF LABORATORY RESULTS FOR WATER SAMPLES COLLECTED JUNE 2004
TOTAL (T) AND DISSOLVED (D) METALS

Sample	Date	pH	Cond.	Alkalinity	TDS	TOC	Calcium	Chloride	Potassium	Magnesium	Sodium	Sulfate	Arsenic		Cadmium		Copper		Lead		Selenium		Zinc	
													total	dissolved	total	dissolved	total	dissolved	total	dissolved	total	dissolved	total	dissolved
ID			umhos/cm	(mg/L) as CACO3	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(ug/L)	(ug/L)	(ug/L)	(ug/L)	(ug/L)	(ug/L)	(ug/L)	(ug/L)	(ug/L)	(ug/L)	(ug/L)	(ug/L)
8A2	Jun-03	8.08	8,390	--	--	--	--	--	--	--	--	--	241	220	2	2	<20	<20	<5	<5	7	7	13	<10
8A2-1	Jun-04	8.44	7,800	130	4,260	7	149	2,120	48.9	102	1,400	567	165	156	2	1	<20	<20	<5	<5	7	6	12	<10
8A2-2	Jun-04	8.21	8,390	136	4,620	5	164	2,360	54.3	116	1,530	618	253	204	1	1	<20	<20	<5	<5	5	5	359	12
8A2-3	Jun-04	8.17	8,720	138	4,820	1	170	2,440	57.3	122	1,630	583	249	221	2	1	48	<20	10	<5	5	4	32	11
8B	Jun-03	8.36	8,560	--	--	--	--	--	--	--	--	--	273	264	2	1	<20	<20	<5	<5	8	7	<10	<10
8B-1A	Jun-04	7.99	9,460	142	5,210	4	171	2,640	60.4	125	1,640	678	268	259	1	1	20	<20	10	<5	5	4	38	10
8B-1B [e]	Jun-04	7.99	9,460	141	5,260	4	172	2,690	60.1	126	1,680	722	268	268	2	2	<20	<20	<5	<5	5	4	<10	<10
8B-2	Jun-04	8.05	9,330	140	5,260	18	174	2,580	56.9	122	1,540	708	254	243	1	1	<20	<20	<5	<5	4	4	14	12
8B-3	Jun-04	8.06	8,930	143	5,020	10	175	2,500	56.8	121	1,550	650	236	225	1	1	<20	<20	<5	<5	5	5	14	12
8C	Jun-03	8.63	7,460	--	--	--	--	--	--	--	--	--	147	129	2	1	42	<20	28	<5	10	9	34	<10
8C-1	Jun-04	8.18	7,230	143	3,840	9	147	1,920	41.7	88	1,140	544	121	115	2	1	<20	<20	14	<5	9	9	115	14
8C-2	Jun-04	7.38	6,600	172	3,590	9	174	1,670	38	80	1,030	560	66	58	2	2	65	<20	<5	<5	13	13	498	29
8C-3	Jun-04	7.74	5,680	228	3,070	8	166	1,380	31.8	67	880	486	47	42	2	2	65	35	<5	<5	24	23	230	57
8D1	Jun-03	8.24	6,880	--	--	--	--	--	--	--	--	--	89	77	2	2	<20	<20	<5	<5	7	7	22	<10
8D1	Jun-04	7.83	5,320	218	2,910	2	141	1,210	31.2	60	888	424	41	28	3	3	21	<20	<5	<5	14	14	10	10
8D1 dup	Jun-04	7.83	5,320	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	13.9	--	--	--
8D2	Jun-03	7.78	7,220	--	--	--	--	--	--	--	--	--	714	71	3	2	325	<20	52	<5	9	7	107	<10
8D2	Jun-04	7.9	5,950	222	3,300	3	137	1,530	32.8	65	999	401	143	116	4	4	26	<20	<5	<5	4	4	10	10
8E	Jun-03	8	6,590	--	--	--	--	--	--	--	--	--	69	60	<1	<1	<20	<20	<5	<5	4	4	<10	<10
8EA	Jun-04	7.78	6,650	222	3,570	4	134	1,700	28.3	63	1,060	324	42	37	<1	<1	24	<20	<5	<5	3	3	14	14
8EB	Jun-04	7.78	6,650	225	3,540	4	147	1,780	31.1	70	1,180	297	40	36	<1	<1	<20	<20	<5	<5	3	3	<10	<10
9A	Jun-03	7.99	2,630	--	--	--	--	--	--	--	--	--	102	95	<1	<1	163	21	101	<5	3	3	62	23
9A	Jun-04	7.1	3,070	277	1,670	6	112	584	16.7	42	426	340	96	94	<1	<1	40	27	10	<5	2	<2	31	14
9B	Jun-03	7.32	5,630	--	--	--	--	--	--	--	--	--	93	71	<1	<1	80	32	<5	<5	<2	<2	62	<10
9B	Jun-04	7.94	5,060	238	2,820	30	129	1,110	33.4	58	802	611	143	128	<1	<1	20	20	,5	<5	3	3	12	12
9C	Jun-03	8.05	3,190	--	--	--	--	--	--	--	--	--	45	43	<1	<1	85	50	<5	<5	<2	<2	<10	<10
9C	Jun-04	7.9	5,330	446	2,830	10	132	1,240	29.2	51	907	331	68	52	<1	<1	<20	<20	<5	<5	<2	<2	<10	<10
9D	Jun-03	7.75	2,370	--	--	--	--	--	--	--	--	--	39	35	<1	<1	149	51	<5	<5	5	5	55	37
9D	Jun-04	6.84	4,820	219	2,820	16	239	1,030	33.4	77	649	708	31	28	<1	<1	98	<20	<5	<5	3	2	20	20
10	Jun-03	7.88	2,840	--	--	--	--	--	--	--	--	--	28	28	<1	<1	141	45	<5	<5	3	3	<10	<10
10 [f]	Jun-04	7.88	2,840	272	1,530	4	77	559	21.5	35	418	245	33	35	<1	<1	124	61	9	<5	9	9	30	14
11	Jun-03	6.99	3,860	--	--	--	--	--	--	--	--	--	<5	<5	<1	<1	21	21	<5	<5	5	6	47	38
11	Jun-04	6.99	3,860	263	2,070	6	145	937	22.9	50	615	249	7	6	<1	<1	<20	<20	<5	<5	4	4	13	13
12	Jun-03	7.95	3,190	--	--	--	--	--	--	--	--	--	16	13	1	<1	106	20	8	<5	3	2	30	<10
12	Jun-04	8.55	3,560	289	2,040	7	81	710	32	78	467	429	34	33	<1	<1	53	<20	<5	<5	<2	<2	17	<10
13-1	Jun-04	9.33	45,900	102	31,200	54	854	15,000	334	509	8,070	4,400	600	588	2	2	113	82	<5	<5	4	4	20	20
13-2	Jun-04	9.14	39,300	95	26,900	65	1,200	12,300	352	526	8,030	4,850	619	593	3	2	166	138	<5	<5	4	3	25	17
13-3	Jun-04	9.47	64,100	135	46,000	97	1,070	22,800	671	947	15,600	7,250	397	394	5	4	174	136	<5	<5	<2	<2	24	22

Notes:

[a] Mislabeled in field notes and laboratory report as 5A-1A
[b] Mislabeled in field notes and laboratory report as 5A-1B
[c] Mislabeled in field notes and laboratory report as 5A-2
[d] Mislabeled in field notes and laboratory report as 5A-3
[e] Mislabeled in field notes and laboratory report as 8B-16
[f] Mislabeled in field notes and laboratory report as 9E

Duplicates analyzed by Kennecott Environmental Laboratory:
4A-1A, 4A-1B
5-3A, 5-3B
6D2-A, 6D2-B
8B-1A, 8B-1B
8EA, 8EB

Duplicates analyzed by Frontier Geosciences Inc.
4B-2 dup
5-2 dup
6D1-1 dup
7-1 dup
8D1 dup

Zinc concentrations ranged from less than the method detection limit (<10 µg/L) to 57 µg/L. The highest concentration was measured in samples from the southwest portion of the I-80 pond (8C). Thirteen of the samples collected were below the method detection limit for zinc.

