Final Report

Lower Coeur d'Alene River Water Quality Monitoring

Prepared for:

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1. Introduction

Mining and smelting have been dominant activities in Northern Idaho's Silver Valley since the 1880's. Approximately 72 million tons of mine tailings were released into the South Fork of the Coeur d'Alene River between the 1880's and the 1960's. These tailings have been redistributed throughout the Lower Coeur d'Alene River (CDAR) and into the northern two-thirds of Coeur d'Alene Lake. The Bureau of Land Management (BLM) administers several parcels of public lands along the Lower CDAR. The parcels, totalling approximately 1,100 acres, are located in Kootenai County, Idaho. The area extends from the mouth of the CDAR near the town of Harrison to the Old Mission near Cataldo.

Under the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA, also known as Superfund), the Environmental Protection Agency (EPA) was given the responsibility to identify, investigate, and clean up uncontrolled hazardous waste sites. The Bunker Hill site, located upstream of the BLM parcels near Kellogg, was placed on the National Priorities List as a Superfund site on December 20, 1982.

Also under CERCLA, the BLM has identified the public lands along the Lower CDAR as having potentially hazardous materials resulting from mining wastes. In 1988, a site investigation was completed for the BLM by Roy F. Weston, Inc. (Weston). Surface water grab samples collected from Killarney and Thompson Lakes by Weston exceeded toxicity levels for freshwater organisms for cadmium, lead, mercury, and zinc.

To that end, Grant, Schreiber and Associates (GSA) was contracted by the BLM to further characterize and develop a plan to monitor the surface waters near the BLM's public lands. The objectives of this study were to:

- *review the past water quality sampling efforts in the Lower Coeur d'Alene area,*
- *develop and carry out check characterization sampling of surface waters sampled during the BLM's site investigation,*

- *develop a monitoring plan for surface water areas near public lands, and*
- *establish monitoring sites and carry out initial sampling.*

This report presents the results of GSA's evaluation and findings. Included are a review of past water quality sampling in the area, the results of check characterization sampling, a plan for future monitoring, documentation of the established monitoring sites, and the collection and results of initial water quality samples.

2. Review of Past Sampling

GSA conducted a review of previous studies concerning heavy metals in the surface waters of the CDAR and surrounding lateral lakes. Two types of material were reviewed during this study, 1) data retrieved from EPA's STORET system, a database of sampling sites and their associated quality data, and 2) published and unpublished reports. The following sections summarize GSA's review of available material, identify key literature describing the area water quality, and identify gaps in the existing water quality database.

2.1 STORET Data Review

Data retrieved from EPA's STORET system were reviewed to find stations along the CDAR where samples had been collected and analyzed for cadmium, lead, mercury, and zinc, the metals of concern in this study as determined by the BLM's site investigation. A listing of stations and sampling periods for which some or all of the above metals were analyzed is shown in Table 2-1.

Selected data from the locations in Table 2-1 are shown in Figures 2-1 through 2-6. Figures 2-1 through 2-4 show the concentrations of zinc, lead, cadmium, and mercury in the CDAR during periods of low flow at Cataldo between 1972 and 1986. In each case, and especially in the case of mercury, the concentration appears to have decreased over the period.

Figure 2-5 shows the discharge and the concentration of zinc in the CDAR at Rose Lake between 1975 and 1981. Of particular interest is the apparent annual variation in zinc concentration. Figure 2-5 shows that the zinc concentration is much greater during periods of low flow (late summer and early winter months) than during periods of high flow (spring and early summer).

Figure 2-6 shows the concentration of zinc at stations along the CDAR during the period from January of 1969 through March of 1970. This figure also shows a higher zinc concentration during the late summer and early winter months. The zinc concentration appears to be relatively constant at the various stations along the main stem of the river.

The most current data available from STORET were collected by the U.S. Geological Survey (USGS) at Cataldo between 1986 and 1988. The results of these samples are shown in Table 2-2. Since these results were reported as dissolved metal concentrations (rather than total metal concentrations), a direct comparison cannot be made with the above mentioned data.

2.2 Published and Unpublished Reports

Water quality problems in the CDAR have been documented as early as 1911. Kemmerer, et al. (1923) reported that:

> *"at Harrison it (Coeur d'Alene Lake) receives the muddy waters of the Coeur d'Alene River, which drains an immense area, including the famous Coeur d'Alene Mining District. These waters are so laden with silt that they may be traced far out into the clear waters of the lake, . . ."*

A study by Ellis (1932) concluded that suspended solids had made the river uninhabitable to most aquatic life.

A study by Mink (1971) concluded that water quality along the main stem of the CDAR is primarily a result of the mixing of the waters of the North and South Forks of the CDAR. The South Fork has high concentrations of metals, especially zinc and cadmium. The North Fork, which has no domestic or industrial development, generally has excellent water quality and tends to dilute the high metal concentrations of the South Fork. Water samples were collected from 34 stations (10 along the main stem of the CDAR) over a period of 16 months. The samples were analyzed for 13 metals along with other water quality parameters. Arsenic, chromium, and nickel were not detected in the main stem. Copper and lead were found in concentrations less than or equal to 100 μg/l during the sampling period. Zinc concentrations were found to have a mean concentration of 1,400 μg/l during the winter months, 400 μg/l during the high flow in the spring, and 3,400 μg/l during the low flow in the summer and fall months. A correlation between flow rate and zinc concentration was noticed. During low flow, the zinc concentration was high, while during high flow, the zinc concentration was low. This variation is similar to that mentioned in Section 2.1, regarding Figures 2-5 and 2-6. However, Mink noted that even though the zinc concentration was lowest during high flow, the total zinc mass load was greatest during high flow.

A study by Bauer (1974) included the measurement of heavy metal concentrations in the CDAR and nine lateral lakes along the CDAR. The lakes included Rose, Killarney, Medicine, Cave, Swan, Black, Blue, Thompson, and Anderson Lakes. Water samples were collected in the spring of 1973. Cadmium, copper, and lead concentrations were below detection limits (cadmium - 20 μg/l; copper - 20 μg/l; and lead - 500 μg/l). Zinc was found in high concentrations in the river and in lakes having a direct connection to the river. Sample stations located near the lake inlets typically showed substantially higher zinc concentrations than open water stations. The inlet to Swan Lake had the highest zinc concentration (440 μg/l) of any lake station, followed by the inlet to Thompson Lake (410 μg/l). Killarney Lake, which has the largest channel connection to the river, had the highest overall zinc concentration (220-240 μg/l) and did not have a substantially higher concentration at the inlet (240 μg/l). This is probably a result of more thorough mixing of the lake and river water because of the wide channel connection. Zinc concentrations at open water lake stations ranged from 50-70 μg/l with the exception of Killarney, as noted above, and Rose and Cave Lakes, which were below detection limits (50 μg/l). Two stations along the CDAR, one just upstream of Killarney Lake and one 3.5 miles upstream from Coeur d'Alene Lake (near Anderson Lake), yielded zinc concentrations of 1,100 and 410 μg/l, respectively.

A cooperative study by Washington State University and the University of Idaho (Funk, Rabe, et al., 1975) stated that dissolved elements are present in the river at concentrations which have been shown to be toxic to aquatic life. These elements originate in the South Fork drainage and include zinc, cadmium, lead, and fluoride. Parameters measured at the main stem of the CDAR showed the dilution effect of the mixing of the relatively unpolluted North Fork with that of the South Fork, which carries industrial and domestic waste materials. Data for the nine lateral lakes collected by Bauer (1974), as described above were presented. In addition, zinc concentrations were reported during low flow periods in October of 1973 and January of 1974. The zinc concentration in the CDAR near Anderson Lake rose from 410 μg/l in May (high flow) to 6,300 μg/l in October (low flow). At this time, the zinc concentrations had fallen to less than 50 μg/l at Anderson Lake and the open water station at Thompson Lake, while the concentration at the Thompson Lake inlet had fallen from 410 μg/l in May to 150 μg/l in October. This decrease in concentration probably results from a decreased supply of zinc from the river to the lakes during low flow. In January, the zinc concentration in the river dropped to 1,600 μg/l as winter rains caused a rise in the water level. This was accompanied by a rise in zinc concentration to 250 μg/l at the Anderson Lake inlet, as the river water entered the lake. These data show that the zinc concentration in the lateral lakes is affected by fluctuations in the water level in the river.

The site characterization report for the Bunker Hill Superfund site in the Kellogg area (Woodward-Clyde Consultants and TerraGraphics, 1986) contains surface water quality data for the South Fork and the upper main stem of the CDAR. Tables 2-3 and 2-4 show yearly observed mean concentrations of cadmium, lead, mercury, and zinc for stations at Cataldo and Rose Lake. These data were collected by the USGS and the EPA, and compiled by Woodward-Clyde. In general, these data show downward trends in the concentrations of these metals. However, one must keep in mind that many of the mean concentrations were computed from a small number of observations and that the concentration may vary greatly within any given year as a result of flow conditions. The study reported that when USGS and EPA water quality data from STORET were examined separately, it was observed that the lead concentrations reported by USGS were much higher than those reported by EPA sampling. The USGS data were collected throughout the year, while EPA data were collected mostly during low flow periods. This pattern held true for the years 1975, 1976, 1979, and 1980. In 1980, the USGS average for total lead concentration was 874 μg/l for 10 samples, while the EPA average was 38.8 μg/l for 5 samples, indicating that lead concentrations are higher during high flow events, rather than being diluted as in the case of zinc. The source of lead during high flow events is probably from tailings being transported and from surface runoff from the contaminated hillsides around the Bunker Hill smelter complex.

The draft Bunker Hill Remedial Investigation/Feasibility Study (RI/FS) work plan (Tetra Tech, Inc. and Morrison-Knudsen Engineers, Inc., 1987) stated that:

> *"Loadings from the South Fork Coeur d'Alene River account for between 90 and 100 percent of the total metals loading in the Coeur d'Alene River at Cataldo. Metals loading from other tributaries along the main stem of the Coeur d'Alene River are insignificant."*

The report also addressed concerns regarding gaps in water quality data in recent years. Most of the existing water quality database is prior to the shutdown of the Bunker Hill facility, a major source of contaminants, in 1982. Surveys since this time have been primarily single-day sampling events, mostly during periods of low flow. Results from these samples show generally improving water quality conditions; however, they may not be totally representative of long-term water quality conditions. The report sites a need for sampling under high flow, as well as low flow conditions, stating that, while important in defining critical water quality conditions, low flow periods normally do not play a major role in determining annual mass loading.

The EPA Region 10 office has conducted chemical and biological monitoring during low flow conditions from 1972 through 1986 along the South Fork of the CDAR. Hornig, et al., (1988) summarized this monitoring. They concluded that, although heavy metal concentrations in the South Fork and main stem of the CDAR have been dramatically reduced over the last twenty years, the concentrations of cadmium and zinc remain well above criteria levels for protection of aquatic life. But, even though tests have confirmed the toxicity of the river water, conditions on the South Fork are now suitable for less sensitive populations of aquatic biota, while conditions on the main stem are supporting a successful sports fishery. Concentrations of cadmium and zinc remain the major limiting factors for continued restoration of aquatic biota in both the South Fork and main stem.

A site investigation along areas of the Lower CDAR was conducted by Weston in the summer of 1988 for the BLM (Weston, 1989). The investigation encompassed four sites including:

- *Cataldo,*
- *Dudley,*
- *Killarney Lake, and*
- *Thompson Lake.*

During the course of the investigation, 26 soil samples and three water samples were obtained. Results of the water samples are shown in Table 2-5. A water sample taken at Thompson Lake, TL-W-1, contained lead (7,000 μg/l) that exceeds all applicable water quality criteria. The chronic toxicity criteria for lead (Table 2-6) was exceeded by 5,384 times, the acute toxicity criteria (Table 2-6) by 206 times, and the Federal Drinking Water Standard (Table 2-7) by 140 times. This value also exceeds the EP Toxicity standard for hazardous waste. When compared with other reported lead concentrations (Figure 2-2), it seems likely that a sampling or analysis error may have occurred. The acute toxicity criteria for zinc was exceeded, while the detection limits of cadmium and copper were not exceeded. Two samples, KL-W-1 and KL-W-2, were collected from the wetland area east of Killarney Lake. In sample KL-W-1, zinc and mercury were encountered in concentrations exceeding the acute toxicity criteria (Table 2-6). Sample KL-W-2 contained cadmium and lead concentrations that exceeded acute toxicity criteria (Table 2-6) and the Federal Drinking Water Standard (Table 2-7). Zinc levels exceeded the acute toxicity criteria. Mercury was not analyzed in this sample. Results of soil samples collected in the four areas investigated indicate that each of the areas has been impacted by fluvial deposition of heavy metal contaminated sediment.

A study by Callcott (1989) recorded water quality data at 18 sampling stations along the South Fork and main stem of the CDAR over a six month period (March through August) in 1988. The data were compared to data collected by Mink (1971) and the EPA (1972-84). The samples were analyzed for:

- *antimony,*
- *arsenic,*
- *cadmium,*
- *calcium,*
- *chromium,*
- *copper,*
- *iron,*
- *lead,*
- *potassium,*
- *magnesium,*
- *manganese,*
- *nickel,*
- *sodium, and*
- *zinc.*

The study indicated that the primary metals of interest were cadmium, copper, lead, and zinc. Of these metals, zinc was the only one found in significant quantities. Cadmium, copper, and lead were nearly always below detection limits (100 μg/l). The highest zinc concentration (3,800 μg/l) occurred in mid-March below Smelterville flats. The highest zinc concentration reported at the Cataldo station was 700 μg/l during June, July, and August. The lowest zinc concentration at Cataldo was 200 μg/l in May. As previously mentioned, zinc concentrations are typically highest during periods of low flow. Since this study did not extend beyond August, it is possible that higher zinc concentrations may have occurred later in 1988. Zinc levels appeared to have decreased slightly when compared with Mink's 1969 data. However, one must keep in mind that the zinc concentration appears to vary with flow rate, and that variations in flow rate may have contributed to this apparent decrease.

Krieger (1989) reported lead levels in Thompson Lake, Killarney Lake, and the Lower CDAR near Thompson Lake, and made comparisons with distilled water and samples from the Harrison (Idaho) City Hall, a well near Thompson Lake, the St. Joe River near St Maries, Idaho, and a well near St. Maries. The samples from the CDAR, Killarney Lake, and Thompson Lake contained lead concentrations of 55, 13, and 6 μg/l, respectively. The lead value for the CDAR exceeds the criteria for chronic and acute toxicity and the Federal Drinking Water Standard. The lead values for Killarney and Thompson exceed chronic toxicity criteria. Of the remaining samples, the distilled water and the well near Thompson Lake contained 3 μg/l, the well near St. Maries, Idaho contained 1 μg/l, and the samples from Harrison and the St. Joe River were below detection limits. A separate sample collected from a small pond on the southeast edge of Thompson Lake contained 20 μg/l of lead. In addition, Krieger reported that nine samples collected by the Idaho Department of Fish and Game from the Lower CDAR during the spring of 1985 during high flow contained lead ranging from 10 to 230 μg/l.

The Idaho Department of Health and Welfare is currently conducting water quality monitoring at sites located along the CDAR at Enaville and South Fork of the CDAR near Pinehurst (Tulloch, 1990). This monitoring, which is being conducted in cooperation with the USGS, began in October of 1989. Samples are collected six times annually at Pinehurst and six times per year every three years at Enaville. The samples are analyzed for nutrients, common ions, trace ions, and field constituents including discharge, water temperature, pH, specific conductance, and others.

2.3 Identification of Data Gaps

During the course of this review, the following data gaps were noticed:

- *most studies have been short term,*

- *data collection in recent years has been sparse,*
- *recent data have mostly been collected during low flow periods,*
- *few stations are located along the main stem of the CDAR, and*
- *very little sampling has been conducted in the lateral lakes along the main stem of the CDAR.*

Many of the previous studies conducted along the CDAR have been short term (Mink, 1971; Funk, Rabe, et al., 1975; Weston, 1989; Callcott, 1989; and Krieger, 1989). While helping to characterize the water quality at a given point in time, these studies are not adequate in scope to describe long-term water quality conditions, and the possible changes that have occurred. Although comparisons have been made between some of the studies, a lack of consistency resulting from differences in sampling methods, laboratory procedures, and sampling periods, among other things, may jeopardize the integrity of these comparisons.

The only existing long-term data have been collected by government agencies, primarily the EPA and the USGS. A fairly regular and consistent database of water quality data was maintained by these agencies throughout the late 1960's and early 1970's. The most complete data set was collected by the USGS at Rose Lake from 1972 to 1981 (see Table 2-1). However, the data that have been most heavily relied on in many of the studies reviewed by GSA have been collected by the EPA. These data were collected during low flow periods in 1972, 1974, 1975, 1976, 1979, 1980, 1982, 1984, and 1986. Much emphasis has been placed on these data, which may not be truly representative of the water quality conditions for two different, but related reasons. First, the data consist of point values collected every one to three years, which from a statistical standpoint, is very undesirable. Secondly, since the data are sparse, they do not cover a range of flow conditions (low flow only). In Section 2.2, it was stated that metal concentrations appear to vary according to flow condition (both high and low). As stated in the Bunker Hill RI/FS Work Plan (Tetra Tech, Inc. and Morrison-Knudsen Engineers, 1986), there is reason to believe that the water quality in the CDAR may have improved in recent years in the CDAR with the shutdown of the Bunker Hill Smelter operations and the closure of many mines resulting from low metal prices. However, present data collection efforts have not been adequate to characterize these possible improvements.

Another data gap is the lack of stations along the main stem of the CDAR. With the exception of some sampling in the late 1960's and early 1970's, most of the data collected along the main stem of the CDAR have been collected at stations located near Rose Lake and Cataldo. A greater network of stations would provide a better database for describing long-term trends in water quality. Similarly, data collected in the lateral lakes along the CDAR have been very limited (Bauer, 1974; Weston, 1989; Krieger, 1989).

Table 2-1. Agency Sampling History Along the Coeur d'Alene River.

Sample Location	Starting Date	Ending Date	Comments
EPA (21IDBMG)[a]			
near Kingston	12/68	3/70	monthly
0.5 mi NE of Cataldo	12/68	3/70	monthly
W of Cataldo	12/68	3/70	monthly
near Dudley	12/68	3/70	monthly
Rose Lake	12/68	3/70	monthly
2 Mi N of Lane	12/68	3/70	monthly
1.5 mi N of Medicine Lake	12/68	3/70	monthly
0.75 mi E of Medimont	12/68	3/70	monthly
between Black and Swan Lakes	12/68	3/70	monthly
EPA (21WSU)[a]			
Cataldo	10/03/71		
0.5 mi above French Gulch	10/03/71		
Idaho Dept of H&W (21IDAHO)[a]			
Cataldo	11/68	7/76	periodic
Rose Lake	11/68	7/76	periodic
	11/81	9/83	monthly
U.S. Geol. Survey (112WRD)[a]			
Cataldo	7/72	10/72	monthly 11/86, 3/87, 5/87, 9/87, 3/88, 5/88
Rose Lake	5/72	10/72	monthly 6/73, 8/73
	12/73	6/75	biweekly
	7/75	9/81	monthly
EPA (1119C050)[a]			
Cataldo	8/66	6/73	monthly 7/74, 10/75, 10/76, 9/79 10/80, 9/82, 9/84, 9/86
Rose Lake	3/68	6/73	monthly 6/73, 8/73, 7/74,10/76, 7/77, 9/79
Springston			6/73, 7/74
near Mouth			9/66, 1/71
EPA (10EPACOP)[a]			
Rose Lake	10/80	9/81	monthly

[a]STORET agency code.

Table 2-2. Dissolved Metal Concentrations (μg/l) at Cataldo.

DATE	CADMIUM	LEAD	MERCURY	ZINC
11/86	4	< 5	0.1	860
03/87	2	< 5	0.3	310
05/87	2	13	< 0.1	260
09/87	4	< 5	0.1	640
03/88	2	< 5	0.2	240
05/88	2	< 5	0.1	280

Source: USGS (taken from STORET).

Table 2-3. Yearly Observed Mean Metal Concentrations (μg/l) at Cataldo[1].

YEAR	CADMIUM	LEAD	MERCURY	ZINC
70	32.0 (1)	98.75 (4)	3.17 (3)	3136.7 (3)
71	14.7 (3)	240.0 (3)	1.73 (3)	1186.7 (3)
72	43.0 (7)	55.0 (8)	2.57 (7)	2754.8 (8)
73	23.8 (7)	87.1 (7)	2.30 (7)	1421.4 (7)
74	8.3 (3)	40.0 (3)	0.17 (3)	784.6 (3)
75	21.0 (2)	35.0 (2)		2450.0 (2)
76	25.0 (4)	25.0 (4)	0.06 (4)	3290.0 (4)
79	6.8 (4)	9.0 (4)	0.60 (4)	1650.0 (4)
80	11.0 (1)	10.0 (1)	0.07 (1)	1210.0 (1)
82	5.7 (3)	14.5 (2)	0.07 (3)	1105.3 (3)
84	9.4 (2)	1.6 (2)	0.05 (2)	826.5 (2)
AVG	22.2 (38)	62.0 (41)	1.41 (37)	1913.0 (41)

Source: Woodward-Clyde Consultants and TerraGraphics, 1986.
[1]Values in parentheses indicate how many measured concentrations were used to calculate the mean concentration given.

Table 2-4. Yearly Observed Mean Metal Concentrations ($\mu g/l$) at Rose Lake[1].

YEAR	CADMIUM		LEAD		MERCURY		ZINC	
70	33.0	(1)	97.5	(4)	1.83	(3)	2526.7	(3)
71	36.2	(6)	121.7	(6)	0.92	(5)	1890.0	(6)
72	24.6	(15)	148.6	(15)	3.47	(15)	2280.0	(16)
73	42.5	(8)	108.8	(8)	1.82	(8)	2497.5	(8)
74	20.6	(28)	274.8	(28)	0.45	(25)	1512.1	(28)
75	22.6	(19)	200.0	(19)	0.5	(19)	1319.0	(19)
76	23.1	(12)	146.8	(16)	0.66	(16)	2008.2	(16)
77	25.8	(12)	180.2	(12)	0.58	(12)	1375.0	(12)
78	17.1	(12)	78.1	(12)	0.12	(12)	1171.7	(12)
79	4.9	(2)	105.8	(14)	0.27	(14)	1233.6	(14)
80			129.0	(11)	0.44	(11)	1456.4	(11)
81			50.0	(8)	0.27	(9)	781.1	(9)
AVG	24.2	(119)	159.9	(153)	0.86	(149)	1596.0	(154)

Source: Woodward-Clyde Consultants and TerraGraphics, 1986.
[1]Values in parentheses indicate how many measured concentrations were used to calculate the mean concentration given.

Table 2-5. Metal Concentrations ($\mu g/l$) at Killarney and Thompson Lakes, July, 1989.

Location	Cadmium	Copper	Lead	Zinc	Mercury
KL-W-1[1]	--	--	--	167	0.9
KL-W-2[1]	7	--	230	679	N/A[3]
TL-W-1[2]	--	--	7000	246	N/A[3]

Source: Weston, 1989
[1]Wetland area east of Killarney Lake
[2]Along northern shore of Thompson Lake
[3]Not analyzed

Table 2-6. Federal Water Quality Criteria for Protection of Freshwater Aquatic Organisms.

Metals	Chronic Toxicity (µg/l)	Acute Toxicity (µg/l)
Cadmium	0.66[a]	1.8[a]
Lead	1.3[a]	34[a]
Mercury	0.012	2.4
Zinc	59[a]	65[a]

Source: EPA (1986, 1987)
[a]Based on hardness of 50 mg/l as $CaCO_3$

Table 2-7. Federal Drinking Water Standards (µg/l).

Metal	
Cadmium	10
Mercury	2
Lead	50
Zinc	5,000[a]

Source: EPA (1976)
[a]secondary standard

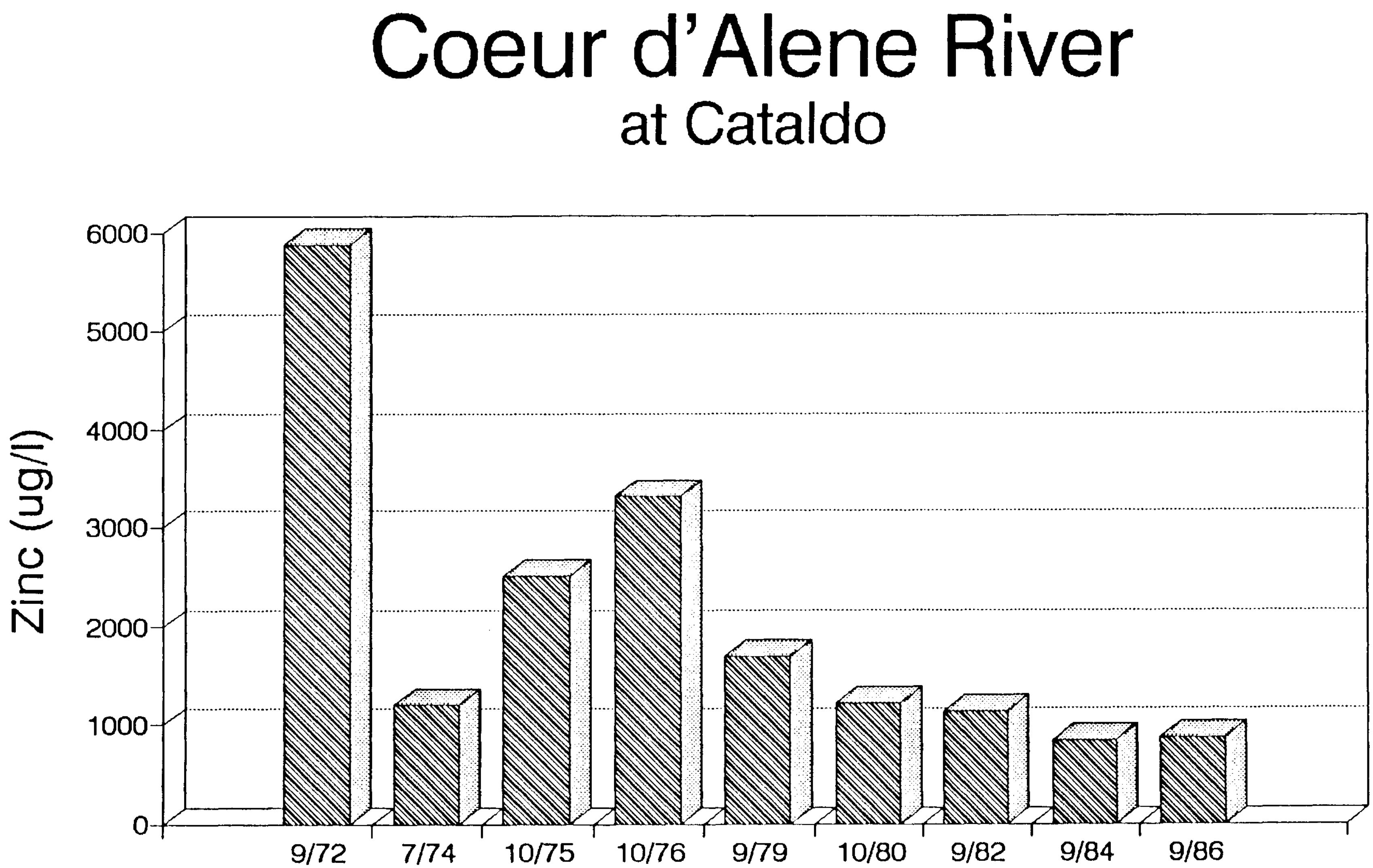

Figure 2-1. Zinc concentration in the Coeur d'Alene River at Cataldo during low flow.