6.2 Sediment Sample Results

Table 6-2 shows the total metals analytical results for the sediment samples. The remainder of this section is a summary of those results for the dry weight data.

Selenium concentrations ranged from less than the method detection limit (<3 mg/kg) to 157 mg/kg. The highest concentration was measured in samples from Kessler Springs (2). Five of the samples were below the method detection limit for selenium.

Arsenic concentrations ranged from 6 to 502 mg/kg. The highest concentration was measured in samples from the Smelter Wetlands east pond (9A). None of the samples were below the method detection limit for arsenic.

Cadmium concentrations ranged from less than the method detection limit (0.01 mg/kg) to 10.7 mg/kg. The highest concentration was measured in samples from Japanese Springs (10). Fourteen of the samples were below the method detection limit for cadmium.

Copper concentrations ranged from 17 to 10,829 mg/kg. The highest concentration was measured in samples from Japanese Springs (10). None of the samples were below the method detection limit for copper.

Lead concentrations ranged from less than the method detection limit (0.07 mg/kg) to 4,061 mg/kg. The highest concentration was measured in samples from the east pond in the Smelter wetlands (9A). Five of the samples were below the method detection limit for lead.

Zinc concentrations ranged from 23 to 2,911 mg/kg. The highest concentration was measured in samples from small pond near the slag pile (6D2). None of the samples were below the method detection limit for zinc.

TABLE 6-2 SUMMARY OF LABORATORY RESULTS FOR SEDIMENT SAMPLES COLLECTED JUNE 2004

		wet weight								*dry weight*					
Sample ID	**Date**	**As (mg/kg)**	**Cd (mg/kg)**	**Cu (mg/kg)**	**Pb (mg/kg)**	**Se (mg/kg)**	**Zn (mg/kg)**	**% TOC**	**% moist.**	**As (mg/kg)**	**Cd (mg/kg)**	**Cu (mg/kg)**	**Pb (mg/kg)**	**Se (mg/kg)**	**Zn (mg/kg)**
2	Jun-03	39	0.5	136	22	72	26	--	83	229.41	2.94	800	129.41	423.53	152.94
2	Jun-04	44	0.6	800	68	91	34	--	42	76	1.0	1379	117	157	59
4A	Jun-03	22	0.5	291	40	9	87	--	37	34.92	0.79	461.9	63.49	14.29	138.1
4A-1 [a]	Jun-04	198	1	715	44	15	98	3	27	271	1.4	979	60	21	134
4A-2 [b]	Jun-04	39	0.8	539	52	8	125	1	29	55	1.1	759	73	11	176
4A-3 [c]	Jun-04	29	0.6	371	14	20	35	6	61	74	1.5	951	36	51	90
4B	Jun-03	14	0.5	162	20	21	42	--	40	23.33	0.83	270	33.33	35	70
4B-1	Jun-04	8	0.4	57	2	4	32	3.2	38	13	0.6	92	3	6	52
4B-2	Jun-04	15	0.4	268	13	11	51	0.9	29	21	0.6	377	18	15	72
4B-3	Jun-04	8	0.3	74	3	4	33	4.4	36	13	0.5	116	5	6	52
4C1	Jun-03	10	1.7	188	10	11	13	--	82	55.56	9.44	1,044.44	55.56	61.11	72.22
4C1-1	Jun-04	48	2.5	1,410	371	13	93	13	73	178	9.3	5,222	1,374	48	344
4C1-2	Jun-04	20	2.4	408	44	12	24	<0.01	74	77	9.2	1,569	169	46	92
4C1-3	Jun-04	27	2.3	725	133	12	45	11.5	73	100	8.5	2,685	493	44	167
4C2	Jun-03	21	0.5	185	5	3	13	--	73	77.78	1.85	685.19	18.52	11.11	48.15
4C2-1	Jun-04	26	1.3	440	7	8	24	<0.01	70	87	4.3	1,467	23	27	80
4C2-2	Jun-04	13	0.6	74	< 0.05	5	8	<0.01	72	46	2.1	264	<0.18	18	29
4C3	Jun-03	108	1.2	447	28	8	59	--	27	147.95	1.64	612.33	38.36	10.96	80.82
4C3	Jun-04	52	1.1	196	7	10	19	19.6	80	260	5.5	980	35	50	95
5	Jun-03	13	0.5	64	9	2	33	--	26	17.57	0.68	86.49	12.16	2.7	44.59
5-1	Jun-04	24	1.4	395	17	9	59	0.3	24	32	1.8	520	22	12	78
5-2	Jun-04	23	0.8	64	4	9	37	0.32	28	32	1.1	89	6	13	51
5-3	Jun-04	49	1.1	167	34	6	83	0.27	29	69	1.5	235	48	8	117
6A1	Jun-03	14	0.5	65	13	6	43	--	36	21.88	0.78	101.56	20.31	9.38	67.19
6A1-1	Jun-04	10	< 0.01	17	< 0.05	5	38	0.7	35	15	<0.02	26	<0.08	8	58
6A1-2	Jun-04	46	1.1	479	61	5	80	1	35	71	1.7	737	94	8	123
6A2	Jun-03	16	0.5	56	16	20	43	--	31	23.19	0.72	81.16	23.19	28.99	62.32
6A2-1	Jun-04	14	< 0.01	141	22	5	59	0.9	35	22	<0.02	217	34	8	91
6A2-2	Jun-04	22	< 0.01	233	13	6	49	0.3	28	31	<0.01	324	18	8	68
6A3	Jun-03	19	0.5	128	27	1	58	--	28	26.39	0.69	177.78	37.5	1.39	80.56
6A3	Jun-04	9	< 0.01	27	2	<2	45	0.4	29	13	<0.01	38	3	<3	63
6B	Jun-03	87	0.5	897	108	6	75	--	37	138.1	0.79	1,423.81	171.43	9.52	119.05