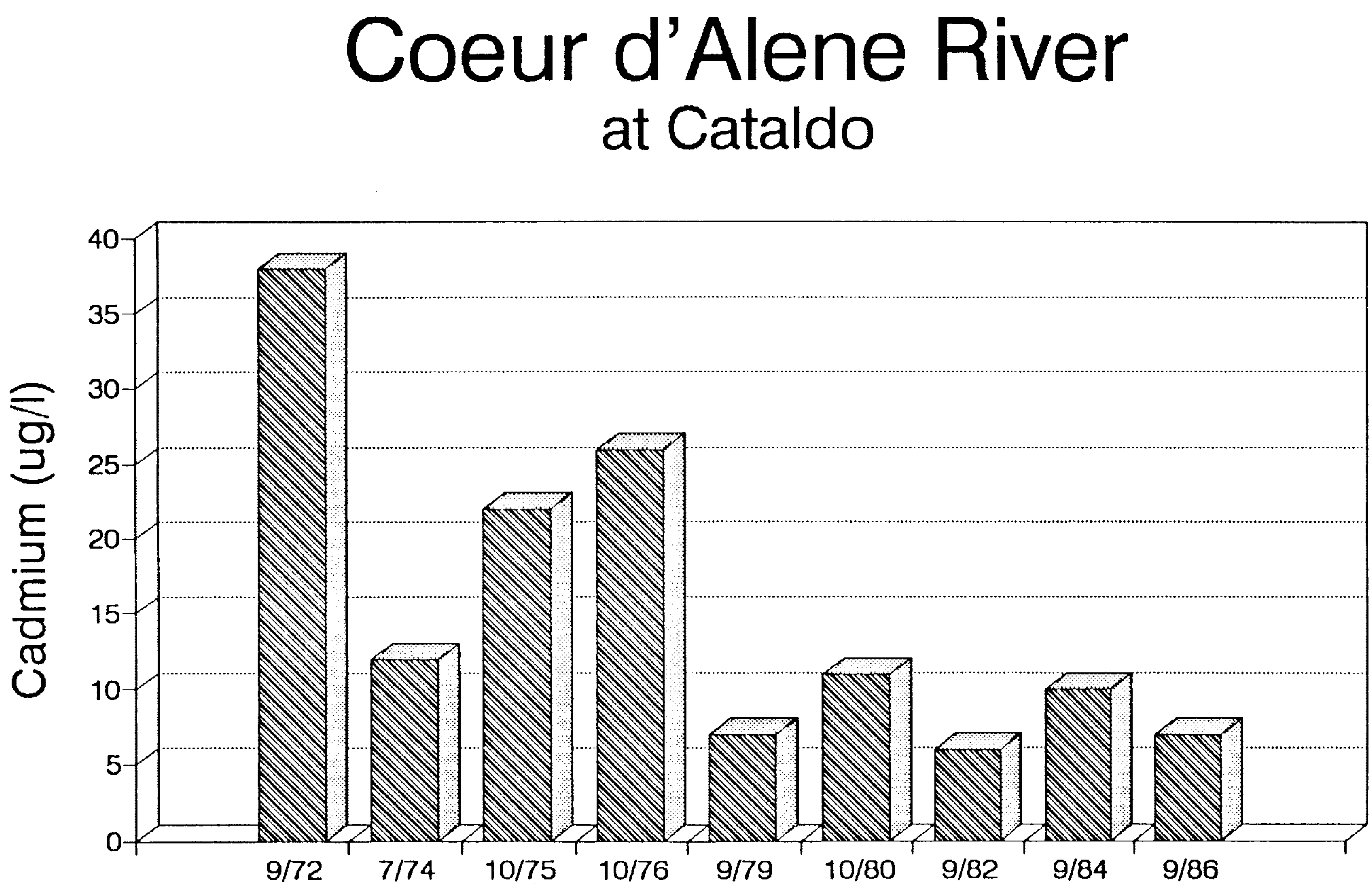

Figure 2-3. Cadmium concentration in the Coeur d'Alene River at Cataldo during low flow.

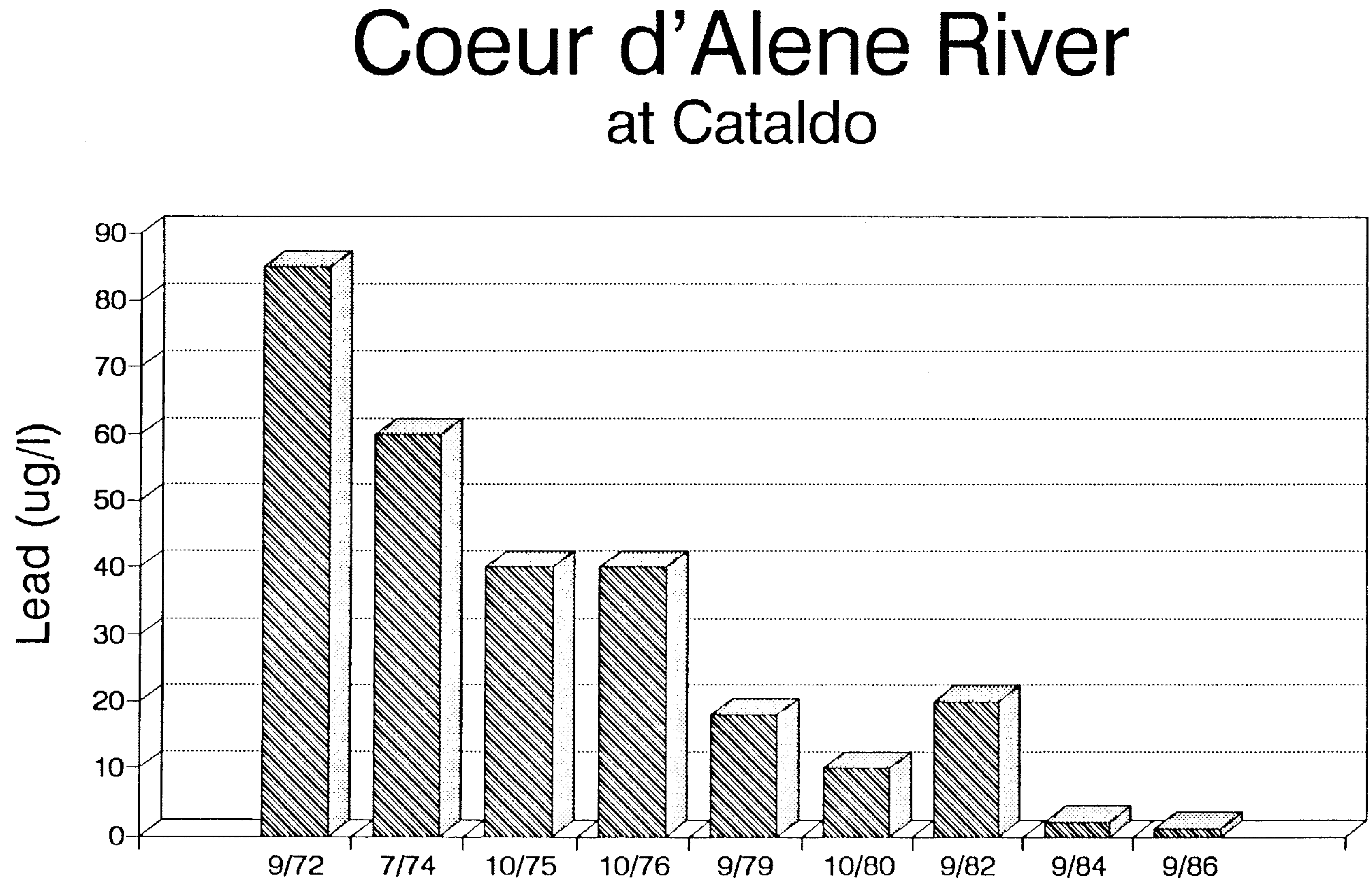

Figure 2-2. Lead concentration in the Coeur d'Alene River at Cataldo during low flow.

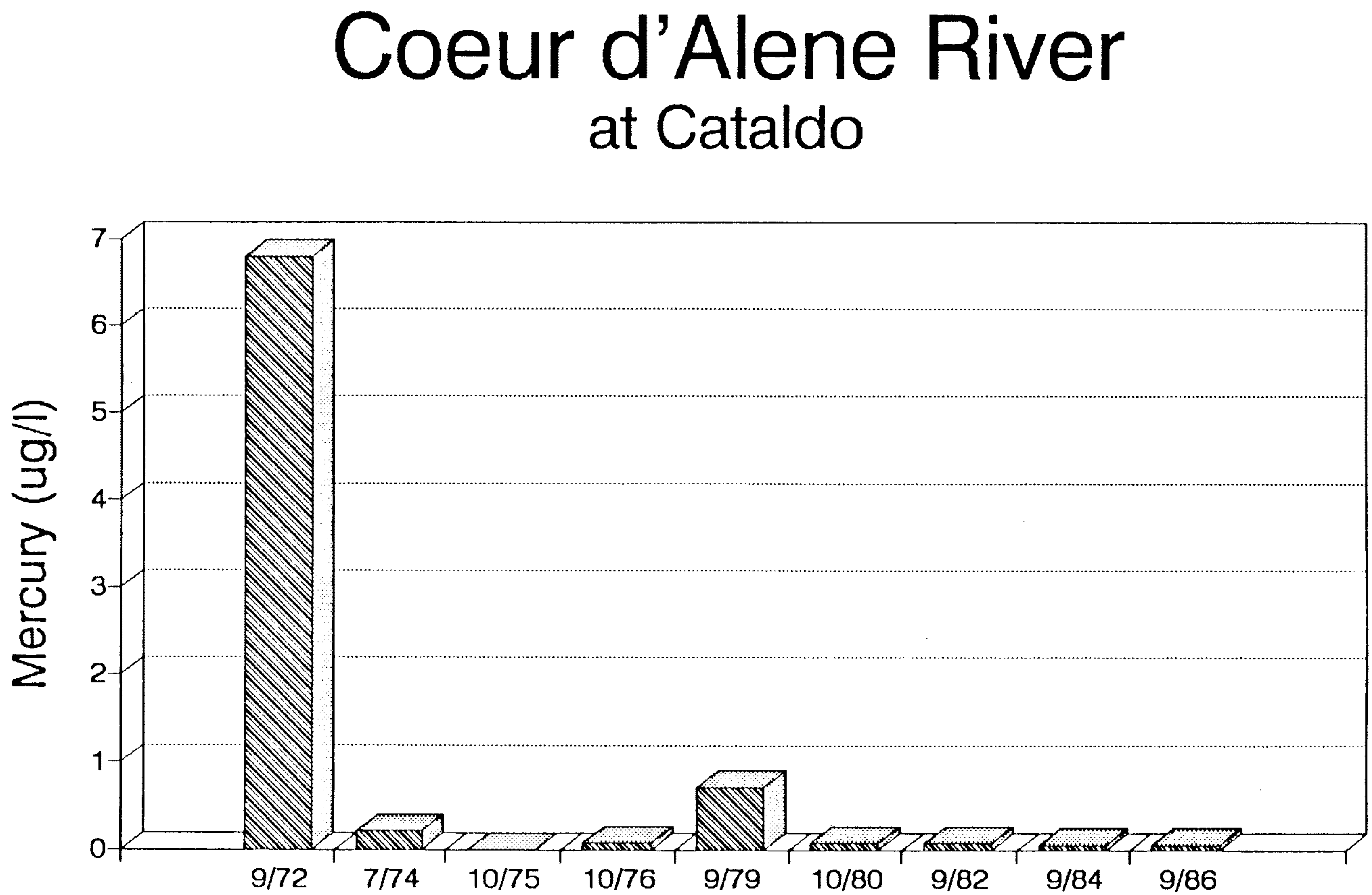

Figure 2-4. Mercury concentration in the Coeur d'Alene River at Cataldo during low flow.

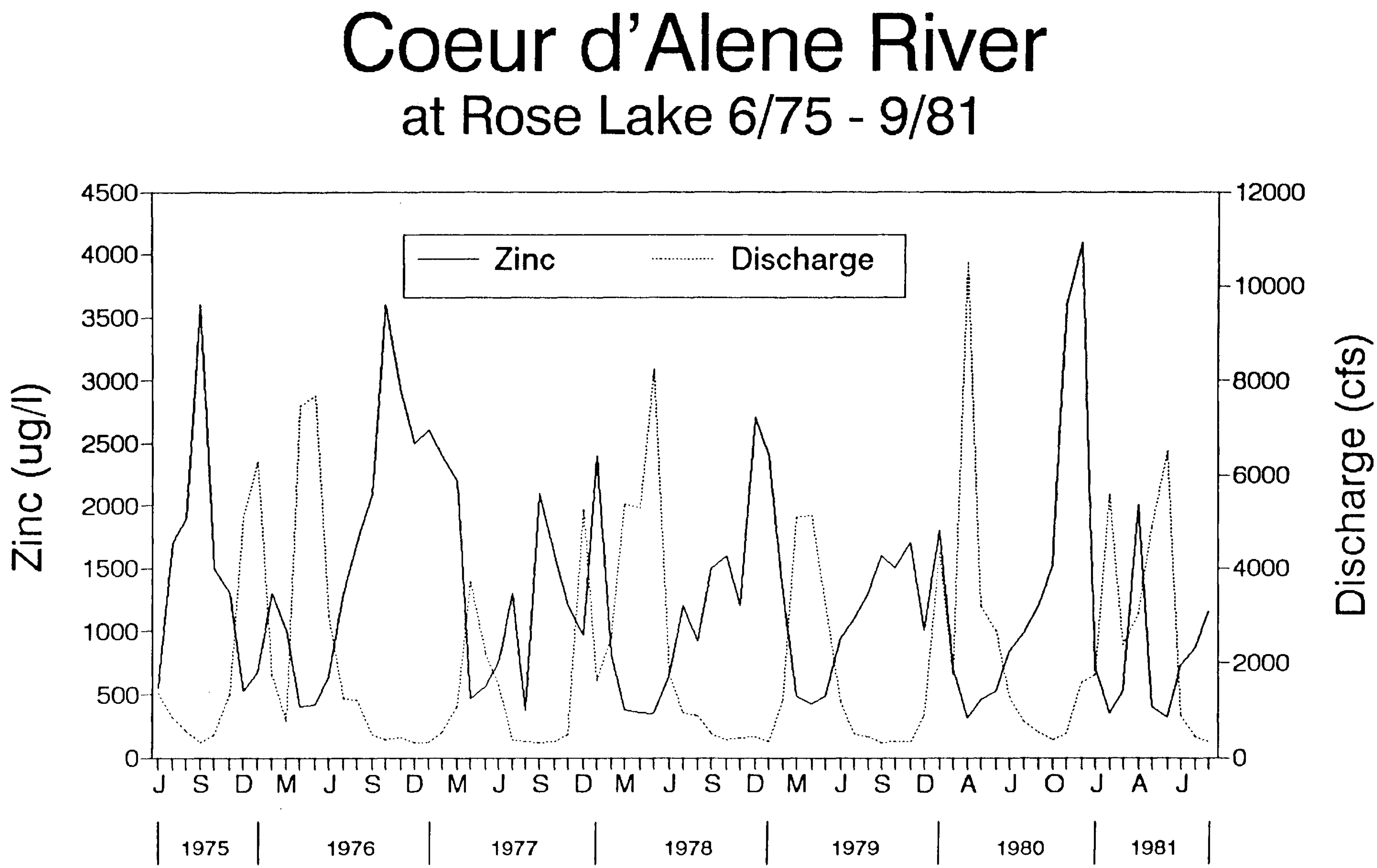

Figure 2-5. Zinc and discharge in the Coeur d'Alene River at Rose Lake.

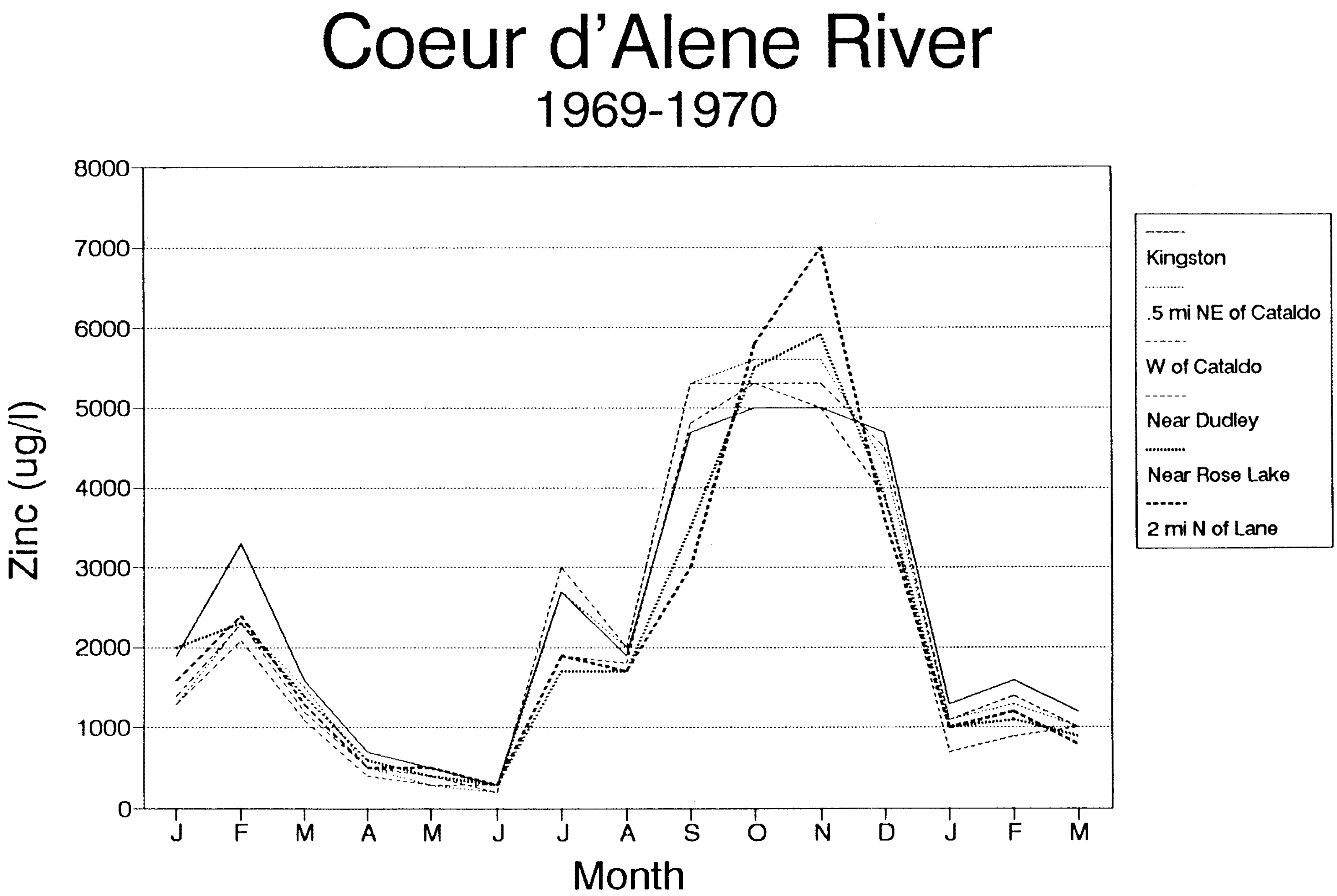

Figure 2-6. Zinc concentration in the Coeur d'Alene River.

3. Check Characterization Sampling

A previous investigation performed by Weston for the BLM showed high concentrations of cadmium, lead, mercury, and zinc near Killarney Lake, and high concentrations of lead and zinc in Thompson Lake (Weston, 1989). To verify and further characterize the presence of these heavy metals, GSA developed a sampling plan and collected samples from four sites at Killarney and Thompson Lakes. The sampling and results are discussed in the following sections.

3.1 Sampling Plan

The purpose of the check characterization sampling was primarily to verify the metal concentrations found in water samples during a BLM site investigation conducted by Weston. In order to provide the best comparison, GSA selected sampling sites that were at or near the locations sampled by Weston in the summer of 1988. The GSA sampling plan called for three rounds of samples at four sites, with a minimum of two weeks between rounds. Based on Weston's sample results and a GSA review of EPA Storet data, cadmium, lead, mercury, and zinc were identified as the constituents to be analyzed.

3.1.1 Site Locations

Samples were collected from one site at Thompson Lake and from three sites at Killarney Lake. The Thompson Lake site (TL-1) was located along the northern shore of the lake. This site is not located on BLM land, but is considered to be representative of the lake conditions. This is the same location that was sampled by Weston. The location of this site is shown in Figure 3-1.

Of the three sites at Killarney Lake, one was located near the boat ramp (KL-1), and two were located in the wetlands east of Killarney Lake. The two wetland sites were located in the main channel west of the dike (KL-2) and near a man-made island west of the dike (KL-3). The locations of the three Killarney sites are shown in Figure 3-2. The man-made islands were constructed by the Idaho Department of Fish and Game to provide waterfowl habitat. Approximately 509 of these islands were constructed in the Killarney wetland area (Weston, 1989). These islands were constructed from dredged sediment, suspected to contain heavy metals from mine tailings transported from the Silver Valley via the CDAR.

The two wetland sites correspond to the locations of Weston's Killarney Lake samples. The boat ramp site was included in addition to the locations sampled by Weston to provide a comparison with Thompson Lake and to determine if differences exist in metal concentrations between Killarney Lake and the wetland area.

3.1.2 Sample Analyses

Sample analyses were conducted both in the field and in the laboratory of Precision Analytics, Inc. (PAI) in Pullman, Washington. Field measurements included pH, specific conductance, water temperature, and air temperature. Specific conductance and pH measurements were made with a portable pH/Conductivity meter. The instrument was calibrated with standard solutions according to the manufacturer's instructions before each use.

The concentrations of total recoverable cadmium, lead, and zinc were determined in the laboratory with an Atomic Absorption Spectrophotometer (AAS) using flame and graphite furnace procedures. Total recoverable mercury was analyzed by the Cold Vapor Technique. These analyses were performed by the following EPA procedures:

- cadmium (EPA 213.2),
- lead (EPA 239.2),
- mercury (EPA 245.1), and
- zinc (EPA 289.2).

3.1.3 Sampling Procedures

A grab sample, from just below the water surface, was collected at each site. Each sample was collected in two preacidified 1-liter plastic bottles. The containers were prepared at the PAI laboratory and shipped to the GSA office in Coeur d'Alene. The container preparation consisted of a 1:1 nitric acid rinse-reverse osmosis deionized water rinse. Nitric acid was then added to each bottle, in accordance with the Standard Methods for the Examination of Water and Wastewater (American Public Health Association, 1986), to stabilize the metals in the collected sample. The collected samples were not filtered.

Sampling at each site was documented on a surface-water sampling form. Information recorded on the sampling form included sample location, date and time of sampling, the sampler's initials, weather conditions, pH, specific conductance, water temperature, air temperature, and general observations.

After collection, the sample containers were labeled, the lids were taped, and the containers were packed in ice. The samples were then transported to the PAI laboratory. In the laboratory, the samples were stored a 4°C until analyzed.

3.2 Sampling Results

A total of thirteen water samples were collected from the four sites included in GSA's sampling plan. These samples were collected between December 6, 1989 and January 22, 1990. During this period, a wide variety of flow conditions were observed. As noted in Section 2, the water level in the CDAR appears to have a significant effect on the concentration of certain metals. This will play an important role in the interpretation of the sampling results.

3.2.1 Field Results

The results of the field measurements are shown in Table 3-1 and Figures 3-3 and 3-4. Table 3-1 shows that the pH ranged from 6.5 to 9.1 with an average of about 8, while the specific conductance ranged from 28 to 134 μmho. Figure 3-3 shows that, while the magnitude of pH varied between the sites, similar patterns of highs and lows were observed. This is especially true for KL-1 and TL-1.

Figure 3-4 shows the specific conductance measured at each site. The specific conductance at the three Killarney Lake sites showed very similar behavior. The pattern of lows and highs for the Killarney Lake sites also roughly corresponds to the observed water levels. The measurements taken on December 6, 1989 were taken at a very high water level. Flooding on the CDAR had caused the lake to rise to a high level, flooding the entire wetland area. This prevented samples from being collected at sites KL-2 and KL-3. On January 3, 1990, the water level was very low. The dock at the Killarney Lake boat ramp was laying almost entirely on the lake bottom. The change in water level at the boat ramp between December 6 and January 3 was approximately nine feet.

During the sampling rounds on December 20, 1989 and January 22, 1989, the water surface was at a moderate level. The specific conductance measurements at the Killarney Lake boat ramp (KL-1) were lowest during the high flow (December 6), increased as the water level decreased (December 20), reached the highest reading during the lowest observed water level (January 3), and then decreased as the water level rose (January 22). A similar pattern occurred in the Killarney wetlands. Thompson Lake followed the same pattern for the first two sampling rounds, but showed a low reading on the same day that Killarney reached the highest specific conductance readings. The water level at Thompson did not fluctuate as much as at Killarney.

As shown in Table 3-1, the water temperature ranged from 32°F to 41°F, with an average of about 34°F. On several occasions, the water surface was frozen at the sites. When this occurred, the ice was carefully broken and removed with as little disturbance to the water as possible, and the sample was collected in the normal manner. The air temperature during the sampling period ranged from 28°F to 41°F.

3.2.2 Laboratory Results

As previously stated, the analyses of metallic constituents were performed in the PAI laboratory in Pullman, Washington. The results of the metals analyses are shown in Table 3-2 and Figures 3-5 through 3-7. The results for each metal are described individually in the following sections.

3.2.2.1 Lead

The total lead concentrations for each of the four sites are shown in Table 3-2 and Figure 3-5. All of the samples exceeded the federal water quality criteria for chronic and acute toxicity, as shown in Table 2-6. The Federal Drinking Water Standard for lead, as shown in Table 2-7, was exceeded in 11 of the 13 samples. Figure 3-5 shows a large variation in lead concentration between the sites. The samples collected from the Killarney wetlands (KL-2 and KL-3) show the highest lead concentrations, while Thompson Lake had the lowest concentrations.

In Section 2.2, it was suggested that lead concentrations in the CDAR were highest during periods of high flow and lowest during periods of low flow. This trend appears to somewhat hold for site KL-1. The first sample from site KL-

1 was collected during the high water and contained the highest lead level observed at the site. As the water level decreased after the flooding, the lead level also decreased. The pattern of lead concentrations in the Killarney wetlands appears to be the opposite. The highest lead concentrations at the wetland sites occurred during the lowest water level (January 3). This may be a result of prolonged exposure of the relatively still, shallow water (approximately 0.5 feet at KL-3) to sediments suspected of being contaminated with heavy metals. Ground water may also have an effect on metal concentrations during low surface-water levels.

3.2.2.2 Cadmium

The total cadmium concentrations for each of the sites are shown in Table 3-2 and Figure 3-6. Twelve of the thirteen samples collected showed cadmium levels above the detection limit of 1 μg/l and exceeded federal water quality criteria for chronic toxicity (Tables 3-2 and 2-6). Eleven of the samples exceeded the criteria for acute toxicity (Tables 3-2 and 2-6). The Federal Drinking Water Standard for cadmium, shown in Table 2-7, was equalled or exceeded in 4 of the 10 samples from Killarney Lake. Cadmium levels in Thompson Lake were well below drinking water standards. Cadmium levels in the Killarney wetlands were lowest while the water level was low (January 3).

3.2.2.3 Zinc

The total zinc concentrations for each of the sites are shown in Table 3-2 and Figure 3-7. The zinc concentrations exceeded the federal acute toxicity criteria in all ten samples collected at Killarney Lake. Of the three Thompson Lake samples, two exceeded the acute toxicity for zinc and one was below the chronic level. The drinking water standard for zinc was not exceeded in any of the 13 samples.

As with the case of lead, the zinc concentration at site KL-1 appears to follow the pattern suggested Section 2. Previous studies indicate that the concentration of zinc is low during periods of high flow and high during periods of low flow. The lowest zinc concentration was found on December 6 during a flood event. The zinc concentration then increased as the water level decreased from December 20 to January 3, and then decreased as the water level rose, as observed on January 22. Again, as with the case of lead, the zinc concentration pattern appears to be the opposite in the Killarney wetlands. The lowest zinc concentrations in the wetlands were observed on January 3, which corresponds to the lowest observed water level. The sampling rounds before and after January 3 were conducted during higher water levels and resulted in higher zinc concentrations.

3.2.2.4 Mercury

Mercury was not found above the detection limit of 1 μg/l in any of the thirteen samples.

3.2.3 Quality Assurance/Quality Control

During the laboratory analyses, strict quality assurance/quality control procedures were followed. These procedures include strict observance of EPA procedures, chain of custody, and the analysis of duplicate and spike samples.

Mercury spike samples, containing a concentration of 10 μg/l, were analyzed with the regular samples from December 6, January 3, and January 22. The percent recovery of mercury in these samples ranged from 80 to 109 percent with an average of about 90 percent. The results of these samples are shown in Table 3-3. In addition, duplicates of the mercury samples analyzed by PAI were also analyzed at ABC Laboratory in Spokane, Washington. The results of these samples are shown in Table 3-4

Just prior to the laboratory analyses of the first round of samples, problems were encountered that prevented the use of a graphite furnace at the PAI laboratory. Instead, the analyses of lead, cadmium, and zinc were performed in laboratories at the University of Idaho and Washington State University. These analyses were performed using the equipment and procedures specified in the sampling plan and approved by the BLM. Since the analyses were performed in two different laboratories, extra duplicate samples were analyzed for comparison purposes. The results of these duplicate samples are shown in Table 3-5. The metal concentrations determined at Washington State University were typically higher than those determined at the University of Idaho, although the two generally agreed.

3.3. Comparisons with Previous Work

The data collected by GSA during the check characterization sampling were compared with data from the BLM's site investigation by Weston (1989) and also with data reported by Bauer (1974) and Krieger (1989).

3.3.1 Killarney Lake

The data from this study generally compare well with that collected by Weston. The site located at the Killarney Lake boat ramp was not considered in this comparison because it did not correspond to the sites sampled by Weston. While the lead concentrations from this study in the Killarney wetlands ranged from 105 to 470 μg/l, the average of the six samples was 234 μg/l. This agrees with the value of 230 μg/l reported by Weston. Cadmium levels from this study ranged from 3 to 12 μg/l, with an average of 7.8, which compares well with the value of 7 μg/l reported by Weston. Zinc concentrations from this study ranged from 340 to 1890 μg/l in the Killarney wetlands, with an average of 1,118 μg/l. This is higher than the values of 167 and 679 μg/l reported by Weston. Since Weston's samples were collected in the summer (July) and GSA's were collected in the winter (December and January), differences in the water level could be responsible for the difference in the concentrations.

Bauer (1974) reported a zinc concentration of 220 μg/l in the spring of 1973 from a station located approximately in the middle of Killarney. This is considerably lower than the concentrations found in this study at the Killarney Lake boat ramp. High water levels could possibly be responsible for this lower zinc level. Bauer reported that the lake was not flooded by the CDAR in the spring of 1973, but that the river did reach bank level causing river water to flow into the lake via the inlet channel. The additional water from the river may have caused a dilution effect, resulting in lower zinc concentrations.

Krieger (1989) reported a lead concentration of 130 μg/l in Killarney near the boat ramp. This sample was collected in July of 1989. The samples collected by GSA at this location contained lead ranging from 85 to 285 μg/l, with an average of 132.5 μg/l for four samples, which compares well with Krieger's data.

3.3.2 Thompson Lake

The zinc concentrations found at Thompson Lake during this study ranged from 30 to 350 μg/l, with an average of 210 μg/l. This agrees with the value of 246 μg/l reported by Weston.

Bauer (1974) reported a zinc concentration of 60 μg/l at a station in Thompson Lake near the location sampled by GSA and Weston. This is within the range of values observed by GSA, but lower than the average of 210 μg/l. Bauer's sample was collected in the spring of 1973 during a high water level.

The lead concentrations found in this study at Thompson Lake ranged from 35 to 50 μg/l with an average of 43 μg/l. This is well below the lead concentration of 7,000 μg/l reported by Weston. As stated in Section 2.2, compared to other studies, it is likely that this extremely high value is the result of a sampling or analysis error.

Krieger (1989) reported a lead concentration of 6 μg/l in a sample collected in July of 1989 from the north shore of Thompson lake. This is considerably lower than the average of 43 μg/l from this study.

Table 3-1. Field Water Quality Measurements at Killarney and Thompson Lakes.

Location	Date	pH	Elec. Cond. Imho	Temperature °F Water	Air
KL-1	12/06/89	8.3	28	39	42
	12/20/89	7.0	110	34	39
	01/03/90	9.1	120	32	28
	01/22/90	8.8	70	34	36
KL-2	12/20/89	7.4	107	32	39
	01/03/90	8.0	111	32	28
	01/22/90	8.3	65	32	36
KL-3	12/20/89	7.3	103	33	39
	01/03/90	8.4	134	32	28
	01/22/90	8.8	100	33	36
TL-1	12/06/89	8.7	43	41	39
	12/20/89	6.5	95	35	37
	01/03/90	7.6	43	32	31

Table 3-2. Total Recoverable Metal Concentrations (μg/l) at Killarney and Thompson Lakes.

Location	Date	Lead	Cadmium	Zinc	Mercury
KL-1	12/06/89	285	3	410	ND
	12/20/89	70	13	1400	ND
	01/03/90	90	8	1540	ND
	01/22/90	85	5	1100	ND
KL-2	12/20/89	190	7	1640	ND
	01/03/90	325	3	610	ND
	01/22/90	150	10	1020	ND
KL-3	12/20/89	105	12	1890	ND
	01/03/90	470	5	340	ND
	01/22/90	165	10	1210	ND
TL-1	12/06/89	50	2	250	ND
	12/20/89	45	1	350	ND
	01/03/90	35	ND	30	ND
Detection Limit		5	1	5	1

ND = not detected

Table 3-3. Mercury Spike Quality Control Samples.

Location	Date	10 μg/l Spike Concentration	Percent Recovery
KL-1	12/06/89	9.0	90
	01/03/90	8.1	81
	01/22/90	10.4	104
KL-2	01/03/90	8.0	80
	01/22/90	10.1	101
KL-3	01/03/90	8.2	82
	01/22/90	10.9	109
TL-1	12/06/89	8.5	85
	01/03/90	8.1	81

Table 3-4. Inter-Laboratory Quality Control Duplicates for Mercury

Sample	Date	Precision Analytics	ABC Laboratory
KL-1	12/20/89	ND	ND
KL-2	12/20/89	ND	ND
KL-3	12/20/89	ND	ND
TL-1	12/20/89	ND	ND

ND = not detected

Table 3-5. Inter-Laboratory Quality Control Duplicates for Lead, Cadmium, and Zinc (µg/l).

Metal	Sample	Date	University of Idaho	Washington State Univ.
Lead	KL-1	1/3/90	89	109
	KL-2	1/3/90	324	348
	KL-3	1/3/90	472	528
	Tl-1	1/3/90	47	43
Cadmium	KL-1	1/3/90	8	8
	KL-2	1/3/90	3	4
	KL-3	1/3/90	5	6
	TL-1	1/3/90	ND	ND
Zinc	KL-1	1/3/90	1540	1680
	KL-2	1/3/90	610	850
	KL-3	1/3/90	340	350
	TL-1	1/3/90	29	19

ND = not detected

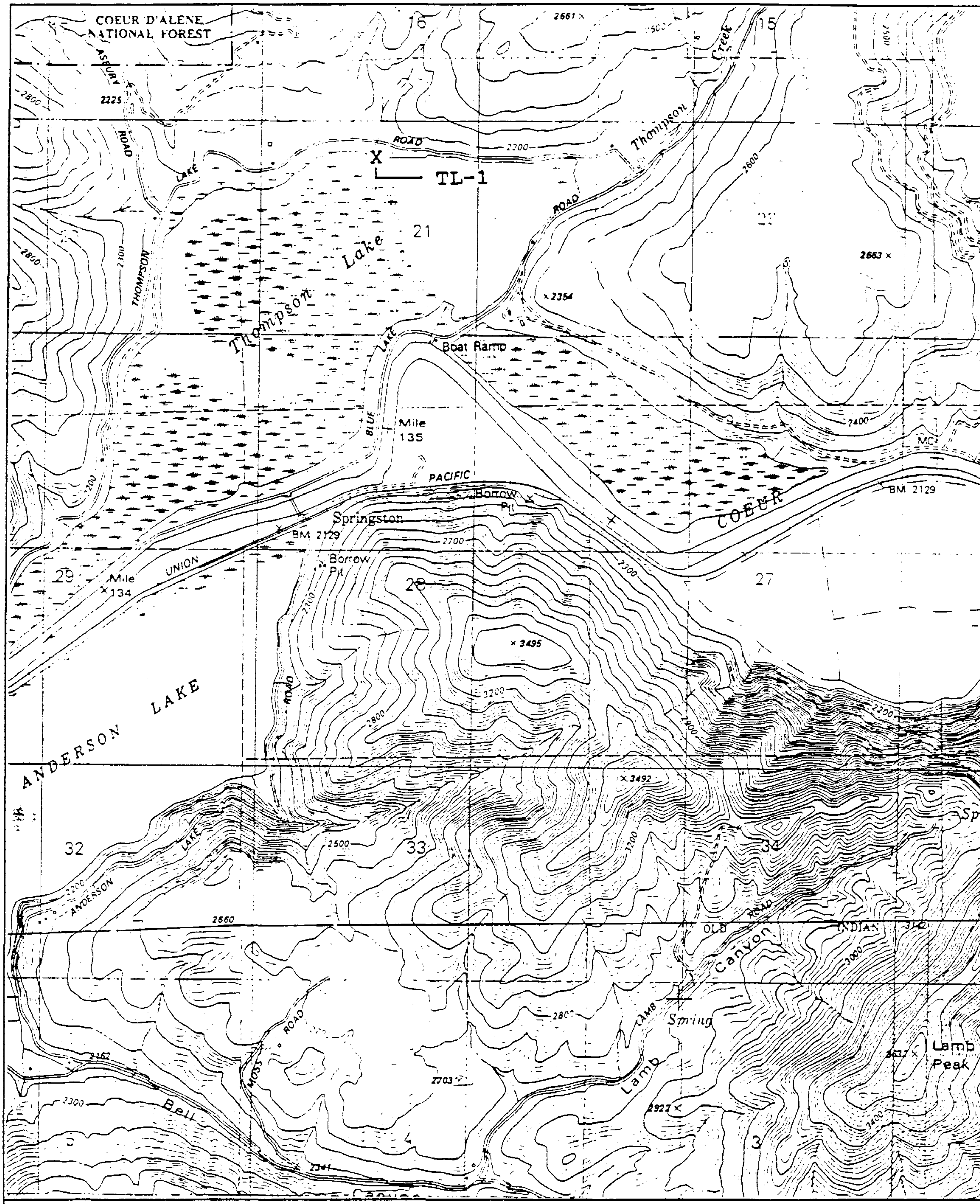

Figure 3-1. Thompson Lake check characterization sampling sites.

X - Approximate location of sampling site

Scale: 1 inch = 2,000 feet

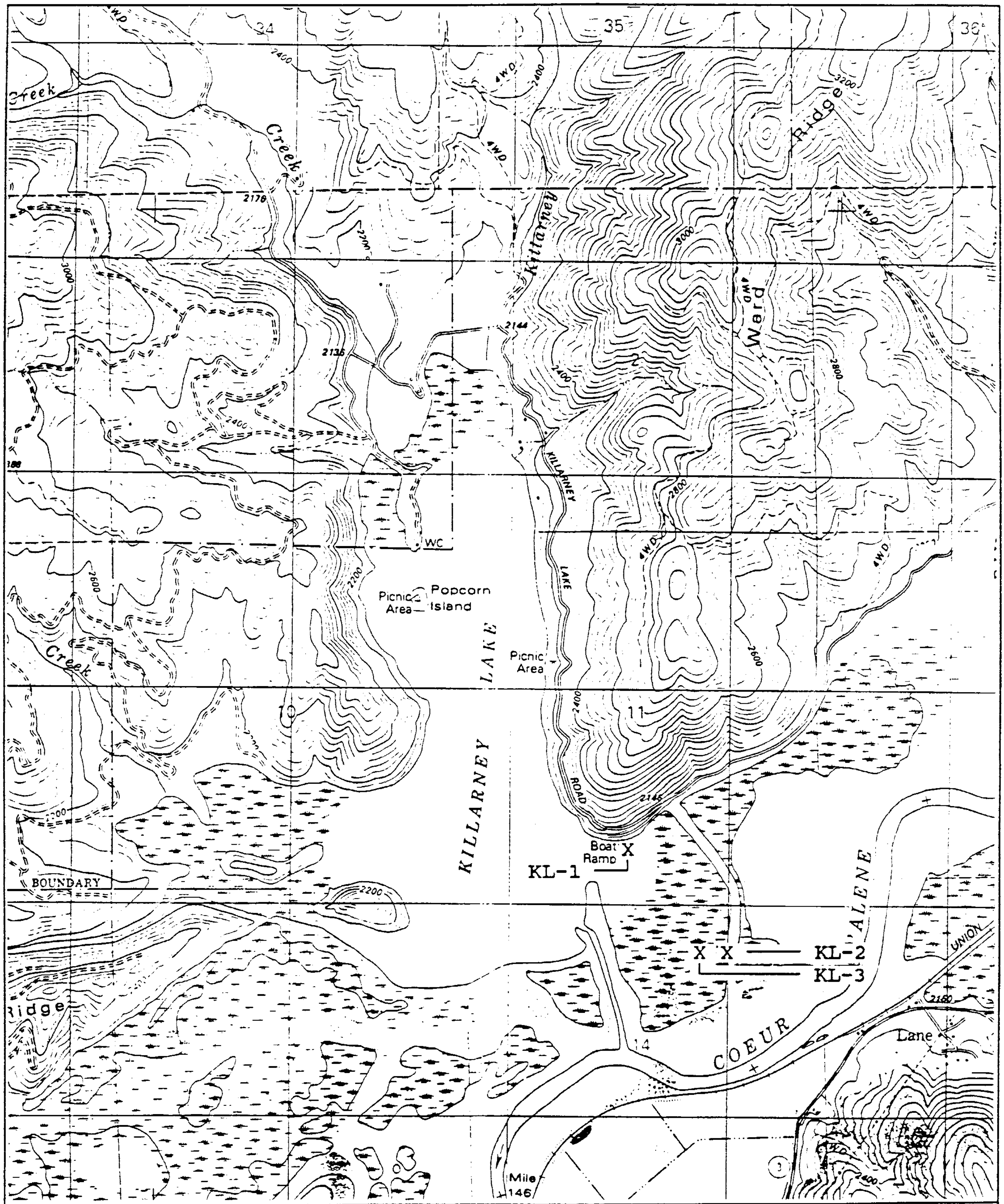

Figure 3-2. Killarney Lake check characterization sampling sites.

X - Approximate location of sampling site

Scale: 1 inch = 2,000 feet

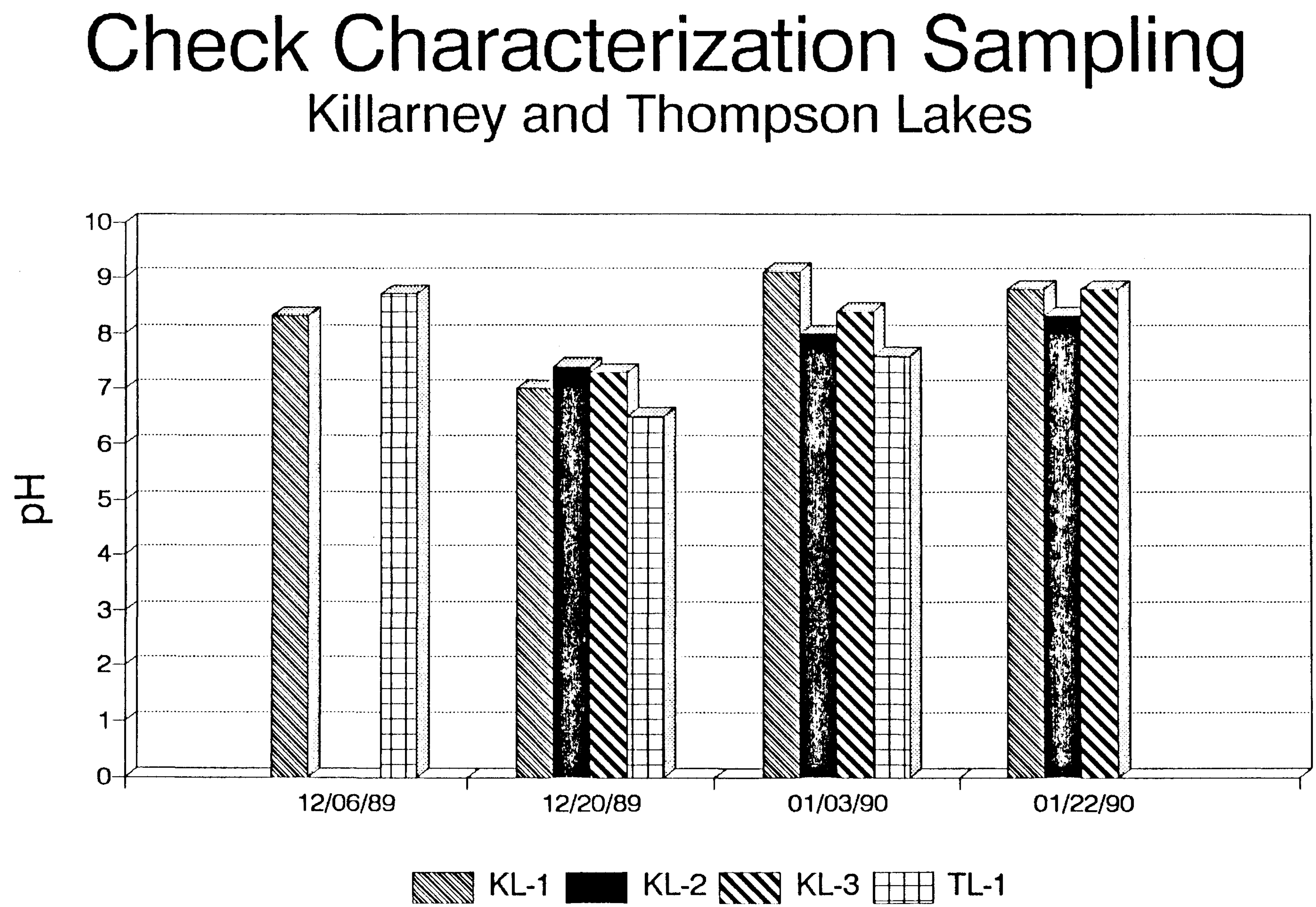

Figure 3-3. Results of pH measurements at Killarney and Thompson Lakes.

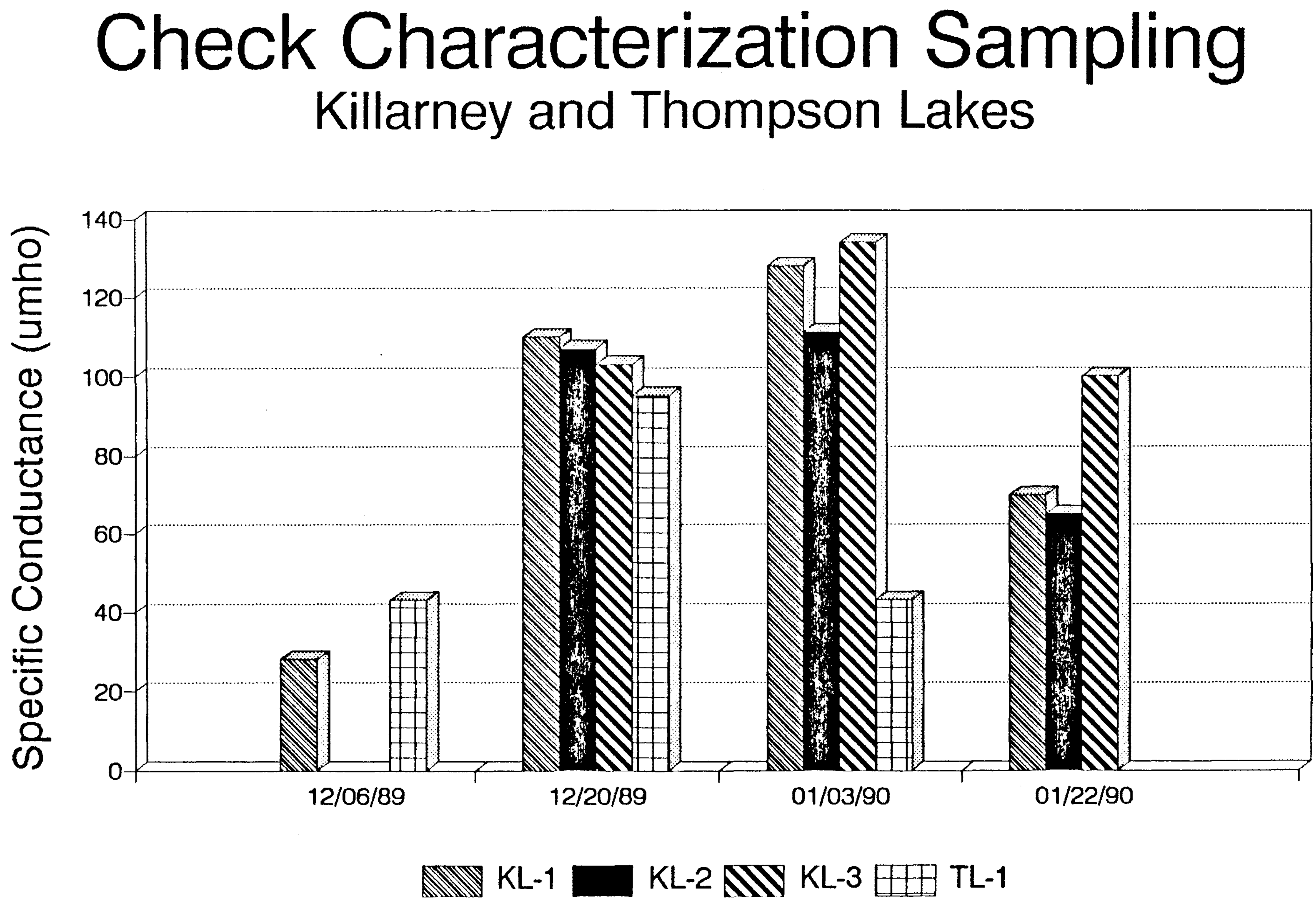

Figure 3-4. Results of specific conductance measurements at Killarney and Thompson Lakes.