TABLE 6-2 SUMMARY OF LABORATORY RESULTS FOR SEDIMENT SAMPLES COLLECTED JUNE 2004

		wet weight								*dry weight*					
Sample ID	**Date**	**As (mg/kg)**	**Cd (mg/kg)**	**Cu (mg/kg)**	**Pb (mg/kg)**	**Se (mg/kg)**	**Zn (mg/kg)**	**% TOC**	**% moist.**	**As (mg/kg)**	**Cd (mg/kg)**	**Cu (mg/kg)**	**Pb (mg/kg)**	**Se (mg/kg)**	**Zn (mg/kg)**
6B-1	Jun-04	85	0.8	1,280	111	8	90	2.3	36	133	1.3	2,000	173	13	141
6B-2	Jun-04	78	0.8	997	111	7	90	2.02	34	118	1.2	1,511	168	11	136
6B-3	Jun-04	90	0.7	742	114	6	102	1.66	36	141	1.1	1,159	178	9	159
6C	Jun-03	100	0.5	1,570	144	3	88	--	44	178.57	0.89	2,803.57	257.14	5.36	157.14
6C-1	Jun-04	73	< 0.01	1,090	162	3	83	1.4	35	112	<0.02	1,677	249	5	128
6C-2	Jun-04	96	0.8	1,560	152	5	97	2.8	36	150	1.3	2,438	238	8	152
6C-3	Jun-04	103	0.7	2,030	163	6	147	2.3	40	172	1.2	3,383	272	10	245
6D1	Jun-03	88	0.5	1,290	140	5	246	--	35	135.38	0.77	1,984.62	215.38	7.69	378.46
6D1-1	Jun-04	99	1	1,160	102	3	184	6.3	35	152	1.5	1,785	157	5	283
6D1-2	Jun-04	69	1.3	1,320	100	6	106	1.8	32	101	1.9	1,941	147	9	156
6D1-3	Jun-04	92	0.8	1,610	95	7	107	2.3	31	133	1.2	2,333	138	10	155
6D2	Jun-03	38	1.4	440	87	3	397	--	78	172.73	6.36	2,000	395.45	13.64	1,804.55
6D2	Jun-04	156	3.7	2,870	483	<2	1310	0.8	55	347	8.2	6,378	1,073	<4	2,911
7A	Jun-03	14	0.5	51	10	1	31	--	24	18.42	0.66	67.11	13.16	1.32	40.79
7-1	Jun-04	26	0.7	362	18	4	41	0.7	27	36	1.0	496	25	5	56
7-2	Jun-04	64	1.3	875	59	4	74	0.8	28	89	1.8	1,215	82	6	103
7-3	Jun-04	122	0.8	659	75	4	64	1	22	156	1.0	845	96	5	82
8A1	Jun-03	49	0.9	227	46	3	107	--	23	63.64	1.17	294.81	59.74	3.9	138.96
8A1-1	Jun-04	26	< 0.01	162	13	2	61	1	26	35	<0.01	219	18	3	82
8A1-2	Jun-04	17	< 0.01	52	3	2	38	1.4	25	23	<0.01	69	4	3	51
8A1-3	Jun-04	8	< 0.01	71	< 0.05	2	18	0.5	21	10	<0.01	90	<0.06	3	23
8A2	Jun-03	24	0.5	76	22	1	24	--	22	30.77	0.64	97.44	28.21	1.28	30.77
8A2-1	Jun-04	15	0.8	32	< 0.05	5	18	0.6	27	21	1.1	44	<0.07	7	25
8A2-2	Jun-04	26	0.9	161	10	7	30	0.8	27	36	1.2	221	14	10	41
8A2-3	Jun-04	35	2.7	125	37	5	64	1.1	25	47	3.6	167	49	7	85
8B	Jun-03	33	2.4	57	25	1	32	--	23	42.86	3.12	74.03	32.47	1.3	41.56
8B-1	Jun-04	82	0.8	75	47	3	27	0.7	26	111	1.1	101	64	4	36
8B-2	Jun-04	44	1.1	212	34	<2	44	2	31	64	1.6	307	49	<3	64
8B-3	Jun-04	21	< 0.01	194	40	3	26	1.5	22	27	<0.01	249	51	4	33
8C	Jun-03	19	0.5	91	80	1	98	--	24	25	0.66	119.74	105.26	1.32	128.95
8C-1	Jun-04	22	0.8	110	91	3	88	0.7	26	30	1.1	149	123	4	119
8C-2	Jun-04	11	< 0.01	108	2	3	36	1.2	37	17	<0.02	171	3	5	57
8C-3	Jun-04	4	< 0.01	11	< 0.05	3	20	1.7	35	6	<0.02	17	<0.08	5	31

TABLE 6-2 SUMMARY OF LABORATORY RESULTS FOR SEDIMENT SAMPLES COLLECTED JUNE 2004

		wet weight								*dry weight*					
Sample ID	**Date**	**As (mg/kg)**	**Cd (mg/kg)**	**Cu (mg/kg)**	**Pb (mg/kg)**	**Se (mg/kg)**	**Zn (mg/kg)**	**% TOC**	**% moist.**	**As (mg/kg)**	**Cd (mg/kg)**	**Cu (mg/kg)**	**Pb (mg/kg)**	**Se (mg/kg)**	**Zn (mg/kg)**
8D1	Jun-03	9	0.5	36	9	1	26	--	22	11.54	0.64	46.15	11.54	1.28	33.33
8D1	Jun-04	24	0.4	154	15	3	76	1.2	30	34	0.6	220	21	4	109
8D2	Jun-03	32	0.5	200	28	3	71	--	24	42.11	0.66	263.16	36.84	3.95	93.42
8D2	Jun-04	31	0.4	109	15	4	23	0.3	26	42	0.5	147	20	5	31
8E	Jun-03	16	0.5	62	12	2	21	--	32	23.53	0.74	91.18	17.65	2.94	30.88
8E	Jun-04	26	0.6	397	16	6	43	9.8	52	54	1.3	827	33	13	90
9A	Jun-03	14	0.7	67	283	1	19	--	22	17.95	0.9	85.9	362.82	1.28	24.36
9A	Jun-04	332	6.9	4,500	2,680	15	153	6.6	34	503	10.5	6,818	4,061	23	232
9B	Jun-03	90	2.1	500	130	4	85	--	50	180	4.2	1,000.00	260	8	170
9B	Jun-04	15	< 0.01	78	8	<2	31	1.3	24	20	<0.01	103	11	<3	41
9C	Jun-03	87	0.7	673	74	1	113	--	52	181.25	1.46	1,402.08	154.17	2.08	235.42
9C	Jun-04	65	0.8	511	46	<2	77	4.3	66	191	2.4	1503	135	<6	226
9D	Jun-03	45	0.5	987	89	1	209	--	78	204.55	2.27	4,486.36	404.55	4.55	950
9D	Jun-04	54	1.2	2,550	66	3	72	2.4	36	84	1.9	3,984	103	5	113
10 [d]	Jun-04	243	7.5	7,580	1,540	8	494	2	30	347	10.7	10,829	2,200	11	706
11	Jun-04	5	< 0.01	60	10	7	17	5.8	39	8	<0.02	98	16	11	28
12	Jun-03	7	0.5	121	13	1	36	--	37	11.11	0.79	192.06	20.63	1.59	57.14
12	Jun-04	10	0.5	161	12	0.5	159	--	--	10	<0.01	161	12	1	159
13-1	Jun-04	67	0.6	396	38	6	65	2.3	28	93	0.8	550	53	8	90
13-2	Jun-04	80	0.7	423	50	4	64	2.1	26	108	0.9	572	68	5	86
13-3	Jun-04	127	1.9	697	81	7	142	2.4	29	179	2.7	982	114	10	200

Notes:

[a] Mislabeled in field notes and laboratory report as 5A-1

[b] Mislabeled in field notes and laboratory report as 5A-2

[c] Mislabeled in field notes and laboratory report as 5A-3

[d] Mislabeled in field notes and laboratory report as 9E

6.3 Macroinvertebrate Sample Results

Table 6-3 summarizes the various species found at each sampling location. Table 6-4 shows the analytical results for the macroinvertebrate samples. The remainder of this section is a summary of those results for the dry weight data.

Selenium concentrations ranged from 1.65 to 36 mg/kg. The highest concentration was measured in samples from Horseshoe Pond (4C2), and the lowest was in samples from Lee Creek (12).

Arsenic concentrations ranged from 0.73 to 76.5 mg/kg. The highest concentration was measured in samples from Pond A (7A), and the lowest was in samples from the pond west of NEG486 (4C1).

Cadmium concentrations ranged from 0.13 to 27.21 mg/kg. The highest concentration was measured in samples from the pond east of NEG488 (4C3), and the lowest was in samples from the Garfield Well-field north near NEG485 (4A).

Copper concentrations ranged from 12.8 to 643 mg/kg. The highest concentration was measured in samples from the southwest Oolitic Pond (6C), and the lowest was in samples from the southwest portion of the I-80 Pond (8C).

Lead concentrations ranged from below the detection limit to 109 mg/kg. The highest concentration was measured in samples from the east pond in the Smelter Wetlands (9A), and the lowest detection was in samples from the pond west of NEG486 (4C1).

Zinc concentrations ranged from 27.3 to 372 mg/kg. The highest concentration was measured in samples from a small pond near the railroad tracks in the northeast area of the Oolitic Sand Ponds(6A2), and the lowest was in samples from Kessler Springs (2).