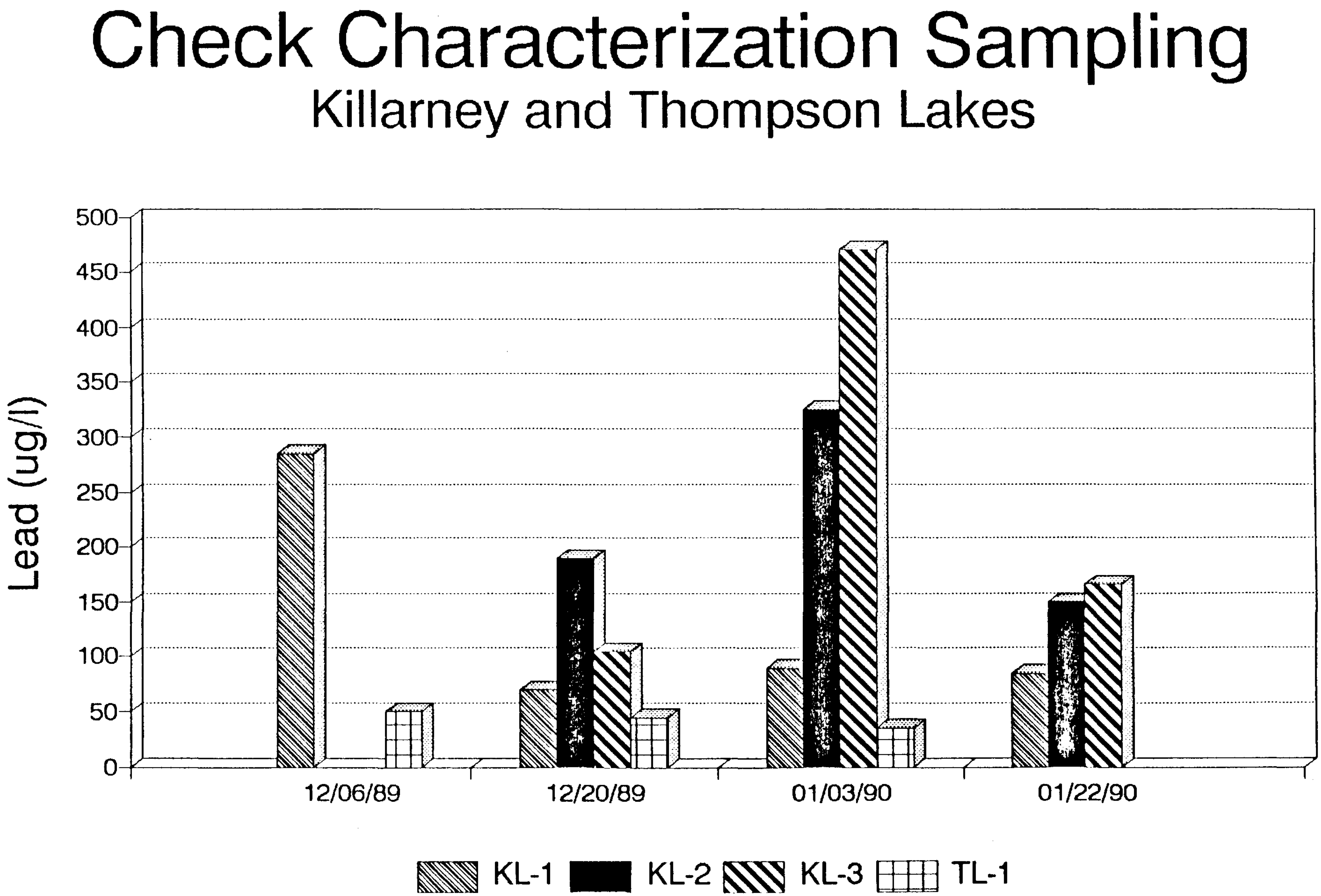

Figure 3-5. Lead concentrations at Killarney and Thompson Lakes.

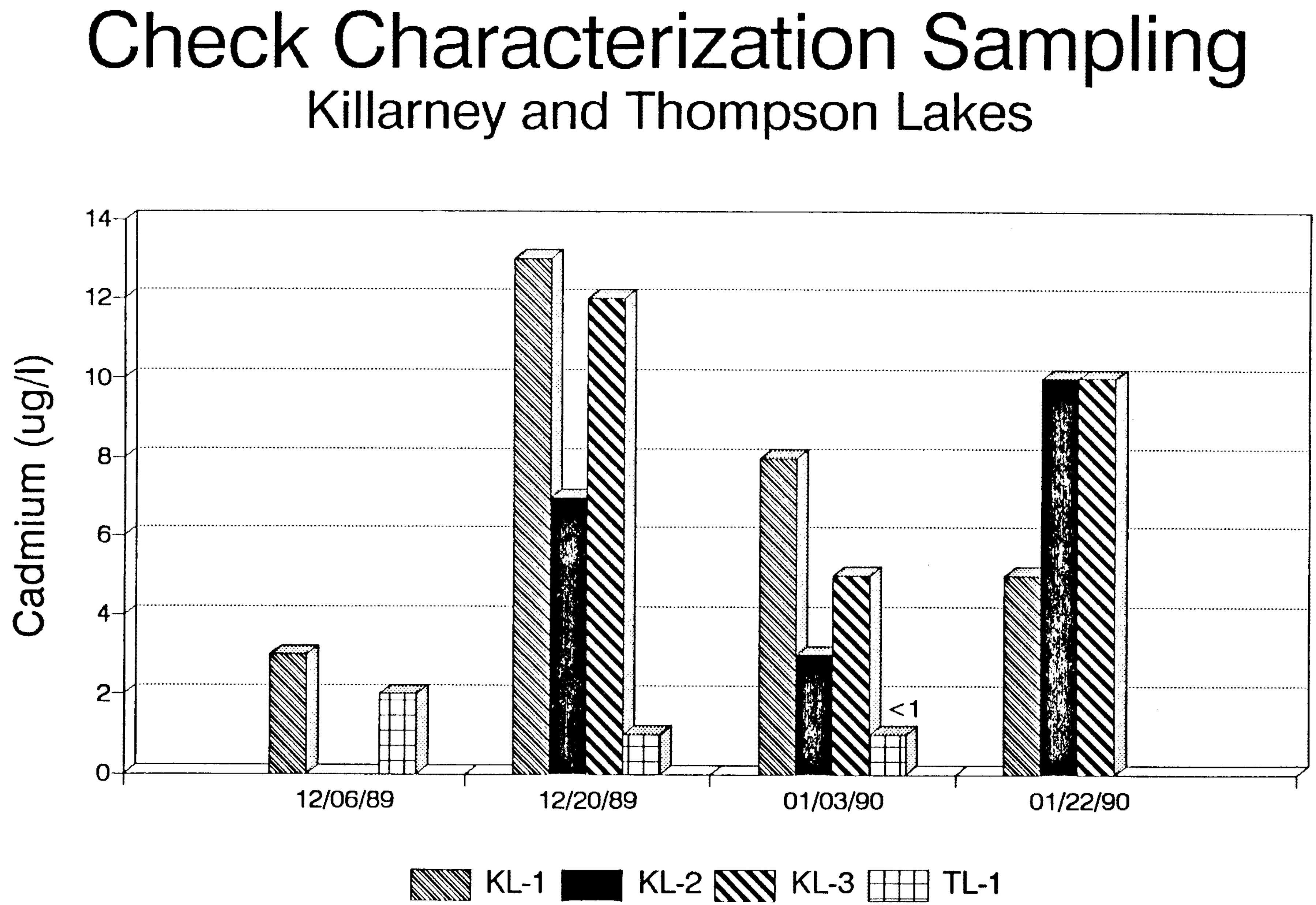

Figure 3-6. Cadmium concentrations at Killarney and Thompson Lakes.

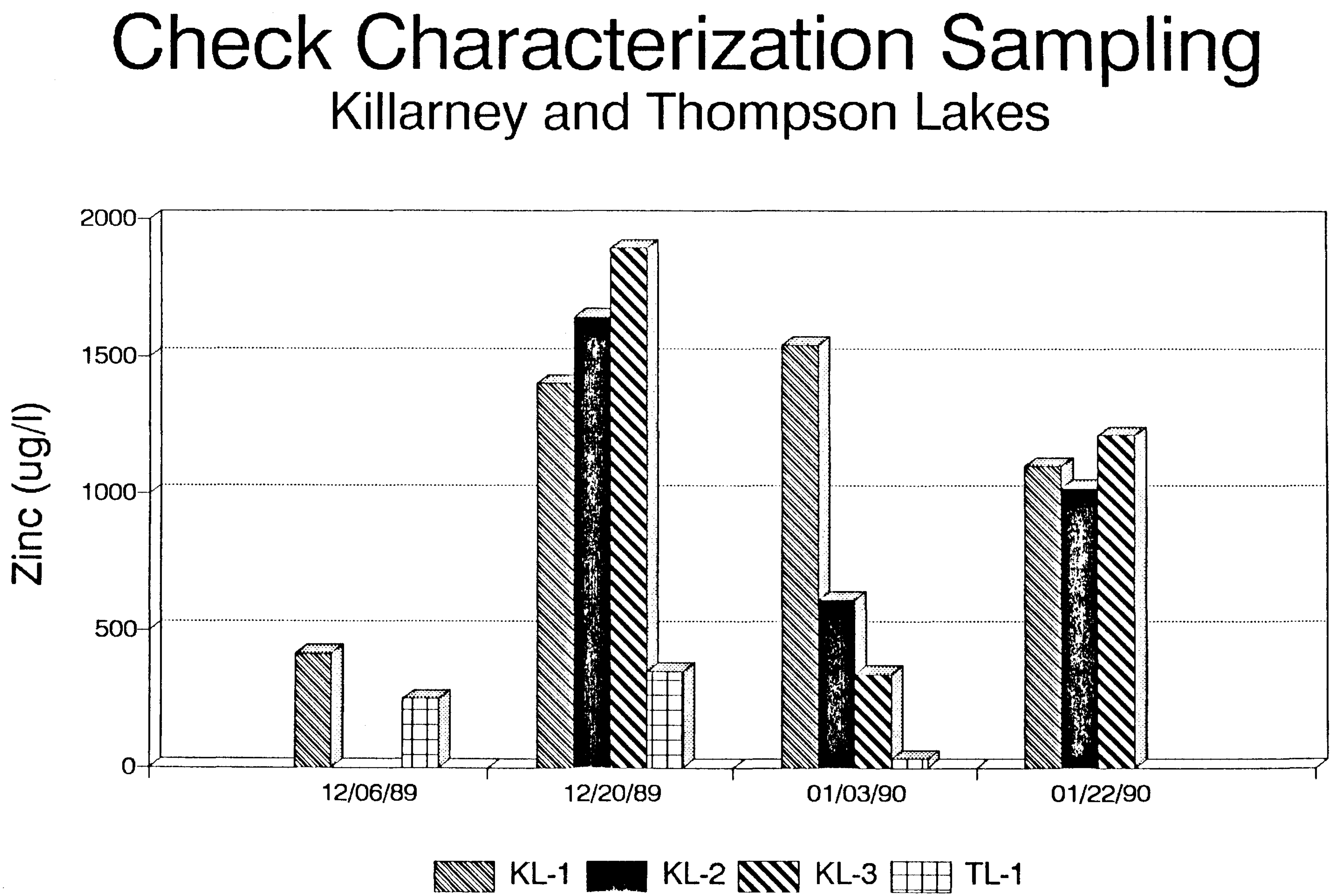

Figure 3-7. Zinc concentrations at Killarney and Thompson Lakes.

4. Monitoring Plan

As described in the previous sections, historical data collected by government agencies and recent data collected by GSA and Weston have shown the presence of high concentrations of heavy metals including lead, cadmium, and zinc in the CDAR. As a result of these findings, GSA has prepared a plan enabling the BLM to carry out long-term water quality monitoring near the public lands along the Lower CDAR. The details of the monitoring plan are outlined in the following sections.

4.1 Water Quality Sampling Needs

A review of historical water quality data performed by GSA showed that heavy metals, especially lead, cadmium, and zinc are the primary contaminants present in the CDAR. During this review, GSA concluded that the existing database is not sufficient to describe present day water quality conditions in the CDAR and identified the need for a long-term monitoring plan.

Reductions in mining activities and the closure of the Bunker Hill Smelter Complex have led to the possibility of improving water quality in the CDAR. However, recently collected data consist primarily of single-day sampling events during periods of low flow at a few selected locations. Since the concentrations of certain metals have been shown to vary according to river discharge, these single-day low flow samples are probably not representative of the overall water quality in the CDAR. This represents a serious gap in the water quality database. More frequent monitoring is necessary to further characterize the current conditions.

Another gap in the database is the lack of stations along the main stem of the CDAR. With the exception of some sampling in the late 1960's and early 1970's, most of the data collected along the main stem of the CDAR have been collected at stations located near Rose Lake and Cataldo. A greater network of stations would provide a better database for describing long-term spatial trends in water quality.

Very little water quality data exist for the lateral lakes along the CDAR. The existing data consist of samples collected by Bauer (1974), Weston (1989), Krieger (1989), and GSA. These data are limited in scope and provide no long-term record for water quality trend analyses. Additional monitoring stations are needed in these areas.

The above points illustrate the need for a long-term monitoring plan for the CDAR. The following sections describe a monitoring plan developed by GSA for the BLM. The objectives of this plan are to:

- *monitor potential chemical hazards (pH and trace metal concentrations) near the BLM lands at regular intervals over a long period of time,*
- *provide water quality data that will allow the BLM to assess potential health hazards to humans, wildlife, and aquatic life near the BLM lands,*
- *provide water quality data indicating of the effects of upstream mining and Superfund site activities,*
- *aid the BLM in determining future actions regarding management policies.*

Under CERCLA, the BLM has identified public lands along the Lower CDAR as having potentially hazardous materials resulting from upstream mining wastes. Therefore, heavy metals, especially cadmium, lead, and zinc, are suspected to be the primary contaminants. As a result, the monitoring plan must focus on concentrations of heavy metals in vicinity of the BLM's public lands. The BLM can then use these data to assess the potential health hazards to humans, wildlife, and aquatic life, associated with these mining wastes, as well as other environmental concerns regarding management policies and current and future Superfund activities in the area.

Included in the monitoring plan are a list of potential monitoring sites, an evaluation of each potential site, recommendations of future monitoring sites, recommended analysis constituents, proposed and alternative sampling schedules, estimated costs for implementation of the plan, and an evaluation of the best methods of implementation.

4.2 Monitoring Sites

GSA has identified 16 locations along the main stem of the CDAR as potential monitoring sites. These sites were selected based on their location at or near BLM land and/or because of significance in past sampling. These sites were evaluated based on their accessibility, the likelihood of heavy metal contamination given the site location and topography, the significance of the site in past studies, the potential for public exposure at sites, and the amount of existing data available to characterize prospective sites.

4.2.1 Evaluation of Potential Monitoring Sites

The 16 sites selected by GSA as potential monitoring sites include:

- *Cataldo (two sites),*
- *north of the CDAR near Dudley,*
- *south of the CDAR near Dudley,*
- *near the town of Rose Lake,*
- *near the boat ramp at Killarney Lake,*
- *the wetlands southeast of Killarney Lake ,*
- *the picnic area on the east side of Killarney Lake,*
- *Popcorn Island at Killarney Lake,*
- *along the west side of Killarney Lake ,*
- *Medicine Lake,*
- *Springston,*
- *Thompson Lake, and*
- *near the mouth of the CDAR (three sites).*

The locations of these sites are shown in Figures 4-1 through 4-7. The evaluation of each of the sites is described in the following sections.

4.2.1.1 Cataldo

The BLM owns a 49.5-acre parcel of land approximately 0.4 miles west of the Cataldo Mission. The location of this land is shown in Figure 4-1. As shown in the figure, this parcel is bisected in a northwest-southeast direction by the CDAR. The portion of the site north and east of the river is accessible via the road leading from Interstate 90 to the Old Mission State Park. The road passes approximately 800 feet north of the BLM land. The portion of the site south and west of the river does not have road access. The BLM land encompasses the western portion of Old Mission State Park. Recreational facilities, including a boat ramp and dock, are located in the northern portion of a bay located approximately 500 feet north of the BLM land.

According to the site investigation report by Weston (1989), the Cataldo area periodically received sediments dredged from the CDAR in efforts to keep the river channel open for paddleboats. This greatly increases the likelihood that heavy metal contamination has occurred. The park and recreation facilities located in the area produce the potential for public use, resulting in increased likelihood of public exposure to contaminants.

A second potential monitoring site in the Cataldo area is at the county road bridge across the CDAR, just west of Cataldo (Figure 4-1). Water samples could be collected from the bridge, which provides convenient sampling access and a permanent datum for water level measurements. This area has been the primary target of past monitoring along the main stem of the CDAR. Monitoring has been conducted by the EPA, USGS, and the Idaho Department of Health and Welfare (IDHW) in this area for the past 22 years, resulting in a fairly consistent data base for characterizing the area's past water quality. The USGS is currently conducting basin trend monitoring at this location as part of the National Stream Quality Accounting Network (NASQAN) program.

Based on the likelihood of contamination, the potential for public exposure, and the significance of the area in past monitoring, both of the potential sites in the Cataldo area are considered good candidates for future monitoring.

4.2.1.2 Dudley

The BLM owns two parcels of land in the Dudley area, as shown in Figure 4-2. One parcel is north of the CDAR, approximately 1.5 miles east of the town of Rose Lake. This parcel contains approximately 1800 feet of river front. Access to this area is provided via a gravel road from Rose Lake. This road provides easy sampling access as the road passes close by the river. The river bank is only a short walk from the road. While public use of this area is not anticipated to be high, the potential for exposure exists because of the close proximity of the road to the river. Since a portion of the property is located on the CDAR floodplain, there is a possibility of contamination of floodplain sediments from mine tailings. Because of the easy access and location, the potential for public exposure, and the likelihood of contamination, this site is considered a good candidate for future monitoring.

The second parcel in the Dudley area is south of the CDAR, approximately 3 miles east of the town of Rose Lake (Figure 4-2). This parcel contains approximately 4700 feet of river front. Access to the site is provided by a county road leading southeast from the Interstate 90 Cataldo exit. However, the road passes high above the river, with a steep embankment making foot travel down to the river difficult. The parcel is separated from the river by a railroad embankment. Because of the steepness of the terrain and the limited access, the potential for public exposure is considered minimal. Since the parcel is mostly steep upland area and is protected from the river by the railroad embankment, the likelihood of contamination of BLM land from mine tailings transported by the CDAR is greatly decreased, reducing the necessity of monitoring. Given the above reasons, this site is not considered to be a good candidate site for future monitoring.

4.2.1.3 Rose Lake

The BLM does not currently own any land in the Rose Lake area. However, as a result of its significance in past sampling, the area along the CDAR near the town of Rose Lake will be considered a viable candidate for futuring monitoring (Figure 4-3). State Highway 3 runs through the town of Rose Lake and directly adjacent to the CDAR, providing easy road access. Since significant monitoring has been conducted in the past at this location, direct comparisons can be made between past and future collected data. The disadvantage of this site is that, while it would give valuable information regarding water quality in the CDAR, it would not give water quality data directly applicable to BLM land. However, given the fact that the town of Rose Lake is located adjacent to the CDAR, there is a potential for public exposure to heavy metal contamination in the water and sediments of the CDAR. In addition, this location is about mid-way along the CDAR between the BLM lands at Dudley and Killarney Lake. Therefore, the area along the CDAR near the town of Rose Lake is considered a good candidate for future monitoring.

4.2.1.4 Killarney Lake

The BLM owns four parcels of land in the Killarney Lake area. These four parcels, shown in Figure 4-4, include the area extending north from the boat ramp along the east side of the lake, a wetland area southeast of the lake, Popcorn Island located in the northern part of the lake, and a parcel along the west side of the lake. Access to Killarney Lake is provided by Killarney Lake Road which intersects State Highway 3 approximately 2 miles west of the town of

Rose Lake. A total of five potential monitoring sites have been identified on the four BLM parcels. These sites include:

- *near the boat ramp,*
- *the wetlands southeast of Killarney Lake,*
- *the picnic area on the east side of the lake,*
- *Popcorn Island, and*
- *the parcel along the west side of the lake.*

Popcorn Island and the parcel along the west side of the lake are considered poor candidate sites for future monitoring for the following reasons:

- *Limited access.* Access to these areas is primarily by boat. This can potentially make sampling more dificult, especially in the winter months when the lake may be frozen. Limited access also greatly reduces the potential for public exposure to possible heavy metal contamination.

- *Topography.* The topography of the parcel along the west side of the lake is mostly steep upland area, with little likelihood of heavy metal contamination from the lake water or transported sediment. Popcorn Island is also relatively steep, but probably has a greater potential for contamination than the western parcel. Heavy metal contamination at both sites would most likely be a narrow strip along the perimeter.

Little water quality data, none of which are current, are available for characterization of these two sites. The only existing information was collected by Bauer (1974) in the spring of 1973 and June of 1974. These samples were collected approximately midway between the most eastern point of the western parcel and the picnic area north of the boat ramp. The sample analyses resulted in zinc concentrations between the federal chronic and acute toxicity criteria. However, based on the above reasons, these two sites are not considered suitable for future monitoring.

The parcel along the east side of the lake contains two potential monitoring sites, the boat ramp area and a picnic area located approximately 0.6 miles north of the boat ramp. Both sites have the advantage of having boat docks, providing a convenient place to collect samples. The boat ramp site, with its easy access and appeal to boaters, has the highest potential for public exposure to possible contamination. While the surrounding area is primarily steep upland area, the boat ramp and parking area have the potential for receiving contaminated waters, especially during periods of flooding. The only known existing data at this site are four samples collected by GSA between

December of 1989 and January of 1990. The results of these samples showed elevated levels of cadmium, lead, and zinc (see Table 3-2). Based on the accessibility, the potential for public exposure, and the proven presence of heavy metals, this is considered a good potential monitoring site.

The picnic area north of the boat ramp is not as easily accessed as the boat ramp. Access to the picnic area is provided by a steep narrow trail leading from Killarney Lake Road, which rises to an elevation high above the lake at this point. Thus, public use and the potential for public exposure to contaminants is expected to be less than at the boat ramp. As in the case of the parcel along the west side of the lake, the topography near the picnic area is mostly steep upland area, reducing the likelihood of heavy metal contamination by the lake water and transported sediment. Based on these observations, this site is not considered one of the better candidate sites for future monitoring. Bauer (1974) reported that zinc levels were relatively uniform at three stations located throughout the lake. Therefore, it is believed that water quality conditions at the picnic area, Popcorn Island, and the western parcel may be well represented by samples collected at the boat ramp.

The final potential monitoring site in the Killarney Lake area is located in the wetland area southeast of the lake. The Idaho Department of Fish and Game has constructed approximately 509 man-made islands in this area to provide waterfowl habitat (Weston, 1989). These islands were constructed from dredged wetland sediments suspected of containing heavy metals. A dike, leading from Killarney Lake Road out through the wetland area, was also constructed. This dike has a main channel running along the west side. During favorable weather conditions, the dike provides vehicle access to the northern part of the wetland area, while during periods of inclement weather, the dike can be used for walking access. During previous sampling, GSA observed that access to this area may be a problem during high water and frozen conditions. To access the wetlands, GSA walked along the dike and used waders to cross the main channel west of the dike. On one occasion, GSA was not able to get to the wetlands because of frozen conditions. The ice on the channel was too thick to get through with a raft, but not thick enough to walk across. On another occasion, the wetlands, including the dike and islands, were totally submerged by flood waters. A raft or canoe may be necessary for sampling during these periods of high water.

Given the low-lying topography of the wetland area, it is very likely that tailings may have been deposited there, especialy during periods of flooding. While the potential for public exposure to heavy metals is not of concern in the wetland area, the effect of heavy metal contamination on waterfowl is a concern. Water quality data for the wetland area have been collected by Weston in July of 1988, and by GSA in December of 1989 and January of 1990. Both of these studies showed elevated levels of cadmium, lead, and zinc in the wetland area. A slight amount of mercury was detected in a sample collected by Weston, but was not detected in the samples collected by GSA. Given the likelihood that contamination has occurred and the popularity of the area for waterfowl, this site is considered a good candidate for future monitoring. However, accessibility is a potential problem.

4.2.1.5 Medicine Lake

The BLM owns a 20-acre parcel of submerged land in Medicine Lake. The location of the parcel is shown in Figure 4-5. Since the parcel is small and submerged, and since the area is not considered a high use area, this site is not considered a good candidate for future monitoring.

4.2.1.6 Springston

The BLM owns approximately 38 acres of land in the Springston area along the CDAR. As shown in Figure 4-6, the parcel is almost entirely upland with approximately 600 feet of river front. The river front portion of the parcel is protected from the river by a railroad embankment. The property is inaccessible by vehicle, and as a result of the steep topography, high public use is not anticipated. Given the limited river exposure, the inaccessibility, and the low use potential, this site is not considered a good candidate for future monitoring.