TABLE 6-3 KENNECOTT INVERTEBRATE IDENTIFICATION

	TAXA																
Sample	Amphipoda	Coleoptera (Dytiscidae)	Diptera (Chironomidae)	Diptera (Ephydridae)	Diptera (Simuliidae)	Diptera (Stratiomyidae)	Diptera terrestrial adults species	Ephemeroptera (Baetidae)	Gastropoda	Hemiptera (Corixidae)	Hemiptera (Gerridae)	Hemiptera (Notonectidae)	Megaloptera (Corydalidae)	Odonata (Coenagrionidae)	Odonata (Gomphidae)	Ostracoda (Podocopa)	**Sample Total**
6D1-1	-	-	-	-	-	-	-	-	-	32	-	48	-	32	-	-	112
6D1-2	-	-	-	-	-	-	-	-	-	36	-	88	-	12	-	-	136
6D1-3	-	-	-	-	-	-	-	-	-	164	-	52	-	-	-	-	216
6C-2	-	32	8	12	-	-	-	-	-	324	-	4	-	-	-	-	380
5-1	-	-	-	-	-	-	-	-	-	96	-	28	-	16	-	372	512
5-2	-	13	2	-	12	-	-	-	-	130	-	92	-	6	-	157	412
6B-3	-	-	11	-	-	-	-	-	-	388	-	37	-	-	-	-	436
6C-3	-	-	-	-	-	-	-	-	-	282	-	-	-	-	-	-	282
5-3	-	-	-	-	-	-	-	-	-	136	-	54	-	3	-	36	229
6B-1	-	-	16	-	-	-	-	-	-	164	-	92	-	-	-	-	272
6B-2	-	-	-	-	-	-	-	-	-	412	-	4	-	-	-	-	416
6C-1	-	-	-	-	-	-	-	-	-	896	-	-	-	-	-	-	896
6A1-1	-	-	-	-	-	-	-	-	-	940	-	332	-	-	-	-	1272
6A1-2	-	-	-	-	-	-	2	-	-	238	-	178	3	-	-	-	421
7-2	-	-	-	-	-	-	-	-	-	116	-	128	-	-	-	-	244
4C2-2	-	-	-	-	-	-	-	-	-	64	-	184	-	16	-	-	264
8A1-1	-	-	-	-	-	-	-	-	-	20	-	-	-	12	-	-	32
8C-3	-	-	44	-	-	-	-	-	-	16	-	-	-	36	-	-	96
8C-1	-	-	32	-	-	-	-	-	-	-	-	-	-	4	-	-	36
8A2-1	-	-	-	-	-	-	-	-	-	44	-	-	-	12	-	-	56
8A1-3	-	-	24	-	-	-	-	-	-	36	-	12	-	48	-	-	120
8A2	-	-	-	-	-	-	-	-	-	88	-	16	-	-	-	-	104
8C-2	-	-	-	-	-	-	-	-	-	12	-	8	-	28	-	-	48
8A2-3	-	-	-	-	-	-	-	-	-	56	-	12	-	8	-	-	76
8B-3	-	-	-	-	-	-	-	-	-	64	-	-	-	24	-	-	88
8B-2	-	-	44	-	-	-	-	-	-	112	-	12	-	12	-	-	180
8B-1	-	-	-	-	-	-	-	-	-	52	-	-	-	-	-	-	52
9A	52	16	204	-	-	-	-	-	168	48	-	16	-	8	-	-	512
5A-1	88	-	-	-	-	-	-	-	-	84	-	16	-	68	-	-	256
13-2	-	-	48	-	-	-	-	-	-	1824	-	16	-	-	-	56	1944

TABLE 6-3 KENNECOTT INVERTEBRATE IDENTIFICATION

	TAXA																
Sample	Amphipoda	Coleoptera (Dytiscidae)	Diptera (Chironomidae)	Diptera (Ephydridae)	Diptera (Simuliidae)	Diptera (Stratiomyidae)	Diptera terrestrial adults species	Ephemeroptera (Baetidae)	Gastropoda	Hemiptera (Corixidae)	Hemiptera (Gerridae)	Hemiptera (Notonectidae)	Megaloptera (Corydalidae)	Odonata (Coenagrionidae)	Odonata (Gomphidae)	Ostracoda (Podocopa)	**Sample Total**
9D	44	1	-	-	-	-	-	8	232	48	-	40	-	-	-	-	373
11 (JAP)	-	-	28	-	-	-	-	-	-	-	-	-	-	96	8	-	132
4C2-1	-	-	-	-	-	-	-	-	-	52	-	392	-	-	-	-	444
6A2-1	-	-	-	-	-	-	-	-	-	412	-	44	-	-	-	-	456
7-3	-	-	-	-	-	-	-	-	-	76	-	84	-	-	-	-	160
7-1	-	-	-	-	-	-	-	-	-	96	-	92	-	-	-	-	188
6A2-2	-	-	-	-	-	-	-	-	-	620	-	28	-	-	-	-	648
6D2	-	-	216	-	-	-	-	-	-	40	-	-	-	12	-	-	268
8E	-	-	260	-	-	-	-	-	-	84	-	-	-	20	-	-	364
4C1-3	-	-	368	16	-	88	-	-	-	60	80	204	-	-	-	-	816
8D-2	-	-	56	-	-	-	-	-	-	28	-	8	-	-	-	-	92
8D-1	-	-	152	-	-	-	-	-	-	68	-	4	-	24	-	-	248
4B-3	-	-	20	-	-	-	-	-	-	300	-	56	-	-	-	-	376
4B-1	-	-	-	-	-	-	-	-	-	416	-	124	-	-	-	-	540
4C1-1	-	-	-	-	-	8	-	-	-	-	12	16	-	8	-	-	44
4B-2	-	-	-	-	-	-	-	-	-	12	-	12	-	20	-	-	44
4C1-2	-	-	-	-	-	8	-	-	-	8	76	44	-	-	2	-	138
8A2-2	-	-	32	-	-	-	-	-	-	12	-	-	-	64	-	-	108
4C3	-	-	8	-	-	12	-	-	-	-	-	16	-	-	-	-	36
13-3	-	-	-	-	-	-	-	-	-	2368	-	-	-	-	-	1116	3484
13-1	296	-	-	-	-	-	-	-	-	1664	-	-	-	-	-	-	1960
5A-3	11	-	-	-	-	-	-	-	-	2	-	8	-	18	-	-	39
5A-2	28	-	-	-	-	-	-	-	-	108	-	24	-	20	-	-	180
9B	-	-	-	-	-	-	76	-	-	-	-	12	-	-	-	-	88
12	-	-	-	-	18	-	-	-	-	98	-	-	-	-	-	-	116
6A3	-	-	-	-	-	-	88	-	-	98	-	-	-	-	-	-	186
2	8	-	-	-	-	-	-	-	40	-	-	-	-	-	-	-	48
9C																	0
Taxa Total	527	62	1573	28	30	116	166	8	440	13544	168	2637	3	627	10	1737	

TABLE 6-4 SUMMARY OF LABORATORY RESULTS FOR MACROINVERTEBRATE SAMPLES COLLECTED JUNE 2004 (ppm – dw)

Sample ID	Date	Se (ug/g)	As (ug/g)	Cd (ug/g)	Cu (ug/g)	Pb (ug/g)	Zn (ug/g)
2	Jun-03	162.77	100.25	0.77	291.18	17.71	636.41
2	Jun-04	33.14	31.13 (D4)	-0.29 (J)	419.78 (D4)	6.12	27.28 (D4)
4A	Jun-03	34.97	5.48	1.92	70.13	2.38	114.39
4A-1 [a]	Jun-04	26.16	2.57	0.13	39.4	0.24 (J)	101.02
4A-2 [b]	Jun-04	15.63	1.9	1.2	56.55	0.15 (J)	186.17
4A-3 [c]	Jun-04	26.03	2.26	0.22	32.86	0.19 (J)	96.87
4B	Jun-03	33.61	2.74	2.07	94.88	2.22	149.35
4B-1	Jun-04	22.45	2.3	1.18	124.35	0.68 (J)	224.41
4B-2	Jun-04	17.0	1.22	0.28	43.84	-0.23 (J)	126.27 (D4)
4B-3	Jun-04	16.45	1.72	2.11	113.64	-0.06 (J)	235.88
4C1	Jun-03	82.67	1.65	1.76	56.27	1.5	98.23
4C1-1	Jun-04	33.74	0.73 (J)	0.6	62.96	0.06 (J)	63.18
4C1-2	Jun-04	19.33	1.27	0.82	58.77 (D4)	1.47	131.54 (D4)
4C1-3	Jun-04	17.77	5.77	2.93	60.62	6.65	66.81
4C2	Jun-03	5.64	10.79	0.68	62.01	0.95	167.42
4C2-1 [d]	Jun-04	36.72	1.68	0.68	43.4	-0.02 (J)	127.15 (D4)
4C2-2	Jun-04	4.71	1.52	0.57	31.37	-0.10 (J)	143.34 (D4)
4C3	Jun-03	27.27	5.13	1.57	58.02	0.57	121.42
4C3	Jun-04	15.01	24.98	27.21	114.49	0.55 (J)	44.98
5	Jun-03	15.43	3.93	1.32	93.13	1.6	149.41
5-1	Jun-04	8.09	11.49	3.01	79.21	2.38	86.36
5-2	Jun-04	15.94	4.1	2.39	66.18	1.99	158.16 (D4)
5-3	Jun-04	21.27	2.99	1.71	81.37	1.29	160.47 (D4)
6A1	Jun-03	18.48	5.83	8.4	164.15	7.19	261.37
6A1-1	Jun-04	12.43	3.89	3.4	127.31 (D4)	3.63	249.87 (D4)
6A1-2	Jun-04	12.82	1.2	4.13	119.17 (D4)	2.44	315.14 (D4)
6A2	Jun-03	16.38	24.2	10.52	211.07	17.39	165.08
6A2-1	Jun-04	9.06	2.03	3.05	119.4 (D4)	2.69	356.5 (D4)
6A2-2	Jun-04	10.85	2.23	3.43	134.9 (D4)	2.13	372.42 (D4)
6A3	Jun-03	9.33	8.72	11.78	108.3	8.1	333.95
6A3	Jun-04	5.97	6.1	4.6	114.11	16.52	140.81 (D4)
6B	Jun-03	25.97	20.77	3.39	496.35	17.06	164.03
6B-1	Jun-04	23.81	4.05	1.65	200.02	7.64	186.99
6B-2	Jun-04	15.8	5.55	1.72	219.5 (D4)	9.82	190.15 (D4)
6B-3	Jun-04	15.23	6.5	1.92	169.1 (D4)	6.53	194.89 (D4)
6C	Jun-03	13.23	16.85	2.18	471.96	23.85	197.22
6C-1	Jun-04	6.23	3.65	1.07	232.83 (D4)	5.91	174.6 (D4)
6C-2	Jun-04	3.29	17.72	-1.57 (J)	643.47	15.53	109.22
6C-3	Jun-04	6.16	3.7	1.08	309.53 (D4)	9.93	203.91 (D4)

TABLE 6-4 SUMMARY OF LABORATORY RESULTS FOR MACROINVERTEBRATE SAMPLES COLLECTED JUNE 2004
(ppm – dw)

Sample ID	Date	Se (ug/g)	As (ug/g)	Cd (ug/g)	Cu (ug/g)	Pb (ug/g)	Zn (ug/g)
6D1	Jun-03	12.55	5.39	2.74	109.94	2.61	148.99
6D1-1	Jun-04	5.06	4.12	0.62	52.94	0.13 (J)	114.81
6D1-2	Jun-04	6.0	2.86	1.48	72.88	0.22 (J)	143.89 (D4)
6D1-3	Jun-04	8.73	1.79	1.28	133.85	1.69	156.97
6D2	Jun-03	7.28	22.07	1.69	159.99	14.28	217.47
6D2	Jun-04	7.78	6.67 (J)	-2.55 (J)	297.45 (D4)	2.92 (J)	120.04 (D4)
7A	Jun-03	13.52	3.32	4.8	122.41	2.19	162.74
7-1	Jun-04	5.58	3.52	3.52	133.35 (D4)	3	221.4 (D4)
7-2	Jun-04	8.78	76.5 (D4)	3.43	617.90 (D4)	104.71	243.69 (D4)
7-3	Jun-04	5.71	2.54	2.51	112.24 (D4)	1.61	192.15 (D4)
8A1	Jun-03	13.57	8.57	1.39	66.85	2.68	187.76
8A1-1	Jun-04	6.88	4.09	-1.47 (J)	31.75	-0.72 (J)	100.33
8A1-2 [e]	Jun-04	6.5	6.4	-0.95 (J)	119.72	-0.36 (J)	88.7
8A1-3	Jun-04	8.67	2.13	1.93	37.54	-0.14 (J)	177.78
8A2	Jun-03	11.51	22.59	2.76	62.93	4.91	266.07
8A2-1	Jun-04	5.04	2.5	-0.36 (J)	29.15	-0.44 (J)	71.19
8A2-2	Jun-04	5.59	5.5	-0.45 (J)	23.57	2.13 (J)	56.5
8A2-3	Jun-04	14.22	3.86	2.67	83.98	0.63 (J)	228.17
8B	Jun-03	17.27	5.85	3.64	96.2	7.23	244.67
8B-1	Jun-04	4.39	3.4 (J)	-2.23 (J)	52.41	1.25 (J)	113.04
8B-2	Jun-04	5.49	4.81	2.48	67.1	4.58	194.04
8B-3	Jun-04	8.23	2.59	1.22	59.38	2.18	68.76
8C	Jun-03	12.63	6.53	1.61	68.06	23.55	323.37
8C-1	Jun-04	75.07 [f]	4.82	-15.53 (J)	20	-11.66 (J)	69.58
8C-2	Jun-04	7.95	2.31	-0.75 (J)	12.8	0.0 (J)	52.65
8C-3	Jun-04	8.22	3.9	-1.2 (J)	34.86	-1.71 (J)	134.94
8D1	Jun-03	9.06	7.13	1.22	99.28	4.29	241.35
8D1	Jun-04	5.99	4.71	0.66	62.01	0.73 (J)	169.37
8D2	Jun-03	8.49	34.77	1.31	93.21	7.9	158.94
8D2	Jun-04	10.77	11.04	1.03	84.22	1.13	189.23
8E	Jun-03	7.29	22.69	1.06	212.49	10.38	111.98
8E	Jun-04	3.61	3.97	0.31	77.08	1.45	159 (D4)
9A	Jun-03	5.79	93.64	1.54	256.36	3.88	48.5
9A	Jun-04	4.74	27.7	1.66	585.64 (D4)	109.18 (D4)	86.89 (D4)
9B	Jun-03	2.22	11.82	4.13	255.24	89.57	126.13
9B	Jun-04	3.48	9.51	0.56	332.6 (D4)	4.39	36.35

TABLE 6-4 SUMMARY OF LABORATORY RESULTS FOR MACROINVERTEBRATE SAMPLES COLLECTED JUNE 2004
(ppm – dw)

Sample ID	Date	Se (ug/g)	As (ug/g)	Cd (ug/g)	Cu (ug/g)	Pb (ug/g)	Zn (ug/g)
9C	Jun-03	2.34	20.3	0.61	164.22	25.03	268.9
	No macroinvertebrates available for sample collection in 2004.						
9D	Jun-03	4.32	0.71	1.46	32.98	0.66	219.38
9D	Jun-04	6.38	8.78	1.47	202.99 (D4)	3.93	157.778 (D4)
10 [g]	Jun-04	2.26	8.81	0.62	259.39 (D4)	24.75	51.39
11	No macroinvertebrates available for sample collection 2003 and 2004.						
12	Jun-03	1.53	3.67	0.31	143.34	7.74	93.25
12	Jun-04	1.65	1.26 (J)	-0.6 (J)	129.40 (D4)	1.85 (J)	84.05
13-1	Jun-04	4.32	15.66	3.04	171.21	0.53	234.43
13-2	Jun-04	3.86	9.2	7.93	138.99 (D4)	1.11	306.71 (D4)
13-3	Jun-04	2.39	15.67	3.04	181.01 (D4)	1.84	232.31 (D4)

Notes:

[a] Mislabeled in field notes and laboratory report as 5A-1
[b] Mislabeled in field notes and laboratory report as 5A-2
[c] Mislabeled in field notes and laboratory report as 5A-3
[d] Mislabeled in field notes and laboratory report as 4C-1
[e] Mislabeled in field notes and laboratory report as 8A2
[f] Result is believed to be suspect and is not used in this report.
[g] Mislabeled in field notes and laboratory report as 11 (JAP)

D Dilution x
J Estimated value below detection limits

The table below summarizes the highest concentrations of all CoCs by location for the three media sampled.