4.2.1.7 Thompson Lake

The BLM owns 67.5 acres of wetlands in the Thompson Lake area. The location of this parcel is shown in Figure 4-6. Access to the lake is provided by Thompson Lake Road along the northern edge of the lake and by Blue Lake

Road south of the lake. Access to the BLM parcel is primarily by canoe or small boat. According to Weston (1989), the parcel is a marshy island comprised of organic matter with very little soil. Weston reported that no visible evidence of mine tailings were observed during their 1988 site investigation. Since the parcel is primarily wetlands, the likelihood of high public use of the land is small. However, there is a potential for high public use by sport fishermen and boaters around the perimeter of the parcel.

Previous samples collected from Thompson Lake by GSA and Weston showed elevated concentrations of cadmium, lead, and zinc. These samples were collected at a point along the northern shore of the lake, directly north of the BLM parcel. Given the fact that the BLM parcel is mostly wetlands and has a high potential for public use around the perimeter, and that previous sampling has indicated the presence of heavy metals, Thompson Lake is considered to be a good candidate for future monitoring. Since the parcel is mostly wetlands and has a low potential for public use in its interior, it is recommended that future samples be collected along the northern shore by Thompson Lake Road. Sampling at this location eliminates the need for a boat, making winter sampling easier. This location is considered representative of the BLM parcel because of the close proximity.

4.2.1.8 Mouth of the CDAR

The BLM owns two parcels near the mouth of the CDAR. The locations of these parcels are shown in Figure 4-7. The larger of the two parcels is approximately 115 acres, with about 112 acres submerged. Access is provided by Harlow Point Road, which intersects the northwest corner of the property. The second parcel, located right at the mouth of the CDAR, is approximately 36 acres and is totally submerged. This parcel is accessible only by boat.

Since both of these parcels are submerged and located near the mouth of the river, it is very likely that they have received heavy metal contamination from water and deposited sediments. There is a potential for exposure of contaminants to sport fishermen, boaters, and others engaged in water related activities in the area.

A third potential monitoring site near the mouth of the river is at the State Highway 97 bridge across the CDAR near Harrison. Water samples could be collected from the bridge, which provides convenient sampling access and a permanent datum for water level measurements. This area also has a potential for exposure of contaminants to sport fishermen, boaters, and others engaged in water related activities.

Past sampling near the mouth of the CDAR consists of samples collected by the EPA in September of 1966 and January of 1971. These samples are outdated and insufficient to characterize the present water quality in the area near the river mouth. Based on the accessibility, the likelihood of contamination, the potential for public exposure to contaminaton, and the lack of existing data, the area along Harlow Point Road and the bridge near the mouth of the CDAR are considered good potential monitoring sites. The submerged parcel located at the mouth is not recommended for future sampling.

4.2.2 Recommended Monitoring Sites

In Section 4.2.1, the 16 sites identified as potential monitoring sites were described. In this section, the sites recommended for future monitoring are presented. Nine locations were identified by GSA as good candidates for future monitoring. These locations include:

- *Cataldo (two locations),*
- *north of the CDAR near Dudley,*
- *near the town of Rose Lake,*
- *near the boat ramp at Killarney Lake,*
- *the wetlands southeast of Killarney Lake,*
- *Thompson Lake, and*
- *near the mouth of the CDAR (two locations).*

Of these locatons sites, GSA recommends that monitoring sites be established at the following locations:

- *the bridge across the CDAR near Cataldo,*
- *the bridge across the CDAR near Rose Lake,*
- *near the boat ramp at Killarney Lake,*
- *the wetlands southeast of Killarney Lake (near the dike),*
- *the northern shore of Thompson Lake, and*
- *the State Highway 97 bridge near the mouth.*

The site located at the county road bridge near Cataldo was chosen over the BLM property near the Mission for the following reasons:

- *The area is located upstream of the backwater caused by Coeur d'Alene Lake. The area near the mission is affected by the backwater.*

- *The USGS operates a monitoring station at this location. Data collected by the BLM could be compared and correlated with data collected by the USGS.*

- *The USGS makes streamflow measurements at this location and has a continuous stage recorder located less than one mile upstream. Streamflow data collected by the USGS could be used by BLM.*

- *The location has an existing water quality database dating back to 1968 (Table 2-1).*

- *The bridge provides convenient access for sampling and a permanent datum for water level measurements.*

The site located on the bridge across the CDAR at Rose Lake was chosen over the site at Dudley for the following reasons:

- *The Rose Lake site is centrally located between the BLM parcels near Dudley and Killarney Lake.*

- *The bridge provides convenient access for sampling and a permanent datum for water level measurements.*

- *The location has an existing water quality database dating back to 1968 (Table 2-1).*

The site located in the Killarney wetlands is recommended for establishment in the main channel west of the dike. This location is recommended instead of a location near the man-made islands because of easier access during high water and frozen conditions. GSA experienced difficulty in reaching the man-made islands during high water and frozen conditions. Based on the samples collected during the check characterization sampling (Section 3), GSA believes that samples collected from the main channel along the dike will be representative of water quality in the island area. Although the magnitude of water quality parameters differed between the two wetland sites (KL-2 and KL-3), the patterns exhibited were similar (Figures 3-3 through 3-7). Therefore, GSA recommends avoiding the area near the islands.

The monitoring sites at the Killarney Lake boat ramp and Thompson Lake are recommended for the reasons stated in Sections 4.2.1.4 and 4.2.1.7, respectively.

The site located on the State Highway 97 bridge near the mouth of the CDAR was chosen over the potential site along Harlow Point Road for the following reasons:

- *The bridge provides convenient access for sampling and a permanent datum for water level measurements.*
- *The BLM parcels near the mouth are submerged and have limited access.*
- *The site should give an indication of the quality of water entering Coeur d'Alene Lake from the CDAR.*

The location of the sites at Cataldo, Rose Lake, and near the mouth provide a nice distribution of stations along the main stem of the CDAR. These sites, along with the three sites recommended at Killarney and Thompson Lakes, should provide a good network of stations for characterizing the water quality in the Lower CDAR drainage.

4.3 Recommended Analysis Constituents

During the review of past water quality sampling in the CDAR, cadmium, lead, mercury, and zinc were identified as the contaminants of concern. However, mercury concentrations appear to have been significantly reduced since 1970 (Figure 2-3 and Tables 2-3 and 2-4). In addition, samples collected by GSA during the check characterization sampling contained no mercury above detectable limits. Therefore, GSA recommends that cadmium, lead, and zinc be the primary analysis constituents at all of the monitoring sites. Since the acute and chronic toxicity of cadmium, lead, and zinc are dependent on hardness (EPA, 1986), GSA also recommends its inclusion on the constituent list. At the present time, EPA (1986) recommends applying the water quality criteria using the total recoverable method for metals. EPA cites two possible impacts resulting from the use of the total recoverable method:

- *certain species of some metals cannot be analyzed directly because the total recoverable method does not distinguish between individual oxidation states, and*

- *the criteria may be overly protective when based on the total recoverable method.*

EPA belives that a measurement such as "acid-soluable" would provide a more correct basis upon which to establish criteria for metals (EPA, 1986). However, at this time, no EPA-approved methods for such a measurement are available to implement the criteria. Therefore, based on EPA's recommendation, GSA recommends that metals analyses be performed using the total recoverable method.

In addition to the above metals, GSA recommends the field measurement of pH, specific conductance, and water temperature, as well as recording observations of general environmental conditions at the time of sampling. Since the concentration of certain metals has been shown to vary with stage in the river and lakes, GSA also recommends measuring relative water levels where it is feasible at the monitoring sites. GSA anticipates that relative water level measurements will be feasible at the following locations:

- *Cataldo (from the county road bridge),*
- *Rose Lake (from the bridge),*
- *Killarney Lake boat ramp,*
- *Thompson Lake (at the bridge across the inlet), and*
- *near the mouth (from the State Highway 97 bridge).*

It is important to note that, of the these five locations, the Cataldo site is the only one that is not located in the backwater caused by Coeur d'Alene Lake. Therefore, changes in water level at the Cataldo location will be directly related to changes in river discharge. At the other locations, changes in water level can be attributed to changes in discharge and changes in lake level, which are not easily separated. However, GSA believes that these measurements may still be of some value. GSA recommends that the water level measurements be made with an electric water level probe.

GSA also recommends that consideration be given to the following as secondary analysis constituents:

- cadmium, lead, and zinc (dissolved concentrations),
- *iron,*
- *dissolved oxygen,*
- *alkalinity,*
- *mercury, and*
- *copper.*

Although total recoverable metals are recommended by EPA, dissolved metal concentrations may give a better idea of the amount that is biologically available. Therefore, the BLM may want to consider analyzing the collected samples for dissolved metals (cadmium, lead, and zinc) in addition to the total recoverable metals.

The BLM may want to consider including iron in the constituent list because it can be important in controlling concentrations of other metals. Dissolved oxygen and alkalinity may also be important parameters because of their effect on trace element chemistry and bioavailability.

Since mercury and copper have also been significant parameters in the past, the BLM may want to consider periodically analyzing samples for copper and mercury.

Although composite samples based on discharge or width increments generally provide more reliable data than grab samples, they are also much more expensive to collect. When done properly, these composite samples can take a significant amount of time and, depending on the sampling location, may require the use of a boat. These issues lead to a significant increase in monitoring costs. Since the main objective of the monitoring program is to evaluate heavy metal concentrations near the BLM lands to aid the BLM in determining future management actions, GSA believes that grab samples, collected at the recommended sites at monthly intervals, will be representative of water quality in these areas. If the objective of the program was to monitor water quality in the river as a whole, then composite samples would be recommended. If the overall water quality in the river is of greater concern, the BLM may want to consider the use of composite samples.

4.4 Monitoring Schedule

One of the most vital components of a monitoring plan is consistency. In order to develop a database for the purpose of water quality characterization and trend analyses, samples must be collected from the same locations at regular time intervals. Thus, the selection of a monitoring schedule is equally as important as the selection of the monitoring sites. The monitoring schedule warrants even more consideration, given the variation of metal concentrations in the CDAR with river discharge (Figure 2-5). Metal concentrations in the CDAR can vary by seven times or more, depending upon the river discharge. Therefore, the monitoring schedule should be designed to account for this variation. This is best accomplished by collecting a series of samples throughout the given year.

Samples collected throughout the given year should be at intervals that represent the overall annual water quality. For example, if a sampling frequency of 4 times annually was selected, it would be reasonable to collect one sample during high flow, one sample during low flow, and two samples during an "average" flow condition. An average of the four samples would give an indication of the overall water quality during that year.

Given the magnitude of variation of metal concentrations in the CDAR, a greater sampling frequency will be more representative than a lessor sampling frequency. An example of this is illustrated by Woodward-Clyde Consultants and TerraGraphics (1986). They stated that the average lead concentration in the CDAR in 1980 as reported by the USGS was 874 μg/l for 10 samples, while the EPA reported 5 samples with an average of 38.8 μg/l. The data reported by the USGS were collected throughout the year, while the data reported by the EPA were collected mostly during low flow periods. These data reveal a drastic difference in the average annual lead concentration, indicating that the sampling schedule is indeed crucial.

Based on the above discussion, GSA recommends the consideration of the following monitoring schedules:

- *four times annually,*
- *bimonthly, and*
- *monthly.*

In order for future monitoring to be effective, a mimimum of four samples must be collected annually. Anything less than four times annually has a high likelihood of being biased by the flow conditions at the time of sampling. As in the example above, collecting one sample during high flow, one sample during low flow, and two samples during an "average" flow condition is a logical choice. These samples will likely detect critical water quality periods during high and low flow, as well as provide a composite of overall annual water quality. The disadvantage of sampling four times annually is selecting sampling intervals that will consistently correspond to high and low flow periods. A greater sampling frequency is desired for this reason.

Monthly sampling will provide a much more consistent water quality database. However, monthly sampling requires a larger commitment of time and resources for sample collection, sample analyses, and data analyses. Among the benefits of monthly sampling are increased statistical significance because of the greater number of observations and the increased likelihood of sampling during a variety of flow conditions. Given the variation in metal concentrations in the CDAR, frequent sampling is crucial to describing water quality trends. Therefore, GSA recommends that future samples be collected on a monthly basis.

Bimonthly sampling is a possible alternative to monthly sampling. This is the sampling frequency used at the USGS NASQAN station located near Cataldo. Samples are collected from this station in January, March, May, July, September, and November. If bimonthly sampling is preferred over monthly by the BLM, it would be advantageous to coordinate the sample collection dates with those used by the USGS at Cataldo to facilitate comparisons between the sites. Bimonthly sampling offers the benefit of lower monitoring costs than monthly monitoring, while still providing consistent measurements throughout the given year.

GSA used existing zinc data collected by the USGS at Rose Lake between 1975 and 1981 to determine the best sampling periods for the three possible sampling frequencies. These data were plotted monthly, bimonthly, and quarterly as shown in Figures 4-8 through 4-10, respectively. Figure 4-8 (monthly) was used as the basis for comparisons between the three frequencies. Bimonthly sampling during this period (Figure 4-9) would have detected the periods of low and high zinc concentration and had several samples in between each. Quarterly sampling during the same period (Figure 4-10) would have detected the periods of low zinc concentration, but would have missed the periods of high zinc concentration in 1975 and 1981. As evidenced in the comparison of Figures 4-8 and 4-10, quarterly sampling will likely detect differences in metal concentrations resulting from seasonal variation in river stage, but may not detect differences in metal concentrations resulting from flood events. Therefore, bimonthly sampling and monthly sampling are preferred over quarterly sampling. In that same regard, monthly sampling is preferred over bimonthly sampling.

Considering the annual variation in metal concentrations (Figure 4-10), GSA recommends that future monitoring span a period of at least five years. A long and consistent record is necessary to distinguish between changes in overall metal concentrations and annual variation in metal concentrations resulting from annual variation in discharge.

4.5 Implementation of Monitoring Plan

GSA has investigated three possible methods for implementing the recommended monitoring plan. These options include:

- *in-house monitoring by the BLM,*
- *contracting with the USGS, and*
- *monitoring by a private contractor.*

The following sections present GSA's evaluation of these alternatives, advantages and disadvantages of each, and estimated costs.

4.5.1 In-house Monitoring by the BLM

According to personnel at the BLM office in Coeur d'Alene, Idaho, the BLM currently has three staff positions that could possibly contribute to future monitoring efforts (Fortier, 1990). These positions include a hydrologist, a soil scientist, and a technician. The hydrologist and soil scientist positions are permanent positions, while the technician position is temporary. The future status of the technician position is currently unknown. Options being considered by the BLM include retaining the technician position, replacing the technician position with a hydrologist, and neither retaining nor replacing the technician position. This decision depends largely on the available funding. Therefore, only the two permanent positions can be relied upon for contributing to the monitoring program. Given the current workloads of the BLM personnel, GSA believes that it will be difficult for the BLM to undertake the monitoring program, unless a technician or additional hydrologist position is retained.

The major advantage of conducting the monitoring in-house is allowing the BLM to have control over the monitoring process. The monitoring could be tailored by the BLM to best serve its own interests. The BLM would also have access to the collected data as soon as laboratory analyses were completed.

The BLM does not currently have the capability to conduct the necessary laboratory analyses in-house. Therefore, it would be necessary for the BLM to contract with a laboratory for these services, or to purchase the necessary equipment. But, based on the cost of such equipment and the relatively small amount of monitoring to be conducted, GSA believes that contracting for laboratory services would be much more cost effective. The BLM currently has equipment for measuring pH and specific conductance. However, GSA recommends that the BLM purchase an electric water level probe for making relative water level measurements at the five sites identified in Section 4.3. The cost of the probe is approximately $450.

GSA has estimated the cost for the BLM to undertake the monitoring plan. The cost estimates are included as Tables 4-1 and 4-2. These estimates are on a per month basis and assume that samples will be collected monthly. It is assumed that the BLM would contract with a laboratory for the analyses of cadmium, lead, zinc, and hardness, and that field measurements of pH and specific conductance would be made with the BLM's existing equipment. A monthly cost of $7.50 has been included for a electric water level probe. This figure is based on monthly use for a period of five years. In developing the estimate, GSA has assumed that grab samples will be collected and that one day (8 hours) would be required to complete the necessary field work.

The estimate included as Table 4-1 assumes that a hydrologist or soil scientist, with an hourly cost of $20.00 (including benefits) would complete the required field work. GSA has also included two hours for the completion of a report documenting each sampling event and the results of the sample analyses. This results in a cost per month of $748.20.

For the development of the cost estimate included as Table 4-2, GSA has assumed that a technician with an hourly cost of $8.40 (including benefits) would complete the required field work. GSA has also included two hours of the technician's time and two hours of the hydrologist/soil scientist's time for the completion of a report documenting each sampling event and the results of the sample analyses. This results in a cost per month of $657.

Assuming that samples are collected monthly, as recommended in Section 4.3, the estimated annual monitoring costs are $7,884.00 or $8,978.40, depending on whether the labor is provided by a technician or a hydrologist/soil scientist. However, as pointed out by GSA, the monitoring program may be difficult for the BLM to undertake without the presence of a technician or second hydrologist.

4.5.2 Monitoring by USGS

A second option for continuation of the monitoring plan is contracting with another agency. The USGS currently conducts monitoring of lakes and streams throughout the United States. The USGS has the ability to perform a wide variety of water quality sampling that would fit the needs of the BLM. Being sister agencies within the Department of the Interior, the BLM and the USGS could combine their efforts and resources to accomplish the goals of the monitoring plan.

The advantage of contracting with the USGS to conduct the monitoring is obtaining the vast experience in water quality monitoring that the USGS possesses. The use of the USGS would also eliminate the need for a laboratory subcontract and eliminate potential staffing problems for the BLM.

The USGS estimates that the cost for them to conduct monthly sampling at the six sites would be $24,000 annually (Woods, 1990). This would include collection of the samples and analyses of total recoverable and dissolved metals (cadmium, lead, and zinc), pH, and hardness. The samples would be collected as composite samples (as opposed to grab samples) by standard USGS procedures. According to the USGS, their laboratory turn-around time for trace elements is about 45 days. Data are usually entered into the WATSTORE database and would be available to the BLM in about 30 to 90 days.

4.5.3 Monitoring by a Private Contractor

The third option for continuation of the monitoring plan is through the use of a private contractor. An engineering firm or other qualified contractor could be retained by the BLM for collection of samples, sample analyses, and reporting of results.

Since the study area is located near a Superfund site, where potential grievances with responsible parties are likely, an independent source of monitoring may be an important factor. As an aggrieved owner of approximately 1,500 acres of land within the Bunker Hill Superfund site (Weston, 1989) and owner of several parcels of land along the Lower CDAR that have been affect by these upstream activies, the BLM has an apparent conflict of interest. A private contractor, having no conflict of interest with the Superfund activities, could provide an independent and unbiased assessment of the area water quality.

Another advantage of a private contractor is the elimination of potential BLM staffing problems associated with the monitoring plan (see Section 4.5.1). A private contractor would require only a supervisory and coordination effort by the BLM and would not require any additional personnel. A private contractor could coordinate with the BLM and provide a timely response to the BLM's needs.

GSA has included an estimated cost for monitoring by a private contractor. This estimate assumes that the work will be provided by a consulting engineering firm with typical billing rates and that monthly grab samples would be collected. GSA assumes that one day (8 hours) will be required for collection of samples. It is assumed that a qualified laboratory would be subcontracted and that a 10 percent subcontract fee would be charged by the contractor. GSA has included two hours of labor for the preparation of a report documenting each sampling event and the sample results and two hours for a senior review of the report. GSA has also included estimates of the BLM's costs for contract development, initiation, and oversight. This results in an estimated cost of $1,248 per month for sample collection, sample analyses, and reporting of results, which corresponds to an annual cost of $14,976.

Table 4-1. Monitoring Cost Estimates for BLM In-House Monitoring (Hydrologist).

Item	Quantity	Unit	Rate	Cost
Field Work				
Labor:				
Hydrologist	8	hr	$20.00	$160.00
Expenses:				
Water level probe	1	mo	$7.50	$7.50
Mileage	120	ea	$0.30	$36.00
Misc. Supplies	1	ea	$20.00	$20.00
Laboratory:				
Cadmium	6	ea	$15.00	$90.00
Lead	6	ea	$15.00	$90.00
Zinc	6	ea	$15.00	$90.00
Hardness	6	ea	$15.00	$90.00
Report				
Labor:				
Hydrologist	2	hr	$20.00	$40.00
		Subtotal		$623.50
Overhead	1	20%	0.2	$124.70
		Monthly cost		$748.20
		Annual cost		$8,978.40

Table 4-2. Monitoring Cost Estimates for BLM In-House Monitoring (Technician).

Item	Quantity	Unit	Rate	Cost
Field Work				
Labor:				
Technician	8	hr	$8.40	$67.20
Expenses:				
Water level probe	1	mo	$7.50	$7.50
Mileage	120	ea	$0.30	$36.00
Misc. Supplies	1	ea	$20.00	$20.00
Laboratory:				
Cadmium	6	ea	$15.00	$90.00
Lead	6	ea	$15.00	$90.00
Zinc	6	ea	$15.00	$90.00
Hardness	6	ea	$15.00	$90.00
Report				
Labor:				
Hydrologist	2	hr	$20.00	$40.00
Technician	2	hr	$8.40	$16.80
		Subtotal		$547.50
Overhead	1	20%	0.2	$109.50
		Monthly cost		$657.00
		Annual cost		$7,884.00

Table 4-3. Monitoring Cost Estimates for Monitoring by a Private Contractor.

Item	Quantity	Unit	Rate	Cost
Contract Development and Initiation				
Labor:				
Technical specifications	4	hr	$20.00	$80.00
Contract documents & advertise	8	hr	$20.00	$160.00
Technical evaluation specifications	4	hr	$20.00	$80.00
Technical proposal evaluation	12	hr	$20.00	$240.00
Contract award	2	hr	$20.00	$40.00
Contractor familiarization	8	hr	$20.00	$160.00
Subtotal (once annually)				$760.00
Overhead	1	20%	0.2	$152.00
Contract Oversight				
Labor:				
Contracting officer admin.	0.5	hr	$20.00	$10.00
Local contract oversight and report review	2	hr	$20.00	$40.00
		Subtotal		$50.00
Overhead	1	20%	0.2	$10.00
Field Work				
Labor:				
Staff Engineer	8	hr	$45.00	$360.00
Expenses:				
pH/Specific Cond.	1	day	$15.00	$15.00
Water level probe	1	day	$15.00	$15.00
Mileage	120	ea	$0.30	$36.00
Misc. Supplies	1	ea	$20.00	$20.00
Laboratory:				
Cadmium	6	ea	$15.00	$90.00
Lead	6	ea	$15.00	$90.00
Zinc	6	ea	$15.00	$90.00
Hardness	6	ea	$15.00	$90.00
Subcontract Fee	1	ea	0.10	$36.00
Report				
Labor:				
Senior Engineer	2	hr	$75.00	$150.00
Staff Engineer	2	hr	$45.00	$90.00
Clerical	1	hr	$30.00	$30.00
		Monthly cost		$1,248.00
		Annual cost		$14,976.00

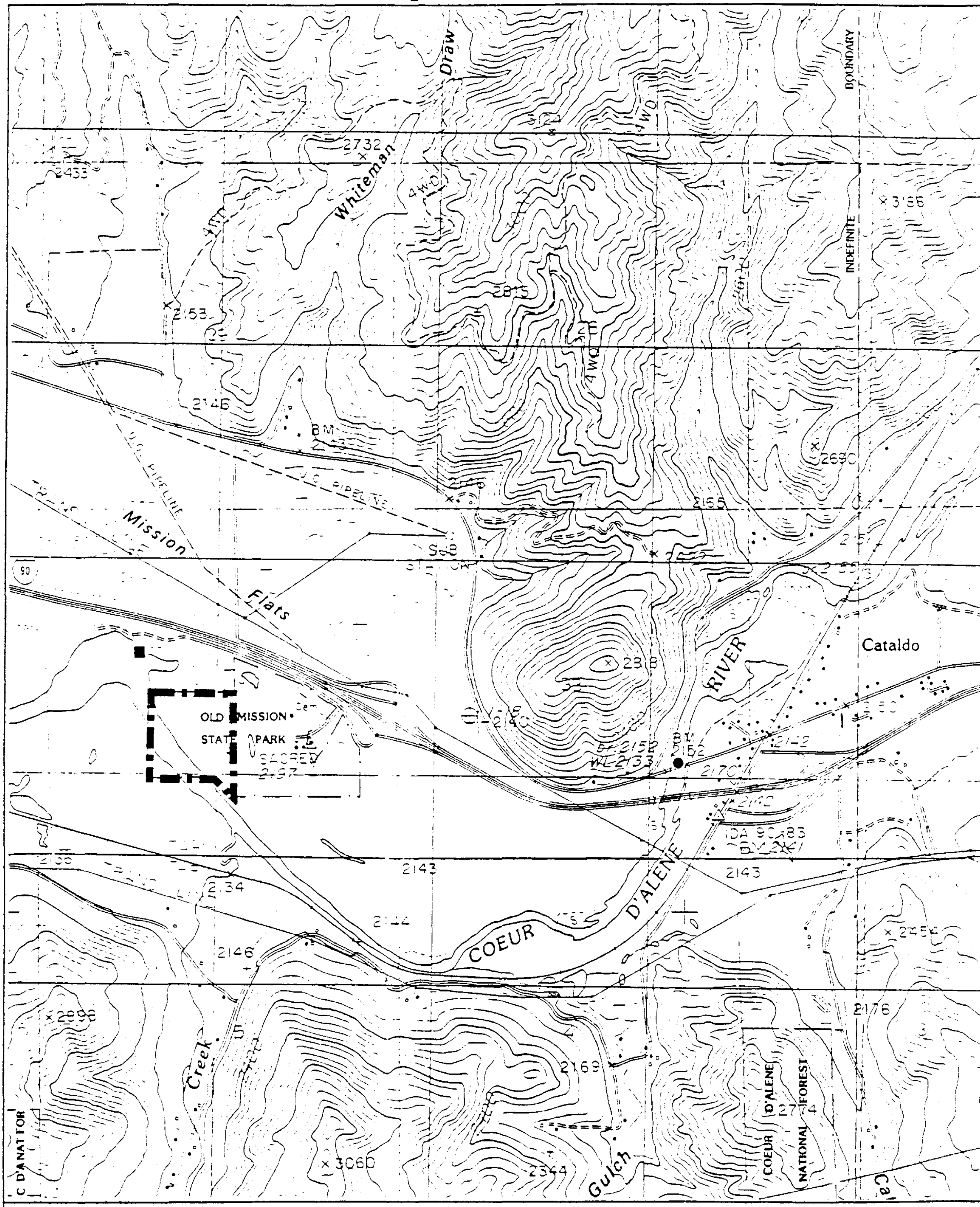

Figure 4-1. Map of Cataldo area.