TABLE 6-5 LOCATION OF HIGHEST CONCENTRATIONS OF CoCs 2004

CoC	WATER	SEDIMENT	MACROINVERTEBRATES
As	6B	9A	7A
Cd	6A2	10	4C3
Cu	6C	10	6C
Pb	6C	9A	9A
Se	6A2	2	4C2
Zn	8C	6D2	6A2

7.0 QA/QC RESULTS

A total of 57 macroinvertebrate, 59 water, and 59 sediment samples were collected in the wetlands in June 2004. The quality of the data was assessed based on precision, accuracy and completeness.

7.1 Precision

Water – The precision was determined in this study by a comparison of replicate sample results within Kennecott Environmental Laboratory (KEL). Five samples out of the 59 samples collected were split and submitted to KEL for CoC analysis. The previously determined data quality objective for this comparison is an RPD of ±25%. Data that exceed relative percent difference (RPDs) in excess of ±25% may still be considered usable if the analyte is detected in quantities less than 4 times the detection limit. The five split samples were submitted and analyzed for total and dissolved metals. Relative percent differences that exceeded the ±25% limit occurred in cadmium (total and dissolved) and zinc (total). Many of the relative percent differences could not be determined due to concentrations below detection limits for the analysis. Table 7-1 shows the QA/QC results for the water samples.

An additional five samples out of the 59 samples collected were split and submitted to Frontier Geosciences Inc. for selenium. None of split samples RPDs exceeded the ±25% limit. Analytical results for these samples are also shown in Table 7-1.

Sediment – The precision was determined in this study by a comparison of split sample results within KEL. Three samples out of the 59 samples collected were split and submitted to KEL for CoC analysis. The previously determined data quality objective for this comparison is an RPD of ±25%. Data that exceed RPDs in excess of ±25% may still be considered usable if the analyte is detected in quantities less than 4 times the detection limit. Many of the relative percent differences could not be determined due to concentrations below detection limits for the analysis. Table 7-2 shows the QA/QC results for the sediment samples.

Macroinvertebrates – Precision is the degree to which a measurement is reproducible. The precision was determined in this study by a comparison of split sample results by Texas A&M.

TABLE 7-1 QA/QC RESULTS FOR WATER SAMPLES 2004

SAMPLE ID	As - T (ug/L)	As - D (ug/L)	Cd - T (ug/L)	Cd - D (ug/L)	Cu - T (ug/L)	Cu - D (ug/L)	Pb - T (ug/L)	Pb - D (ug/L)	Se - T (ug/L)	Se - D (ug/L)	Zn - T (ug/L)	Zn - D (ug/L)
QA: dups												
4A-1A [a]	90	80	<1	<1	20	<20	<5	<5	12	11	15	12
4A-1B [b]	88	80	<1	<1	<20	<20	<5	<5	12	11	41	12
RPD	*2.3%*	*0.00%*	--	--	--	--	--	--	*0.00%*	--	*-92.9%*	*0.00%*
5-3A	43	41	4	3	44	24	<5	<5	10	10	22	22
5-3B	46	44	6	5	<20	<20	<5	<5	10	10	<10	<10
RPD	*-6.7%*	*-7.1%*	*-40%*	*-50%*	--	--	--	--	*0.00%*	*0.00%*	--	--
6D2-A	13	6	1	<1	95	<20	14	<5	<2	<2	24	<10
6D2-B	15	6	1	<1	122	23	16	<5	<2	<2	62	14
RPD	*-14.3%*	*0.00%*	*0.00%*	--	*-24.9%*	--	-13.3%	--	--	--	*-88.4%*	--
8B-1A	268	259	1	1	20	<20	10	<5	5	4	38	10
8B-16	268	268	2	2	<20	<20	<5	<5	5	4	<10	<10
RPD	*0.00%*	*-3.4%*	*-66.7%*	*-66.7%*	--	--	--	--	*0.00%*	*0.00%*	--	--
8EA	42	37	<1	<1	24	<20	<5	<5	3	3	14	14
8EB	40	36	<1	<1	<20	<20	<5	<5	3	3	<10	<10
RPD	*4.9%*	*2.7%*	--	--	--	--	--	--	*0.00%*	*0.00%*	--	--
4B-2	--	--	--	--	--	--	--	--	11	--	--	--
4B-2 dup	--	--	--	--	--	--	--	--	11.3	--	--	--
RPD	--	--	--	--	--	--	--	--	*-2.7%*	--	--	--
5-2	--	--	--	--	--	--	--	--	11	--	--	--
5-2 dup	--	--	--	--	--	--	--	--	9.35	--	--	--
RPD	--	--	--	--	--	--	--	--	*16.2%*	--	--	--
6D1-1	--	--	--	--	--	--	--	--	3	--	--	--
6D1-1 dup	--	--	--	--	--	--	--	--	2.96	--	--	--
RPD	--	--	--	--	--	--	--	--	*1.3%*	--	--	--
7-1	--	--	--	--	--	--	--	--	6	--	--	--
7-1 dup	--	--	--	--	--	--	--	--	6.21	--	--	--
RPD	--	--	--	--	--	--	--	--	*-3.4%*	--	--	--
8D1	--	--	--	--	--	--	--	--	14	--	--	--
8D1 dup	--	--	--	--	--	--	--	--	13.9	--	--	--
RPD	--	--	--	--	--	--	--	--	*0.7%*	--	--	--
QA: blanks												
0-0	<5	<5	<1	<1	<20	<20	<5	<5	<2	<2	<10	<10
0-1	<5	<5	<1	<1	<20	<20	<5	<5	<2	<2	<10	<10
0-2	<5	<5	<1	<1	<20	<20	<5	<5	<2	<2	<10	<10

Notes:
-- indicates that the relative percent difference was unable to be determined due to detections below detection limits.

Four samples from a concurrent sampling event performed by KUC were split and analyzed for CoC's. The previously determined data quality objective for this comparison is an RPD of ±25%. Data that exceed RPDs in excess of ±25% may still be considered usable if the analyte is detected in quantities less than 10 times the detection limit. Table 7-3 shows the QA/QC results for the macroinvertebrate samples.

TABLE 7-2 QA/QC RESULTS FOR SEDIMENTS 2004

SAMPLE ID	Se (mg/kg)	As (mg/kg)	Cd (mg/kg)	Cu (mg/kg)	Pb (mg/kg)
QA: dups					
7-3	4	122	0.8	659	75
DUP	5	114	1.3	747	84
RPD	*-22.2%*	*6.8%*	*-47.6%*	*-12.52 %*	*-11.32*
8A1-3	2	8	<DL	71	<DL
DUP	2	8	<DL	77	<DL
RPD	*0.0%*	*0.0%*	--	*-8.1%*	--
8A2-1	5	15	0.8	32	<DL
DUP	<DL	14	<DL	31	<DL
RPD	--	*6.9%*	--	*3.2%*	--

Notes:
-- indicates that the relative percent difference was unable to be determined due to detections below detection limits.
<DL indicates the sample result was below detection limits.