● Recommended Site ■ Evaluated Site

Approximate boundary of BLM land   Scale: 1 inch = 2,000 feet

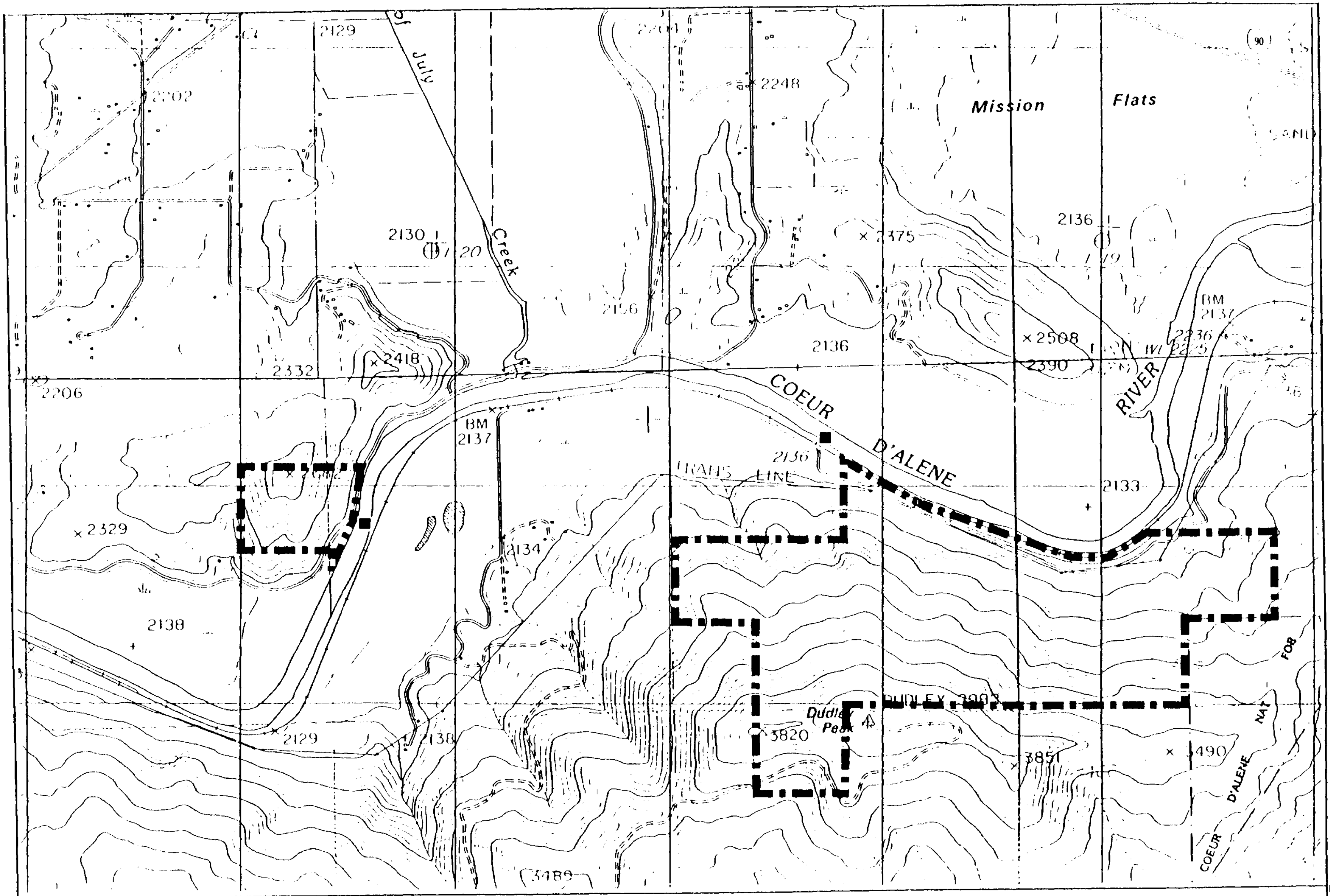

Figure 4-2. Map of Dudley area.

■ Evaluated Site

▬ ▪ ▬ Approximate boundary of BLM land

Scale: 1 inch = 2,000 feet

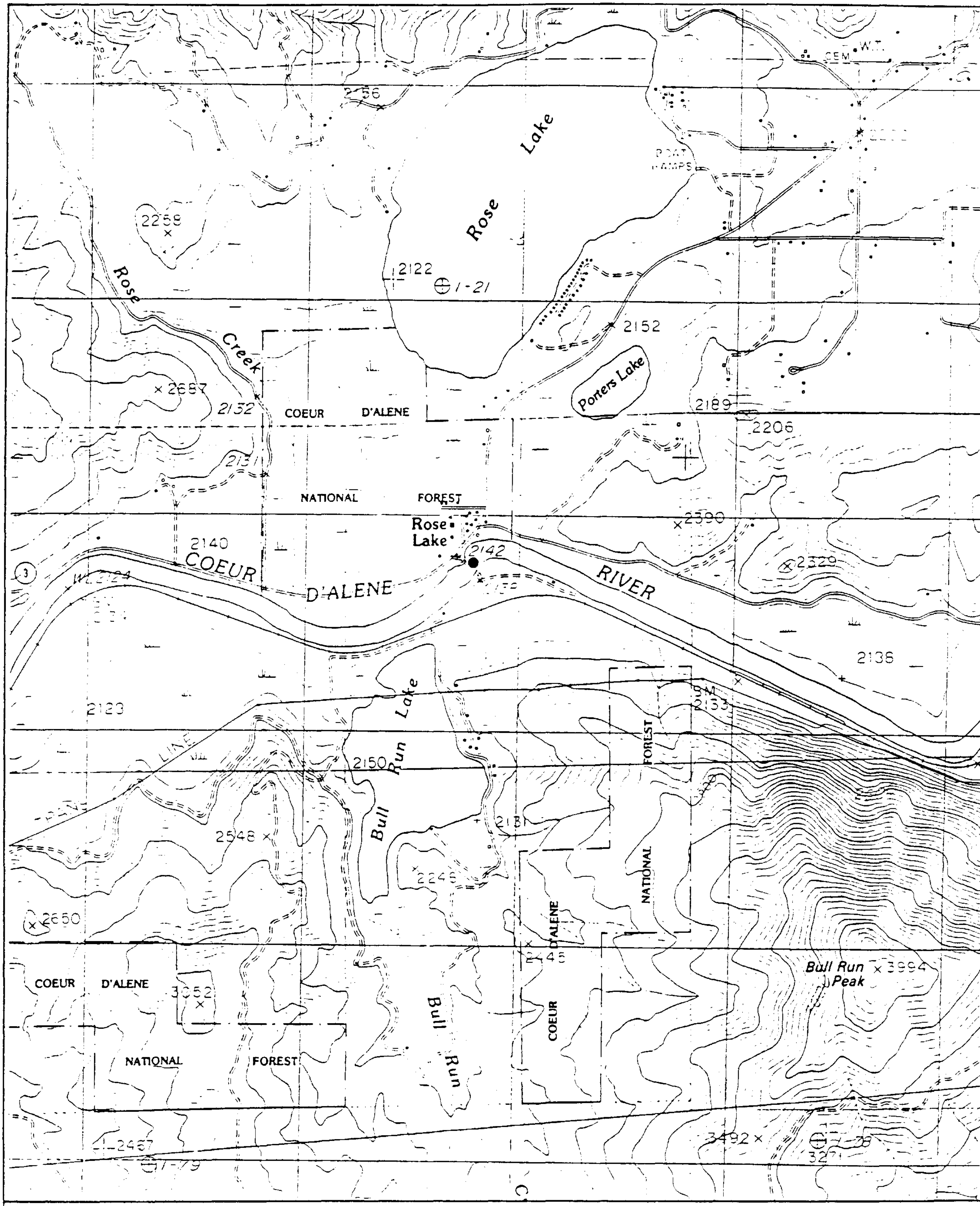

Figure 4-3. Map of Rose Lake area.

● Recommended Site

Scale: 1 inch = 2,000 feet

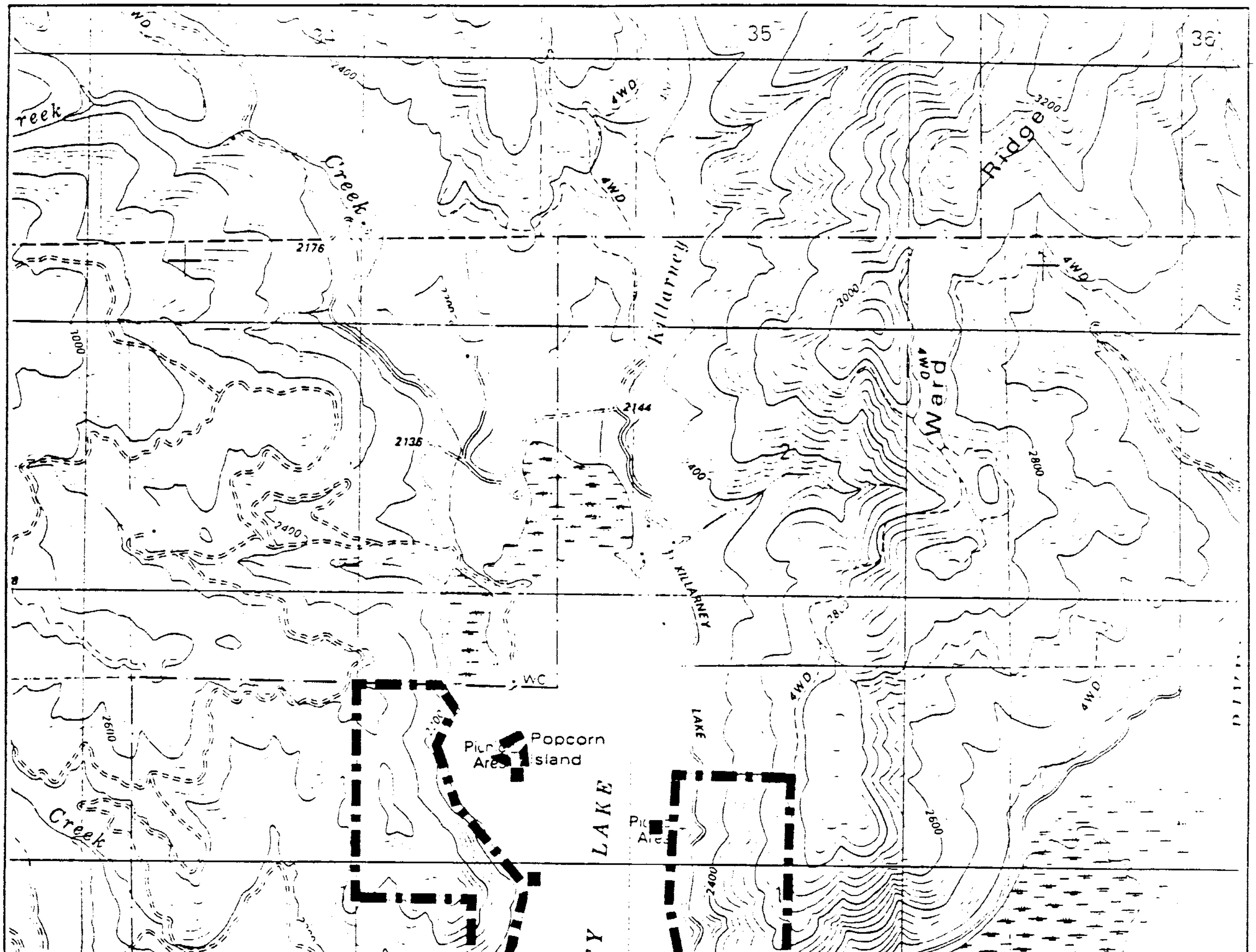

Figure 4-4. Map of Killarney Lake area.

● Recommended Site ■ Evaluated Site

▬ ▪ ▬ Approximate boundary of BLM land Scale: 1 inch = 2,000 feet

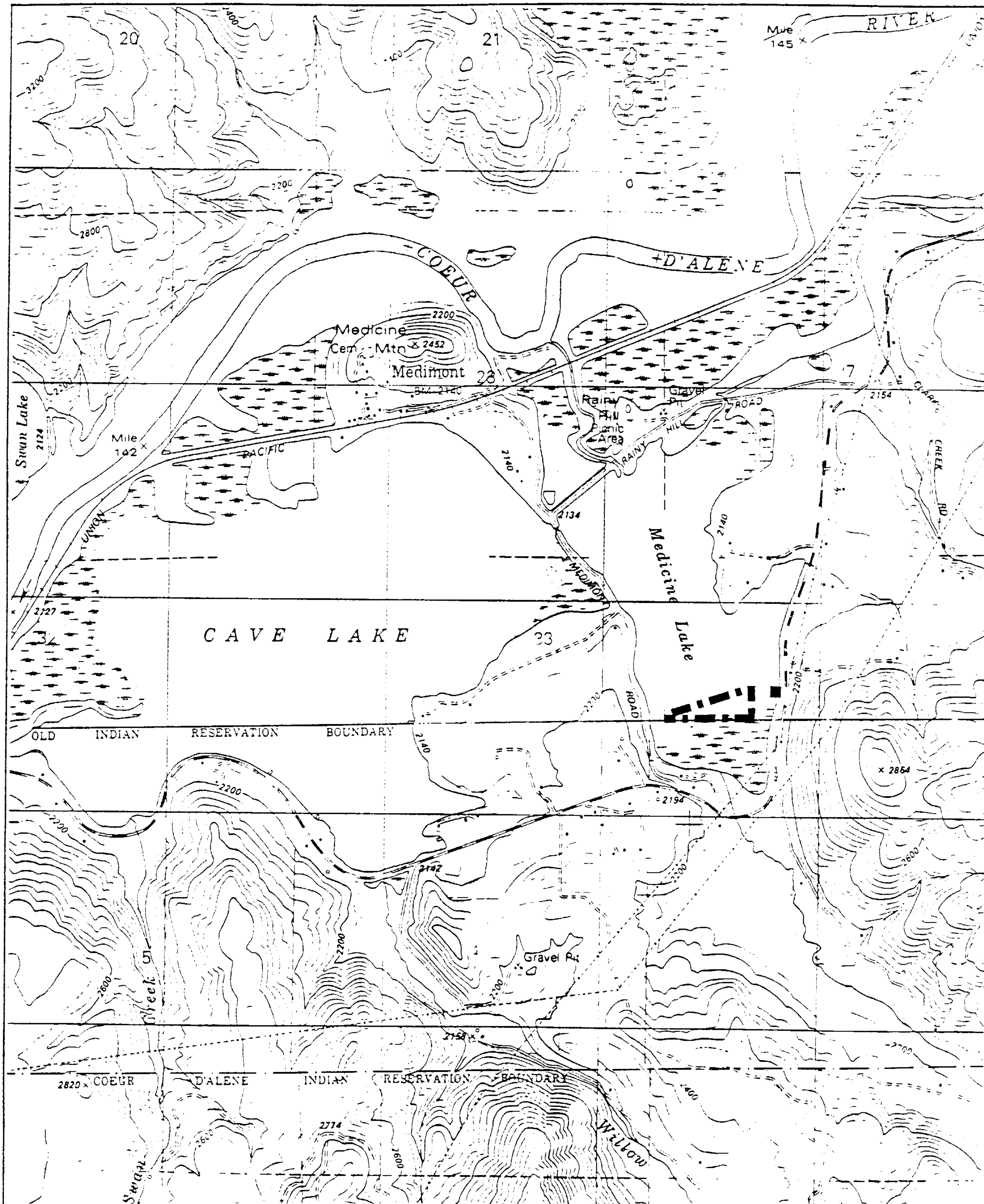

Figure 4-5. Map of Medicine Lake area.

■ Evaluated Site

Approximate boundary of BLM land

Scale: 1 inch = 2,000 feet

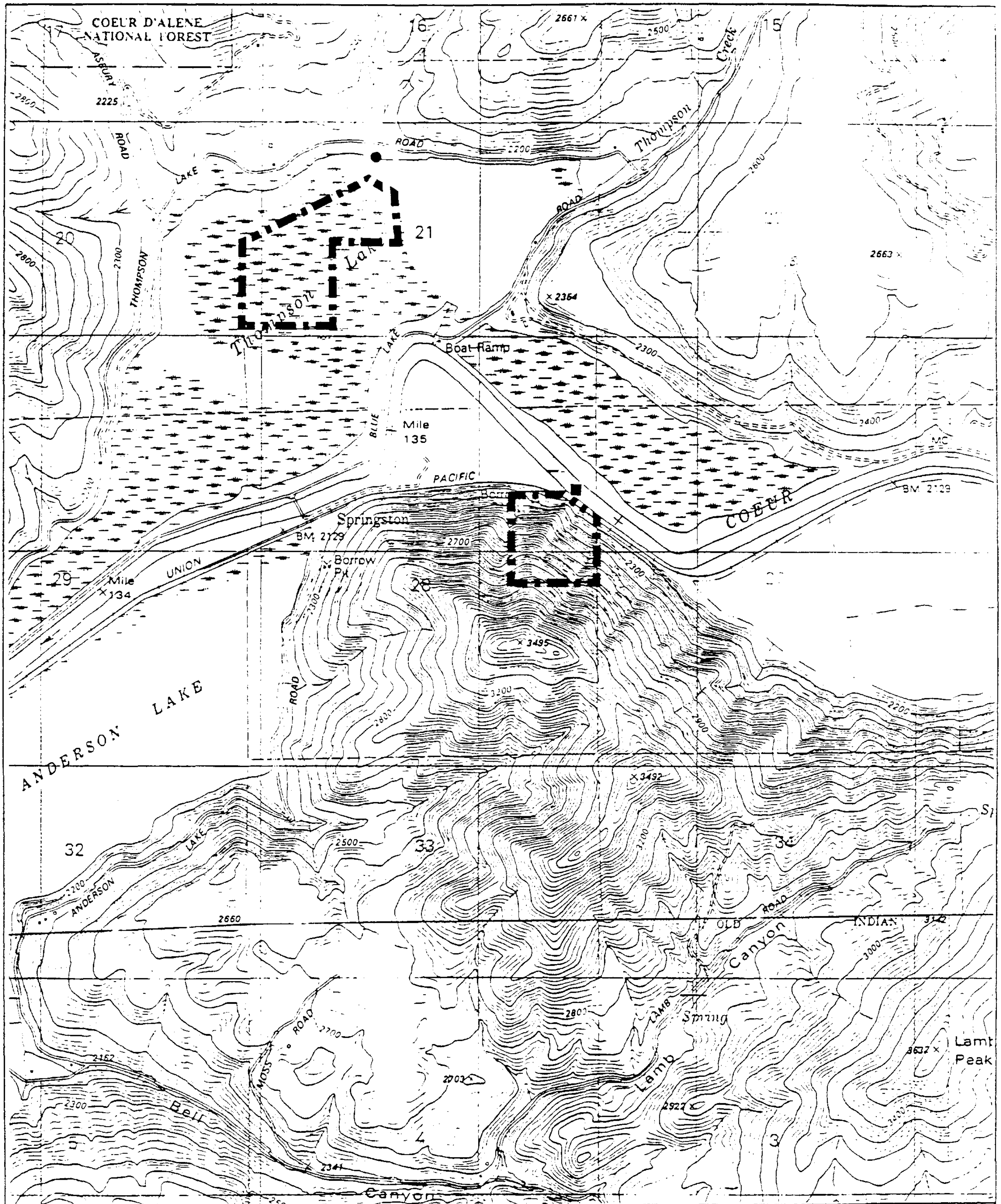

Figure 4-6. Map of Thompson Lake and Springston areas.

● Recommended Site ■ Evaluated Site

▬ ▪ ▬ Approximate boundary of BLM land Scale: 1 inch = 2,000 feet

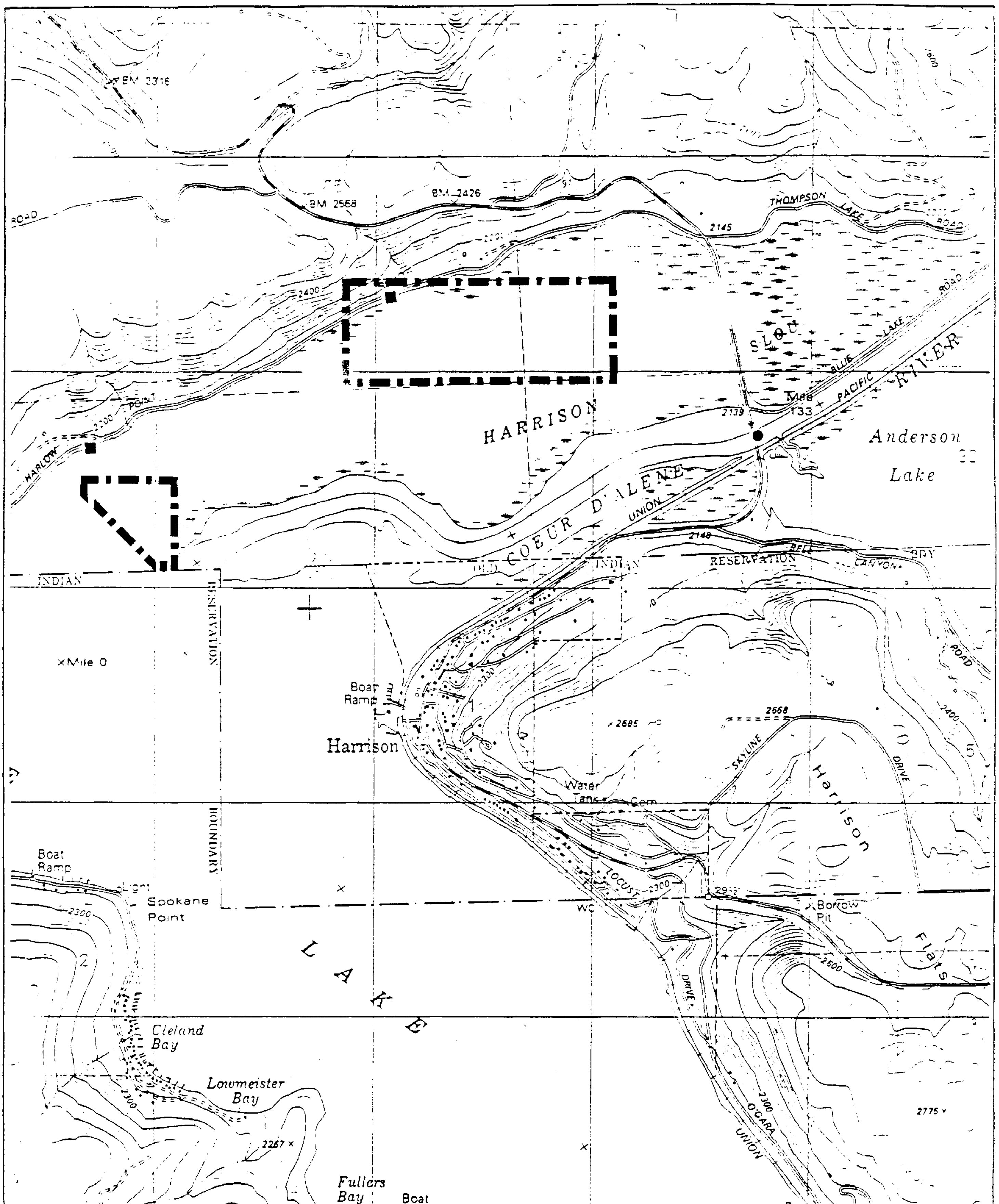

Figure 4-7. Map of area near the mouth of the Coeur d'Alene River.

● Recommended Site ■ Evaluated Site

▬ ▪ ▬ Approximate boundary of BLM land Scale: 1 inch = 2,000 feet

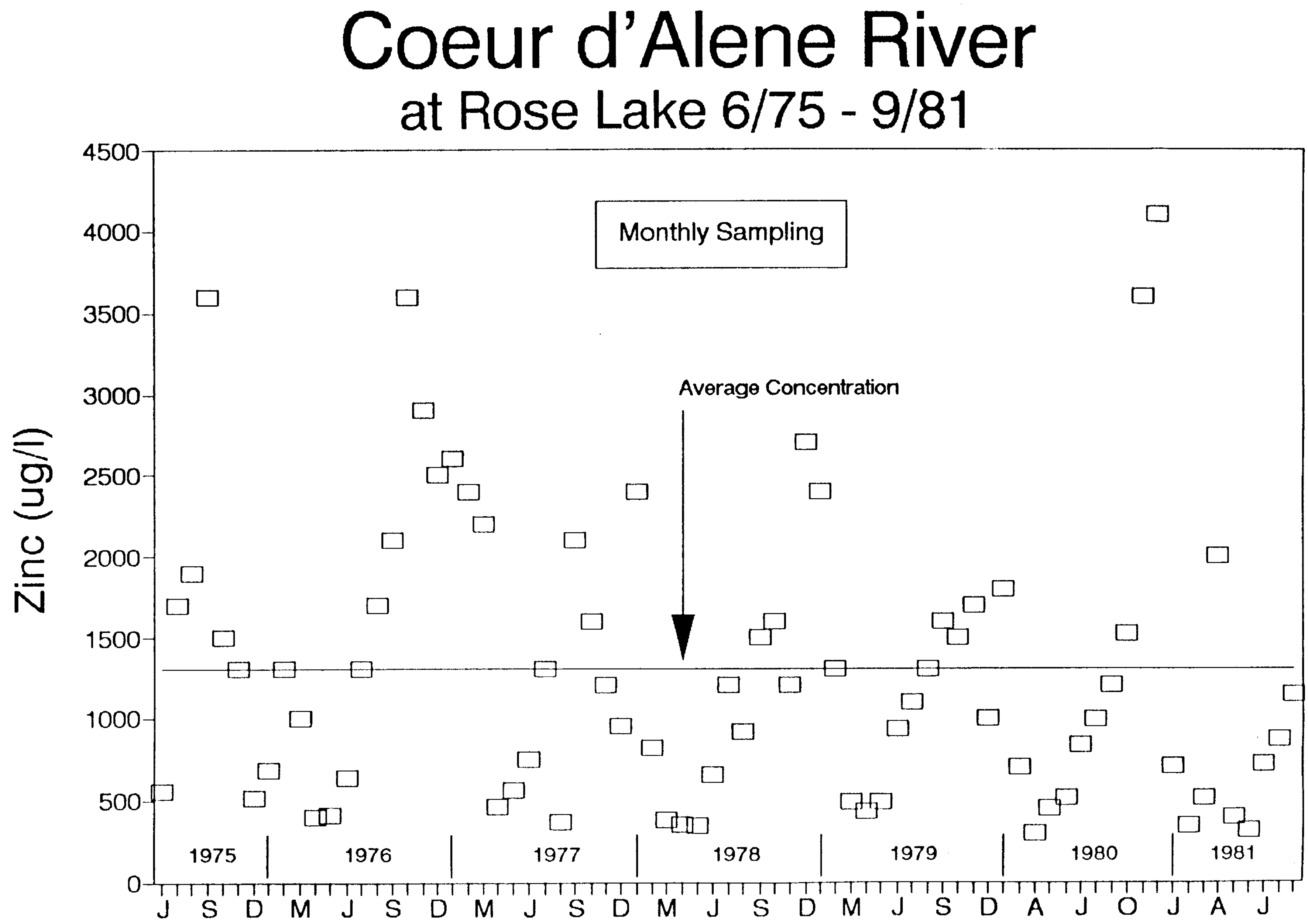

Figure 4-8. Monthly zinc concentration in the Coeur d'Alene River at Rose Lake.

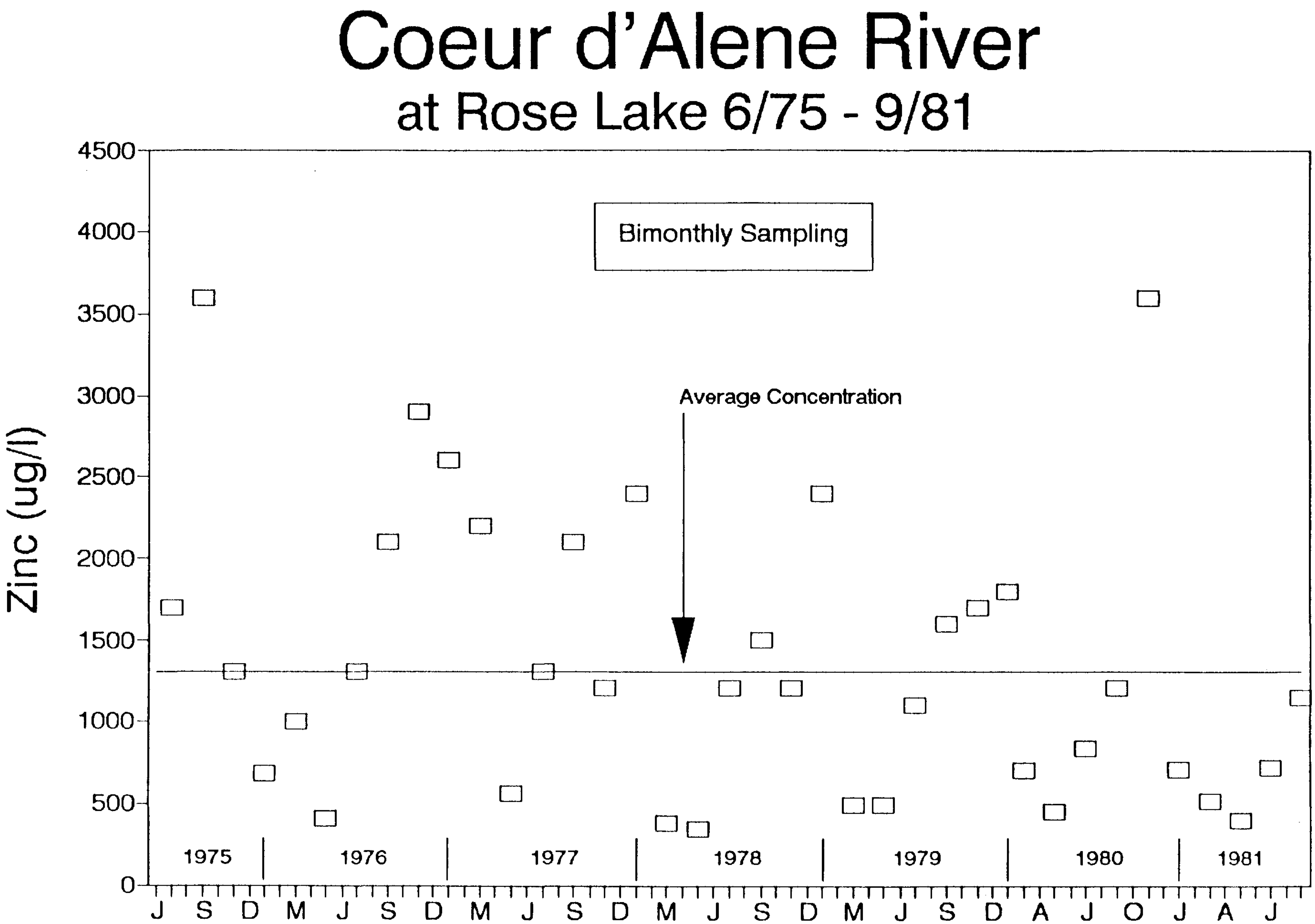

Figure 4-9. Bimonthly zinc concentration in the Coeur d'Alene River at Rose Lake.

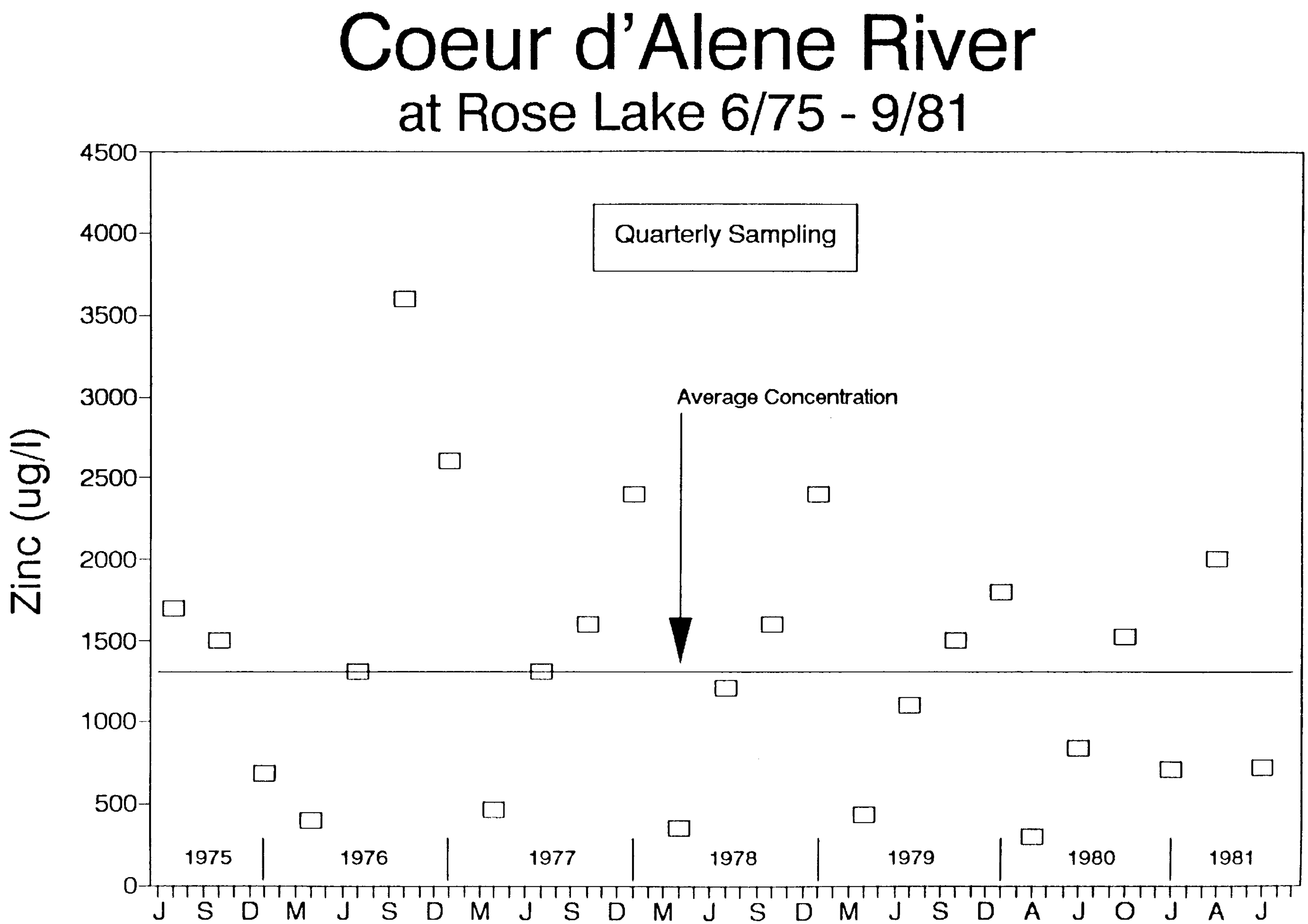

Figure 4-10. Quarterly zinc concentration in the Coeur d'Alene River at Rose Lake.

5. Establishment of Monitoring Sites

The monitoring sites recommended by GSA and approved by BLM were established on March 28, 1990 by GSA personnel. A total of six sites were established at following locations:

- *the CDAR near Cataldo,*
- *the CDAR near Rose Lake,*
- *Killarney Lake,*
- *Killarney wetlands,*
- *Thompson Lake, and*
- *near the mouth of the CDAR.*

Initial water quality samples were collected at each site and analyzed for the recommended constituents (with the exception of hardness). The establishment of each site and the associated sampling are described in the following sections.

5.1 Site Descriptions

Reference markers, maps, and photographs were used to document the location of each of the six sites. The following sections provide narrative descriptions of the locations of each of the monitoring sites.

5.1.1 Cataldo

The site established near Cataldo is located on the county road bridge across the CDAR just west of Cataldo (Figures 4-1 and B-1). A water level measurement and a water sample were collected from near the center of the bridge on the upstream side. The bridge has a series of holes on each side along the curb to allow surface-water drainage. The water level was measured through one of these drain holes with an electric water level probe (Figure B-2). The top of the drain hole, which corresponds to the top of the road surface, was used as the datum for the water level measurement. The drain hole used for the measurement was located on the upstream side of the bridge and was the seventh such hole from the east end of the bridge. This location is approximately 114.5 feet from the beginning of the concrete curb at the east end of the bridge.

A water sample was collected from the bridge at same location as the water level measurement. The sample was collected by lowering a bailer over the railing on the upstream side of the bridge. After collection in the bailer, the sample was transferred into a preacidified 1-liter plastic bottle. A second sample was collected for on-site measurement of water temperature, specific conductance, and pH.

5.1.2 Rose Lake

A monitoring site was established at the bridge across the CDAR at Rose Lake (Figures 4-3 and B-3) A water level measurement and a water sample were collected from near the center of the bridge on the upstream side. The measurements were taken next to the 22nd metal guard rail post from the northwest end of the bridge. This location is approximately 135 feet from the beginning of the concrete bridge deck at the northwest end. The water level measurement was taken with an electric water level probe. The top of the concrete deck beside the guard rail post was used as the datum for the water level measurement (Figure B-4).

A water sample was collected from the bridge at the same location as the water level measurement. The sample was collected by lowering a bailer over the railing on the upstream side of the bridge. After collection in the bailer, the sample was transferred into a preacidified 1-liter plastic bottle and placed on ice. A second sample was collected for on-site measurement of water temperature, specific conductance, and pH.

5.1.3 Killarney Lake

A monitoring site was established at the Killarney Lake boat ramp (Figure 4-4). A water level measurement and a water sample were collected from the western most dock at the boat ramp. A reference point for water level measurements was established on the fourth piling from the shore (near the end of the dock) along the east side of the western most dock (Figure B-5). The reference marker consists of two nails driven through a piece of orange flagging approximately 1-inch square. A third nail was driven into the center of the flagging with approximately 1/8-inch of the nail left showing (Figure B-6). The center of the nail that was left showing was used as the datum for the water level measurement. The marker is on the west side of the piling (facing the dock), approximately 4 feet from the top of the piling. It may be necessary to establish a second marker at a lower elevation on the pole for use during low water levels.

A water sample was collected from the end of the western most dock at the boat ramp. The water temperature, specific conductance, and pH were measured in the field. This is the same location sampled by GSA during the check characterization sampling (site KL-1).

5.1.4 Killarney Wetlands

A monitoring site was established in the wetlands southeast of Killarney Lake (Figure 4-4). The site is accessed by foot along the dike leading south from Killarney Lake Road, and is located along the main channel west of the dike (Figure B-7). The site is approximately 2,500 feet from Killarney Lake Road. The location of the site is identified by a large bird habitat platform constructed by the Idaho Department of Fish and Game (Figure B-8). Two of these platforms exist in this area. The sampling site is located west of platform that is farthest north. This is the same location sampled by GSA during the check characterization sampling (site KL-2, Figure 3-2). A water sample was collected from the channel with a bailer and then transferred into a preacidified 1-liter plastic bottle. A second sample was collected for the field measurement of water temperature, specific conductance, and pH. No water level measurement was made.

5.1.5 Thompson Lake

A monitoring site was established along the northern shore of Thompson Lake. The site is located along Thompson Lake Road approximately 2.95 miles from the junction with State Highway 97 and 0.75 miles east of the junction of Thompson Lake Road and Asbury Road (Figure 4-6). The site is identified by a single large tree in a low lying area beside the lake (Figure B-9), with an open draw north of the road (Figure B-10). The draw is enclosed by a fence with metal gates west and east of the site (Figure B-11). A water sample was collected by wading into the lake near the the tree mentioned above. The water temperature, specific conductance, and pH were measured in the field. This is the same location sampled by Weston and by GSA during the check characterization sampling (site TL-1, Figure 3-1).

The water level was measured at the bridge across the inlet to Thompson Lake with an electric water level probe. The bridge is located on Blue Lake Road south of Thompson Lake, 0.8 miles from the junction with Thompson Lake Road and 3.3 miles from the junction with State Highway 97. The measurement was taken near the center of the bridge on the lake side, beside the fifth rail post from either end (Figure B-12). The datum used for the water level measurement was the top of the wooden deck next to the post. The location of the rail post was marked with orange paint (Figure B-13).

5.1.6 Mouth of the CDAR

A monitoring site was established on the State Highway 97 bridge across the CDAR near Harrison (Figure B-14). A water level measurement and a water sample were collected from near the center of the bridge on the upstream side. The water level was measured with an electric water level probe. The location where the water level measurement and water sample were collected is directly beneath an "X" formed by the cross braces on the bridge (Figure B-15). A metal rail post is located directly below the "X". The measurements were taken beside this post, on the north side. This location was marked on the post with orange paint (Figure B-16). The top of the concrete curb next to the post was used as the datum for the water level measurement.

A water sample was collected from the bridge at same location as the water level measurement. The sample was collected by lowering a bailer over the railing on the upstream side of the bridge. After collection in the bailer, the sample was transferred into a preacidified 1-liter plastic bottle and placed on ice. A second sample was collected for on-site measurement of water temperature, specific conductance, and pH.

5.2 Baseline Sample Collection

Water quality samples were collected at each of the six montoring sites described in Section 5.1. The sampling included field measurements of pH, specific conductance, water temperature, and water level (except for the Killarney wetlands), and laboratory analyses of total recoverable cadmium, lead, and zinc. The results of the sampling are presented in Tables 5-1 and 5-2.

Lead concentrations exceeded the EPA acute toxicity standard (Table 2-6) in all six of the samples and the Federal Drinking Water Standard (Table 2-7) in five of the samples. Cadmium was found above the detection limit of 1 μg/l in three of the six samples. The cadmium levels in these three samples exceeded the acute toxicity criteria (Table 2-6). Zinc levels exceeded the acute toxicity criteria (Table 2-6) in all six of the samples.

The Killarney wetlands contained the highest levels of lead and zinc (131 μg/l and 387 μg/l, respectively). Thompson Lake contained the second highest lead concentration (100 μg/l) and the lowest zinc concentration (134 μg/l). The lowest lead concentration was found at Cataldo (39 μg/l). The highest cadmium concentrations were found at the mouth of the CDAR (5 μg/l) and at Cataldo (4 μg/l).

The results of the samples collected from Killarney and Thompson Lakes were compared with those collected by GSA during December of 1989 and January of 1990 (Table 3-2). This comparison shows that cadmium, lead, and zinc levels at Killarney Lake had decreased during this period. At Thompson Lake, the concentration of cadmium and zinc had decreased, while the concentration of lead had approximately doubled during the same period.

Table 5-1. Field Water Quality Measurements, March 28, 1990.

Location	pH	Specific Cond.[1]	Water Temp.[2]	Water Level[3]
Cataldo	6.22	40	3.7	18.1
Rose Lake	6.40	35	7.5	26.9
Killarney Lake	7.83	30	7.6	6.1
Killarney Wetlands	7.26	60	9.0	N/A
Thompson Lake	6.94	30	15.2[4]	12.3
Mouth	6.75	30	6.0	37.1

[1]μmho
[2]°C
[3]feet below the established datum
[4]measured in shallow water, warmed by the sun

Table 5-2. Metal Concentrations (μg/l), March 28, 1990

Location	Cadmium	Lead	Zinc
Cataldo	4	39	241
Rose Lake	ND	99	286
Killarney Lake	ND	59	224
Killarney Wetlands	3	131	387
Thompson Lake	ND	100	134
Mouth	5	70	252
Detection Limit	1	1	1

ND = not detected

6. Summary and Conclusions

Based on the review of STORET data, previous studies concerning the CDAR and lateral lakes, and the data gaps that have been identified, GSA concludes that:

- *The existing water quality database is not sufficient to characterize present day water quality conditions in the Lower Coeur d'Alene River drainage.*
- *A long-term monitoring plan is necessary to further characterize water quality conditions near the BLM lands in the Lower Coeur d'Alene River drainage.*
- *The monitoring plan should span a minimum of five years, with samples being collected during a variety of flow conditions.*
- *A large network of stations (6), including both the CDAR and the lateral lakes along the CDAR, should be established and sampled regularly.*

A total of 13 water samples were collected by GSA from four sites at Killarney and Thompson Lakes between December 6, 1989 and January 22, 1990. These samples were analyzed for cadmium, lead, mercury, and zinc. Cadmium, lead, and zinc were found in levels exceeding federal chronic and acute toxicity standards. Cadmium and lead were present at levels near or exceeding Federal Drinking Water Standards. Mercury was not found above detectable limits.

The results of the sampling compare favorably with those of previous studies. One exception is a lead concentration of 7,000 μg/l in Thompson Lake reported by Roy F. Weston, Inc (1989). It is believed that this high value is the result of a sampling or analysis error.

In all cases, the concentrations of cadmium, lead, and zinc were considerably lower in Thompson Lake than in Killarney Lake. This is likely a result of a more direct connection to the CDAR (i.e., a larger inlet channel) at Killarney Lake (Bauer, 1974).

The concentrations of lead and zinc at the Killarney Lake boat ramp appear to follow the patterns noticed in the CDAR with fluctuations in water level. High water levels in the CDAR are associated with high lead concentrations and low zinc concentrations, while low water levels in the CDAR are associated with low lead concentrations and high zinc concentrations. However, the patterns observed at Killarney Lake are based on few observations and may not reflect long-term trends. Specific conductance and, to a certain extent, pH at the Killarney Lake boat ramp appear to follow the pattern of zinc.

Samples collected by GSA on March 28, 1990 from the CDAR, Killarney Lake, Killarney wetlands, and Thompson Lake resulted in cadmium, lead, and zinc levels exceeding federal chronic and acute toxicity standards and lead concentrations exceeding the Federal Drinking Water Standards.

7. Recommended Actions

Based on the metal concentrations that have occurred in the past and those found during this study, it is recommended that continued monitoring of the Lower Coeur d'Alene River and lateral lakes be implemented. The monitoring plan has been initiated, but must be continued to be of any benefit. Therefore, GSA recommends that the BLM evaluate the alternatives presented in Section 4.5 and take the necessary steps to implement the most favorable option.

GSA also recommends that the BLM consider posting signs at public facilities along the CDAR and at Killarney and Thompson Lakes alerting the public of the potential hazards of ingesting heavy metal contaminated surface waters. Cadmium and lead levels were near or above the Federal Drinking Water Standards in the samples collected by GSA at Killarney and Thompson Lakes, as were lead levels in samples collected from the CDAR.

8. References

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Appendix A

Laboratory Results

PRECISION ANALYTICS, INC.

N.E. 2345 Hopkins Court • Pullman, WA 99163
TEL. (509) 332-0928

received
1-17-90 BCD

January 15, 1990

Grant, Schreiber & Associates
1000 W Hubbard Ave.
Coeur d'Alene, ID 83814

Report #: GSA_0115.001
Items: JLGA Agreement # S89054I - Metals Analysis
Job #: 609312
Lab Log-In #: 445

Analysis
Lead - EPA 239.2
Cadmium - EPA 213.2
Zinc - EPA 289.2
Mercury - EPA 245.1

All results are in ug/L (ppb)

Sample	Pb	Cd	Zn	Hg
KL-1	285	3	410	< 20
TL-1	50	2	250	< 20

Respectfully,

Mike Pearson
Laboratory Supervisor

JAMES L. GRANT & ASSOCIATES
FILE ENTRY VALIDATION

PROJECT NO. 609312
FILE CATEGORY Data
DESCRIPTION Laboratory results

GENERATED BY Precision Analytics
FILED BY BCD
DATE 1-17-90

PRECISION ANALYTICS, INC.

N.E. 2345 Hopkins Court • Pullman, WA 99163
TEL. (509) 332-0928

received 2-14-90

February 12, 1990

Grant, Schreiber & Associates
1000 W Hubbard Ave.
Coeur d'Alene, ID 83814

Report #: GSA_021290.002
Items: JLGA Agreement # S89054I - Metals Analysis QC Information
Job #: 609312
Lab Log-In #: 445, 460, 468, 487

Analysis
Lead - EPA 239.2
Cadmium - EPA 213.2
Zinc - EPA 289.2
Mercury - EPA 245.1

All results are in ug/L (ppb) ND = Not Detected

Mercury Spike QC Samples

Sample		Sample Conc.	10 ppb Spike Concentration	% Recovery
KL-1	12/6/89	ND	9.0	90
TL-1	12/6/89	ND	8.5	85
KL-1	1/3/90	ND	8.1	81
KL-2	1/3/90	ND	8.0	80
KL-3	1/3/90	ND	8.2	82
TL-1	1/3/90	ND	8.1	81
KL-1	1/24/90	ND	10.4	104
KL-2	1/24/90	ND	10.1	101
KL-3	1/24/90	ND	10.9	109

Inter-Laboratory Mercury Duplicates

Detection Limit (Both Labs) = 1.0 ppb

Sample		Precision Analytics	ABC Lab (Spokane)
KL-1	12/20/89	ND	ND
KL-2	12/20/89	ND	ND
KL-3	12/20/89	ND	ND
TL-1	12/20/89	ND	ND

PRECISION ANALYTICS, INC.
N.E. 2345 Hopkins Court • Pullman, WA 99163
TEL. (509) 332-0928

Inter-Lab QC Duplicates - Pb, Cd, Zn

UOI = University of Idaho
WSU = Washington State University
RPD = Relative Percent Difference

Sample	Pb UOI	Pb WSU	Pb RPD	Cd UOI	Cd WSU	Cd RPD	Zn UOI	Zn WSU	Zn RPD
KL-1 1/3/90	89	109	20	8	8	0	1540	1680	9
KL-2 1/3/90	324	348	7	3	4	29	610	850	32
KL-3 1/3/90	472	528	11	5	6	18	340	350	3
TL-1 1/3/90	47	43	9	ND	ND	0	29	19	41

Respectfully,

Mike Pearson
Laboratory Supervisor

JAMES L. GRANT & ASSOCIATES
FILE ENTRY VALIDATION

PROJECT NO. 609312
FILE CATEGORY Data
DESCRIPTION
Metals Analysis QC Information

GENERATED BY DLS
FILED BY BRO
DATE 2-12-90/2-14-90

PRECISION ANALYTICS, INC.