TABLE 7-3 QA/QC RESULTS FOR MACROINVERTEBRATES 2004

SAMPLE ID	Se (ppm)	As (ppm)	Cd (ppm)	Cu (ppm)	Pb (ppm)	Zn (ppm)
QA: dups						
Station #17	6.1	5.06	0.19	5.4	<DL	168.85
DUP	6.13	6.21	0.11	5.64	<DL	179.33
RPD	*0.0%*	*-20%*	*-52%*	*-4 %*	--	*-6%*
Station #2	1.59	23.94	<DL	12.2	0.8	46.06
DUP	1.3	29.13	0.16	17.07	0.95	63.51
RPD	*-20%*	*-20%*	--	*-33%*	*-17%*	*-32%*
Station #4	1.23	13.78	0.14	30.62	2.98	74.22
DUP	1.14	19.0	0.19	29.21	2.12	73.93
RPD	*-8%*	*-32%*	*-33%*	*-5%*	*-34%*	*-0.0%*
Station #5	1.05	26.25	0.48	50.51	2.82	94.89
DUP	1.09	28.76	0.16	46.78	2.29	93.7
RPD	*-3%*	*-9%*	*-100%*	*-8%*	*-21%*	*-1%*

Notes:
-- indicates that the relative percent difference was unable to be determined due to detections below detection limits.
<DL indicates the sample result was below detection limits.

7.2 Accuracy

The accuracy of the water and soil data was determined by KEL's splits, spike duplicates and spike recoveries for arsenic, cadmium, copper, lead, selenium and zinc. KEL performs splits, spike duplicates and spike recoveries on a daily basis. During the 2004 sampling event the percent accuracy and RPD objectives for water samples were met for arsenic, copper, lead, and selenium. Accuracy and RPD objectives for water samples were not met for cadmium and total zinc. During the 2004 sampling event the percent accuracy and RPD objectives for sediments samples were met for all analytes.

The accuracy of the macroinvertebrate data was determined by Texas A&M's splits, spike duplicates and spike recoveries for arsenic, cadmium, copper, lead, selenium and zinc. Texas A&M performed splits, spike duplicates and spike recoveries for this data set. The percent accuracy and RPD objectives of this study were met for all elements. Appendix C contains Texas A&M's splits, spike duplicates and spike recovery data.

Blanks were also submitted to KEL with each daily batch of water samples as an additional accuracy check. Three blanks were submitted, all of which showed non-detectable levels for arsenic, cadmium, copper, lead, selenium and zinc (see Table 7-1). Texas A&M ran two blanks with this data set and none of the analytes measured were above the detection limits.

8.0 COMPARISON TO HISTORICAL DATA

8.1 Water Sample Results

As discussed in the 2003 Wetlands Monitoring Report (KUCC, 2004), selenium in water collected during the 2003 monitoring event were unreliable due to analytical difficulties. Thus, a comparison of the results to those from the 2004 monitoring event is not possible. The 2004 results will be compared to those from the samples collected during the 2005 monitoring event.

8.2 Sediment Sample Results

Table 8-1 presents a comparison of the results of the selenium concentrations in sediment samples from the 2003 event to those of the 2004 event. The selenium concentrations in sediment samples decreased in six of the twenty-seven sample locations where data is available from both years. The selenium concentrations increased in samples from twenty of the sampling locations.

The cause of the increase in selenium concentrations in sediment samples, particularly at sites where remediation efforts were conducted, is not properly understood yet and will be further investigated during the 2005 monitoring event.

8.3 Macroinvertabrate Sample Results

Figure 8-1 compares the changes in tissue selenium from 2003 to 2004 for those areas which have tissue concentrations greater than 10 ppm. The results of the 2004 sampling event show a general reduction in selenium concentrations in tissue samples relative to the 2003 results across the project area. Dramatic decreases from 162.77 ppm to 33.14 ppm at Kessler Spring (2) to 18.48 ppm to 12.63 ppm at the Oolitic Sand Ponds (6A) were observed in the areas where the highest concentrations were measured during the 2003 event. Decreases in selenium concentrations were measured in most of the sampling locations where selenium concentrations in tissue were greater than 10 ppm. The number of sites with selenium concentrations greater than 10 ppm decreased from sixteen of the twenty-seven sites sampled in 2003 to ten of the twenty-eight sites sampled in 2004. The number of sites with selenium concentrations less than 5 ppm increased from three in 2003 to six in 2004. Figure 8.1 presents a comparison of selenium concentrations in the 2004 tissue samples to the results of the 2003 event. Where multiple samples were collected at one location the results are averaged on the figure.

TABLE 8-1 Selenium in Sediment Samples, 2003 versus 2004

Sample Location	2003 Se Sediment (dry) (ppm)	2004 Se Sediment (dry) (ppm)	Change in Se concentration from 2003 to 2004 (ppm)
2	423.53	157	-266.53
6D2	13.64	2[a]	-11.64
4A	35	28	-7.33
9B	8	1.5[a]	-6.50
8A1	3.9	3	-0.90
12	1.59	1	-0.59
6A1	8	8	0.00
6A3	1.39	1.5[a]	0.11
6D1	7.69	8	0.31
9D	4.55	5	0.45
9C	2.08	3[a]	0.92
8D2	3.95	5	1.05
6B	9.52	11	1.48
8B	1.3	3	1.87
6C	5.36	8	2.31
8D1	1.28	4	2.72
8C	1.32	5	3.35
7A	1.32	5	4.01
4B	2.7	9	6.30
6A2	1.59	8	6.41
8A2	1.28	8	6.72
5	1.28	11	9.72
8E	2.94	13	10.06
4C2	1.32	23	21.18
9A	1.28	23	21.72
4C1	9.52	46	36.48
4C3	1.3	50	48.70
Notes: [a] - Concentration was below detection limit - value equal to 1/2 the detection limit entered for calculation.			

An increase in selenium concentrations in tissue was measured at two of the sampling sites. The first, 8D2, exhibited a relatively small increase from 8.49 ppm in 2003 to 10.77 ppm in 2004. Though the selenium concentration in tissue samples at this site exceeds 10 ppm this increase is likely within the range of normal variability and is not of immediate concern. At the second site, 4C2 (Horseshoe Pond), one sample (4C2-1) showed a significant increase in selenium concentrations in tissue from the 2003 result of 5.64 ppm to 36.72 ppm in 2004. However, the results for the other sample from the pond (4C2-2) showed a slight decrease to 4.71 ppm in 2004. The results from the first sample appear to be much higher than would be expected based on the historical data from the pond and may be a result of sampling error.

Figure 8-1

9.0 DISCUSSION

In the North End wetlands, ecological risk is presumed to be primarily through dietary exposure to elevated metals and metalloids—especially selenium—which represents a concern for the reproductive success of birds feeding in the area. Consequently, sampling occurred during the nesting season (May/June), and the primary assessment endpoint was dietary exposure of metals and metalloids to birds using the wetlands, especially species feeding wholly, or in part, on aquatic food chains (macroinvertebrates).

9.1 Selenium

Comparing measured macroinvertebrate tissue selenium to site-specific criteria established by EPA (2002) indicates a continuing, but reduced, risk in portions of the North End wetlands. Table 9-1 compares tissue selenium concentrations measured in 2004 to the predetermined goal selenium concentration ranges set in the ROD (EPA, 2002; Table 2-1), and shows that approximately 40 percent of the macroinvertebrate selenium results in 2004 were greater than the 10 ppm threshold identified as an action level.

TABLE 9-1 MACROINVERTEBRATE SELENIUM RESULTS IN 2004 COMPARED TO ROD GOALS

Se Concentration Range (ppm)	# Samples	% of Total	Cumulative %
0 – 5	11	19	19
6 – 10	23	40	59
11 – 15	5	9	68
16 – 20	9	16	84
21 – 40	8	14	98
40+	1	2	100

However, a comparison of 2004 to 2003 tissue concentrations indicates a overall decrease in tissue selenium concentrations across the wetlands with especially pronounced decreases in “hot spot” such as below Kessler Springs where concentrations decreased from 163 ppm in 2003 to 33 ppm in 2004. The number of sampling locations with tissue concentrations above 10 ppm decreased from 16 of 27 in 2003 to 10 of 28 in 2004. Sites with tissue selenium less than 5 ppm increased from 3 to 6 between 2003 and 2004.

This is an encouraging trend that speaks to the success of soil cleanups, groundwater source control measures, and water capture systems previously implemented. Kennecott is guardedly optimistic that the observed trends will continue, but nevertheless maintains concern over the elevated macroinvertebrate tissue selenium. Sediment selenium concentrations, which appear to have increased relative to both post-removal (in remediated areas) and 2003 sampling are of specific concern and warrant further investigation.

The 2004 monitoring program included increased monitoring and additional parameters in attempt to understand factors controlling selenium occurrence and uptake. Statistical analysis of the data was performed to evaluate correlations between selenium in tissue, water, and sediment. This analysis is presented in Appendix D. Consistent with findings of the 1997 EcoRA (ep&t and Parametrix, Inc., 1997), the analysis of the 2004 dataset did not indicate significant correlation of the selenium in the tissue samples to the selenium concentrations in the water and sediment samples. No correlation was noted between selenium and organic carbon. Analysis of the outlying data did indicate that the types of organisms analyzed for the tissue data may have significant influence on the concentration of selenium measured in the samples. In particular, macroinvertebrate samples at location 2, 4C1-1, 8C-1 and 8C-2 did not contain any corixoids and tended to be significant outliers in the data analysis. The data were subdivided into the areas described in Section 3.3 for additional analysis. Subdividing the data resulted in a much smaller dataset to analyze but allowed areas of similar hydrologic settings to be evaluated. Significant correlations between the tissue, water and/or sediment data were not observed in the subdivisions.

In 2005, a third year of wetlands monitoring will occur. If elevated tissue Se concentrations continue in the wetlands, Kennecott will consider several options including 1) continued monitoring alone, if the substantial downward trends continue suggesting that additional time is needed for complete flushing, 2) a focused investigation in areas of high selenium to discover factors causing elevated tissue selenium, and 3) investigation of other possible sources, and 4) retiring selected areas from wetland service.

9.2 Other Metals

Other metals (As, Cd, Cu, Pb, Zn) were also analyzed on the samples. Table 9-2 shows the results for these metals analyses on the macroinvertebrate tissues. In order to determine the significance of these data, risk quotients (RQs) were calculated using the same no observable adverse effect levels (NOAELs) used in the original EcoRA. The RQ is determined by dividing the concentration found in the sample by the NOAEL: if the RQ is greater than 1.0, there is potential for ecological risk. Table 9-2 highlights the samples where the RQs were found to be greater than 1.0. The sample collected at the pond east of NEG488 (4C3) had RQs greater than 1.0 for cadmium (2.72), and sample 9A exceeded the RQ’s for copper (1.17) and lead (1.16). The zinc analysis for the majority (17 of 28) of the ponds sampled had RQs greater than 1.0, with an overall average RQ of 1.15. However, this was also the case in the original EcoRA, where the average RQ for zinc in 1995 was 2.6. As stated in the EcoRA, much effort was taken to use the most conservative NOAELs .(ep&t and Parametrix, 1997, p. 102-103):

> The zinc NOAEL was based on a laboratory study of day-old Japanese quail. Quail showed no effects when fed diets containing 125 mg/kg (dw) of zinc, and exhibited decreased growth rates at 250 mg/kg (dw) zinc when dietary copper was low. Diets sufficient in copper did not result in zinc-induced growth reduction until 1000 mg/kg (dw) of diet. Mortality did not occur until diets contained 2000 mg/kg (dw) zinc. Chickens do not show any adverse effect from zinc ingestion until diets contain over 2000 mg/kg zinc, at which point weight gain is reduced.(…) Therefore, it appears that Japanese quail are more sensitive to zinc, especially given diets insufficient in copper, and risk to other birds may be overestimated using the 125 mg/kg NOAEL.

In comparison, data from the 2003 event showed RQ’s for cadmium greater than one at ponds 6A1 and 6A2. RQ’s for zinc exceeded one in 21 of 27 ponds sampled.

TABLE 9-2 CONCENTRATIONS OF CoCs in MACROINVERTEBRATES AND CALCULATED RQs

SAMPLE ID	As (ppm)	As RQ dw conc/NOAEL (112)	Cd (ppm)	Cd RQ dw conc/NOAEL (10)	Cu (ppm)	Cu RQ dw conc/NOAEL (500)	Pb (ppm)	Pb RQ dw conc/NOAEL (94)	Zn (ppm)	Zn RQ dw conc/NOAEL (125)
2	31.13	0.28	0.29	0.03	419.78	0.84	6.12	0.07	27.28	0.22
4A	2.24	0.02	0.52	0.05	43.94	0.09	0.19	0.00	128.02	1.02
4B	1.75	0.02	1.19	0.12	93.94	0.19	0.68	0.01	195.52	1.56
4C1	2.59	0.02	1.45	0.15	60.78	0.12	2.73	0.03	87.18	0.70
4C2	1.60	0.01	0.63	0.06	37.39	0.07	0.04	0.00	135.25	1.08
4C3	24.98	0.22	27.21	2.72	114.49	0.23	0.55	0.01	44.98	0.36
5	6.19	0.06	2.37	0.24	75.59	0.15	1.89	0.02	135.00	1.08
6A1	2.55	0.02	3.77	0.38	123.24	0.25	3.04	0.03	282.51	2.26
6A2	2.13	0.02	3.24	0.32	127.15	0.25	2.41	0.03	364.46	2.92
6A3	6.10	0.05	4.60	0.46	114.11	0.23	16.52	0.18	140.81	1.13
6B	5.37	0.05	1.76	0.18	196.21	0.39	8.00	0.09	190.68	1.53
6C	8.36	0.07	1.08	0.11	395.28	0.79	10.46	0.11	162.58	1.30
6D1	2.92	0.03	1.13	0.11	86.56	0.17	0.68	0.01	138.56	1.11
6D2	6.67	0.06	2.55	0.26	297.45	0.59	2.92	0.03	120.04	0.96
7A	27.52	0.25	3.15	0.32	287.83	0.58	36.44	0.39	219.08	1.75
8A1	4.21	0.04	1.45	0.15	63.00	0.13	0.41	0.00	122.27	0.98
8A2	3.95	0.04	1.16	0.12	45.57	0.09	1.07	0.01	118.62	0.95
8B	3.60	0.03	1.85	0.19	59.63	0.12	2.67	0.03	125.28	1.00
8C	3.68	0.03	5.82	0.58	22.55	0.05	4.57	0.05	85.72	0.69
8D1	4.71	0.04	0.66	0.07	62.01	0.12	0.73	0.01	169.37	1.35
8D2	11.04	0.10	1.03	0.10	84.22	0.17	1.13	0.01	189.23	1.51
8E	3.97	0.04	0.31	0.03	77.08	0.15	1.45	0.02	159.00	1.27
9A	27.70	0.25	1.66	0.17	585.64	1.17	109.18	1.16	86.89	0.70
9B	9.51	0.08	0.56	0.06	332.60	0.67	4.39	0.05	36.35	0.29
9D	8.78	0.08	1.47	0.15	202.99	0.41	3.93	0.04	157.78	1.26
10	8.81	0.08	0.62	0.06	259.39	0.52	24.75	0.26	51.39	0.41
12	1.26	0.01	0.60	0.06	129.40	0.26	1.85	0.02	84.05	0.67
13	13.51	0.12	4.67	0.47	163.74	0.33	1.16	0.01	257.82	2.06

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