N.E. 2345 Hopkins Court • Pullman, WA 99163
TEL. (509) 332-0928

received
2-14-90 BCG

February 12, 1990

Grant, Schreiber & Associates
1000 W Hubbard Ave.
Coeur d'Alene, ID 83814

Report #: GSA_021290.001
Items: JLGA Agreement # S89054I - Metals Analysis
Job #: 609312
Lab Log-In #: 445, 460, 468, 487

Analysis
Lead - EPA 239.2
Cadmium - EPA 213.2
Zinc - EPA 289.2
Mercury - EPA 245.1

All results are in ug/L (ppb) ND = Not Detected

Sample/Date		Pb	Cd	Zn	Hg
Detection Limit		5	1	5	1
KL-1	12/6/89	285	3	410	ND
TL-1	12/6/89	60	2	250	ND
TL-1	12/20/89	45	1	350	ND
KL-1	12/20/89	70	13	1400	ND
KL-2	12/20/89	190	7	1640	ND
KL-3	12/20/89	105	12	1890	ND
TL-1	1/3/90	35	ND	30	ND
KL-1	1/3/90	90	8	1540	ND
KL-2	1/3/90	325	3	610	ND
KL-3	1/3/90	470	5	340	ND
KL-1	1/23/90	85	5	1100	ND
KL-2	1/23/90	150	10	1020	ND
KL-3	1/23/90	165	10	1210	ND

JAMES L. GRANT & ASSOCIATES
FILE ENTRY VALIDATION

PROJECT NO. 609312
FILE CATEGORY Data
DESCRIPTION
Metals Analysis

Respectfully,

Mike Pearson
Laboratory Supervisor

GENERATED BY NLS
FILED BY BCG
DATE 2-12-90 / 2-14-90

PRECISION ANALYTICS, INC.

N.E. 2345 Hopkins Court • Pullman, WA 99163
TEL. (509) 332-0928

April 16, 1990

Grant, Schreiber & Associates
1000 W Hubbard Ave.
Coeur d'Alene, ID 83814

Report #: GSA_0416.001
Items: Metals Analysis
Lab Log-In #: 558

Analysis
Lead - EPA 239.2
Cadmium - EPA 213.2
Zinc - EPA 289.2

All results are in ug/L (ppb)   ND = Not Detected

Sample	Pb	Cd	Zn
Detection Limit	1	1	1
KL-1	59	ND	224
KL-2	131	3	387
TL	100	ND	134
RL	99	ND	286
CAT	39	4	241
MOUTH	70	5	252

Respectfully,

Mike Pearson
Laboratory Supervisor

JAMES L. GRANT & ASSOCIATES
FILE ENTRY VALIDATION

PROJECT NO. 609312
FILE CATEGORY Data
DESCRIPTION Lab Results

GENERATED BY Precision Analytics
FILED BY [illegible]
DATE 4-16-90

Appendix B

Photograph Documentation of Monitoring Site Locations

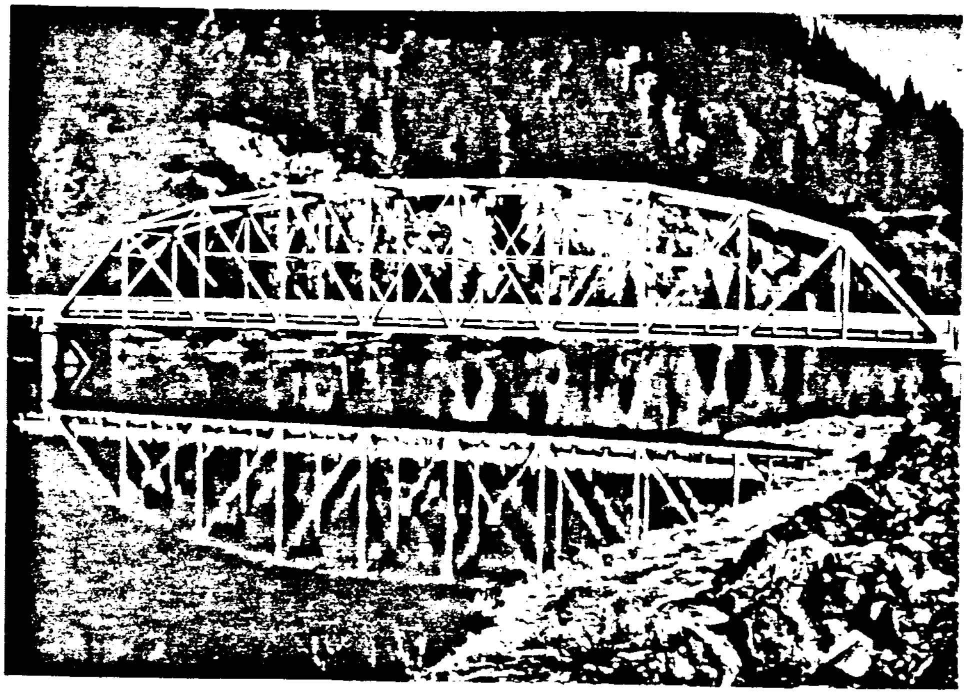

Figure B-1. Bridge across Coeur d'Alene River near Cataldo. (Looking upstream from east side).

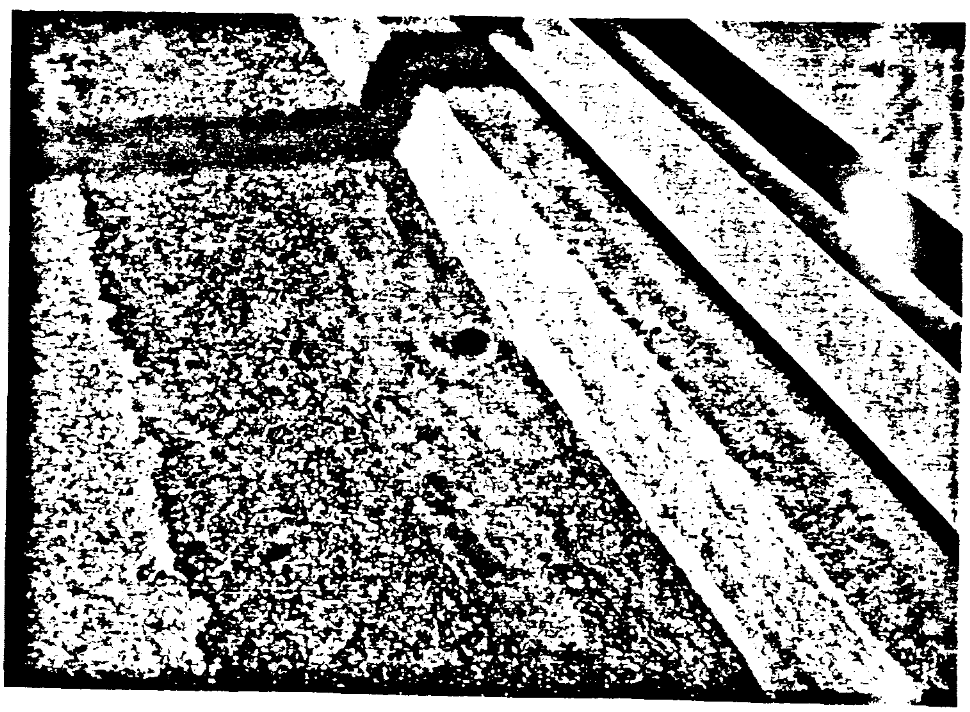

Figure B-2. Drain hole near curb on upstream side of bridge Cataldo.

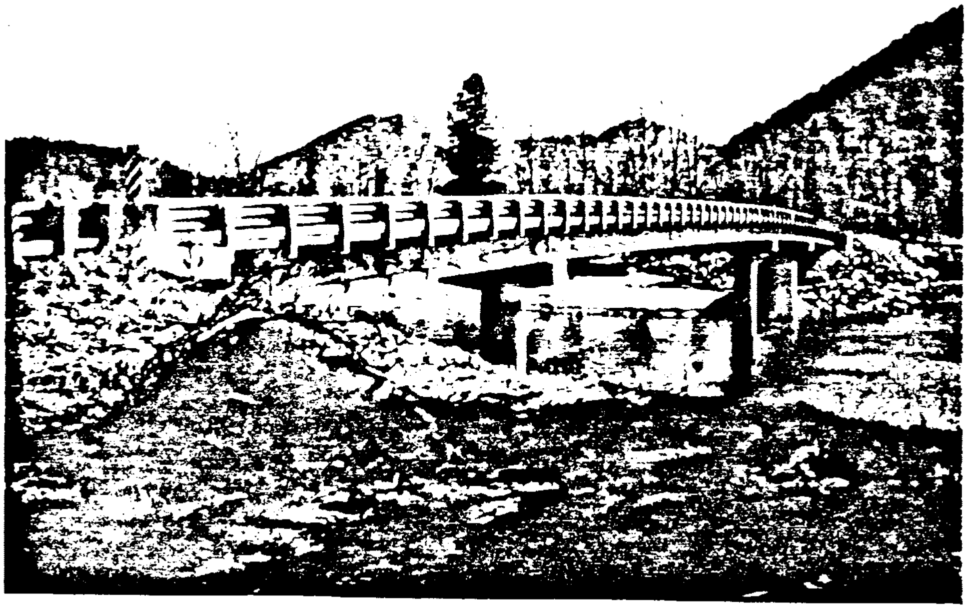

Figure B-3. Bridge across Coeur d'Alene River near Rose Lake.

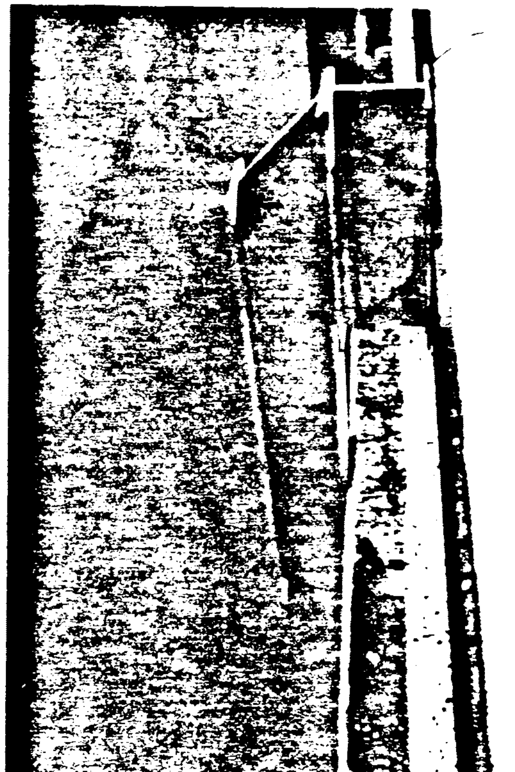

Figure B-4. Bridge across Coeur d'Alene River at Rose Lake. (Notice concrete deck and guard rail post where sample was collected).

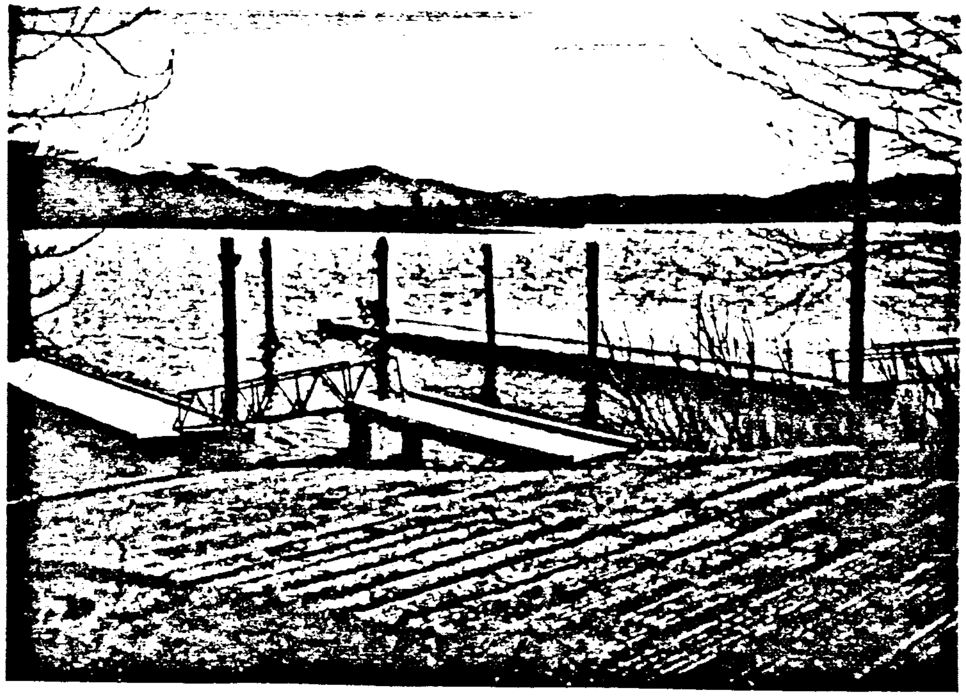

Figure B-5. Killarney Lake boat ramp and docks.

Figure B-6. Piling at Killarney Lake boat dock. (Notice reference marker for water level measurements).

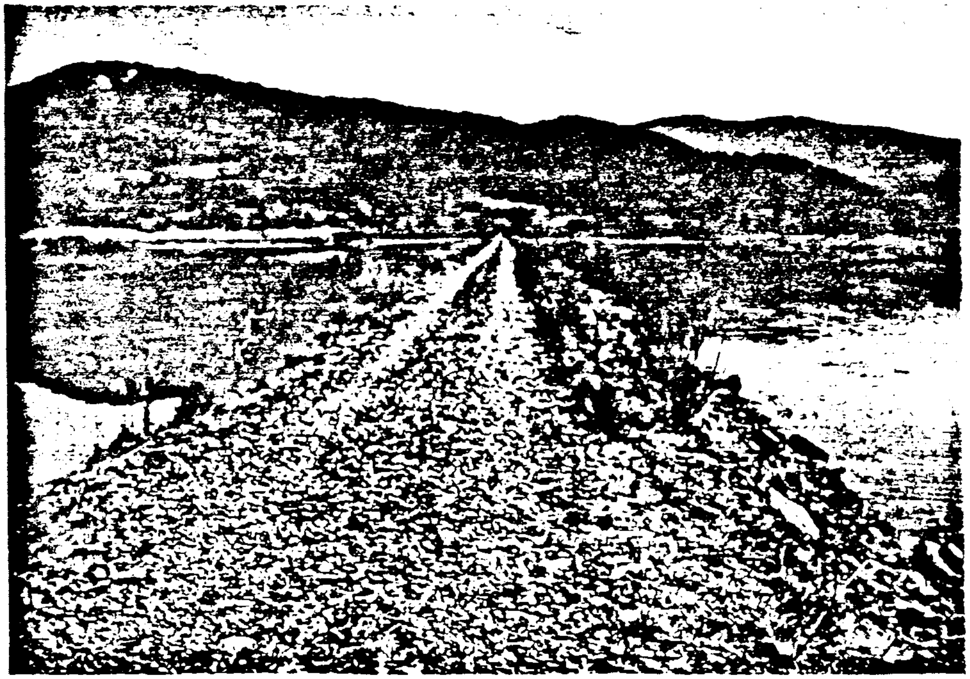

Figure B-7. Dike leading from Killarney Lake Road to wetlands. (Looking south from near Killarney Lake Road).

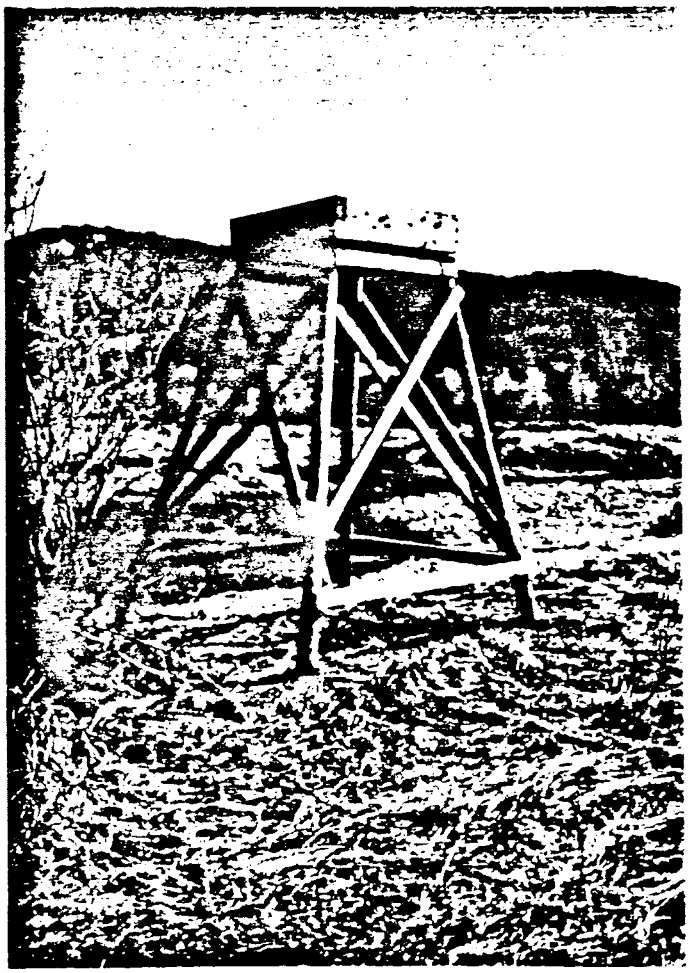

Figure B-8. Bird habitat platform located in the Killarney wetlands.

Figure B-9. Tree located near sampling site at Thompson Lake. (Looking east from Thompson Lake Road).

Figure B-10. Draw north of sampling site along Thompson Lake Road.

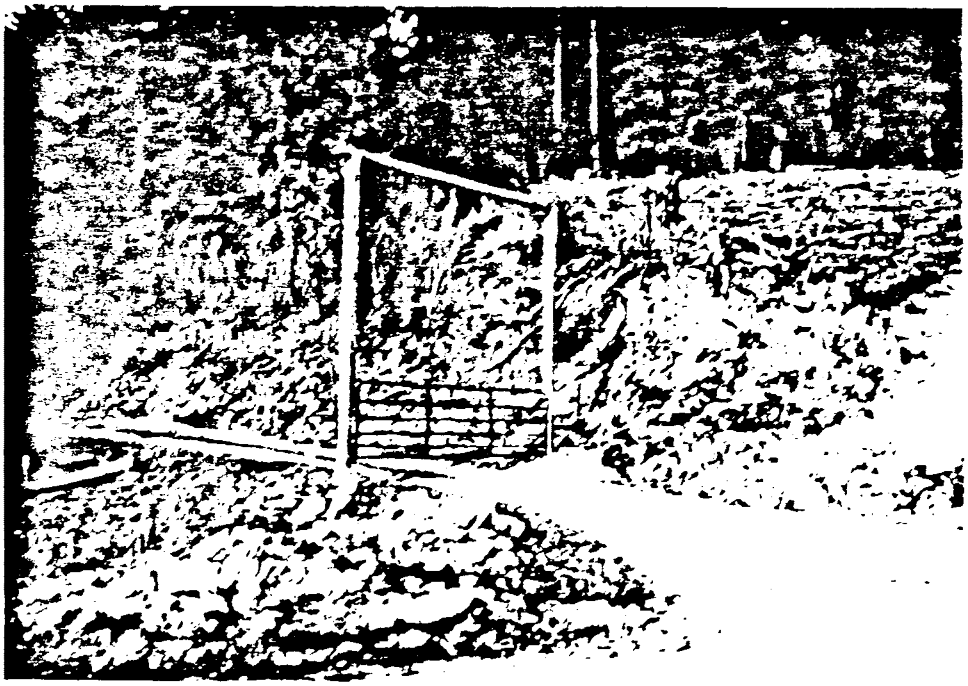

Figure B-11. Gate east of sampling site along Thompson Lake Road.

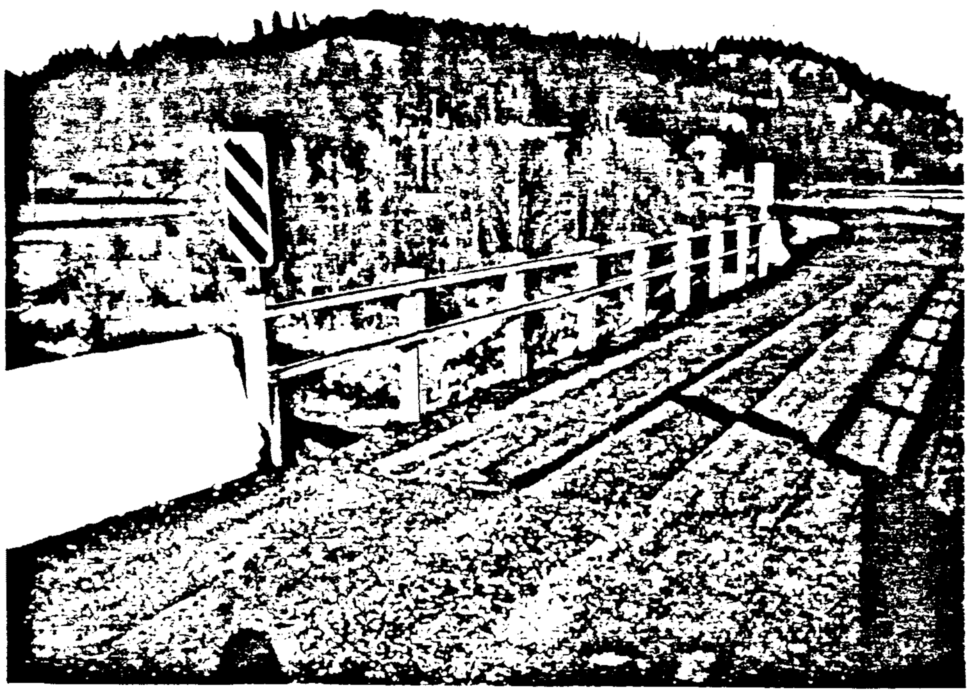

Figure B-12. Bridge across inlet to Thompson Lake. (Located along Blue Lake Road).

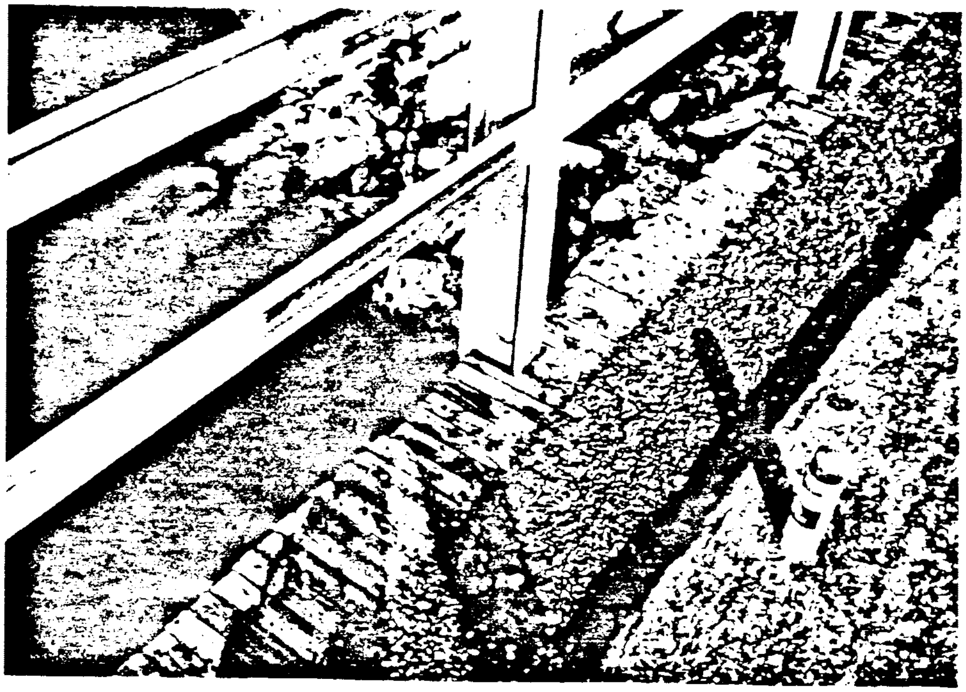

Figure B-13. Location of water level measurement on the bridge across the inlet to Thompson Lake .

Figure B-14. State Highway 97 bridge near the mouth of the Coeur d'Alene River.

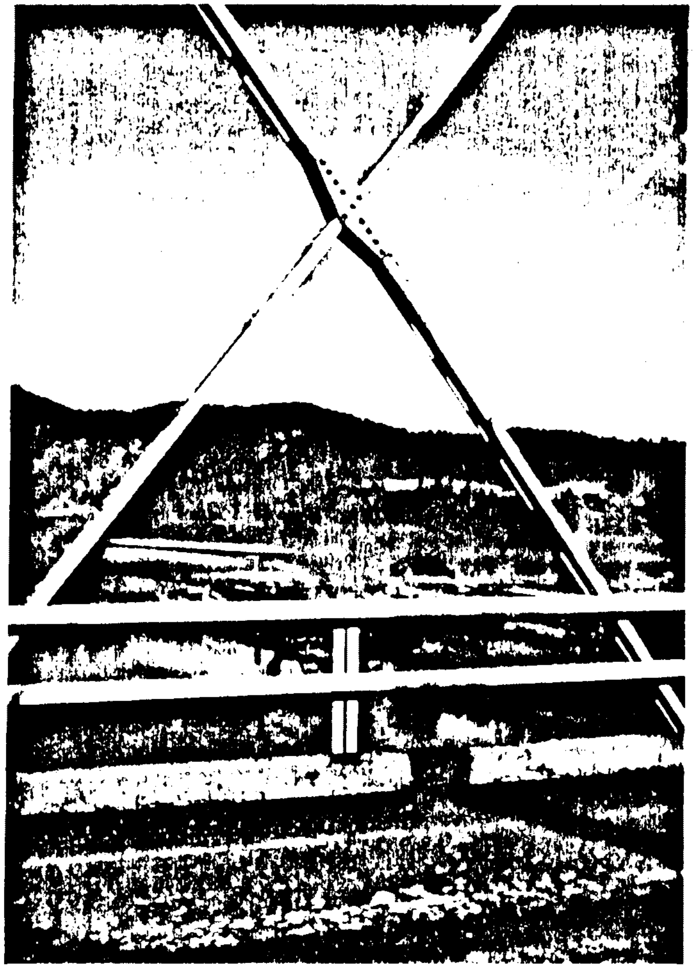

Figure B-15. Location of sampling site beneath "X" created by cross braces on State Highway 97 bridge across the Coeur d'Alene River.

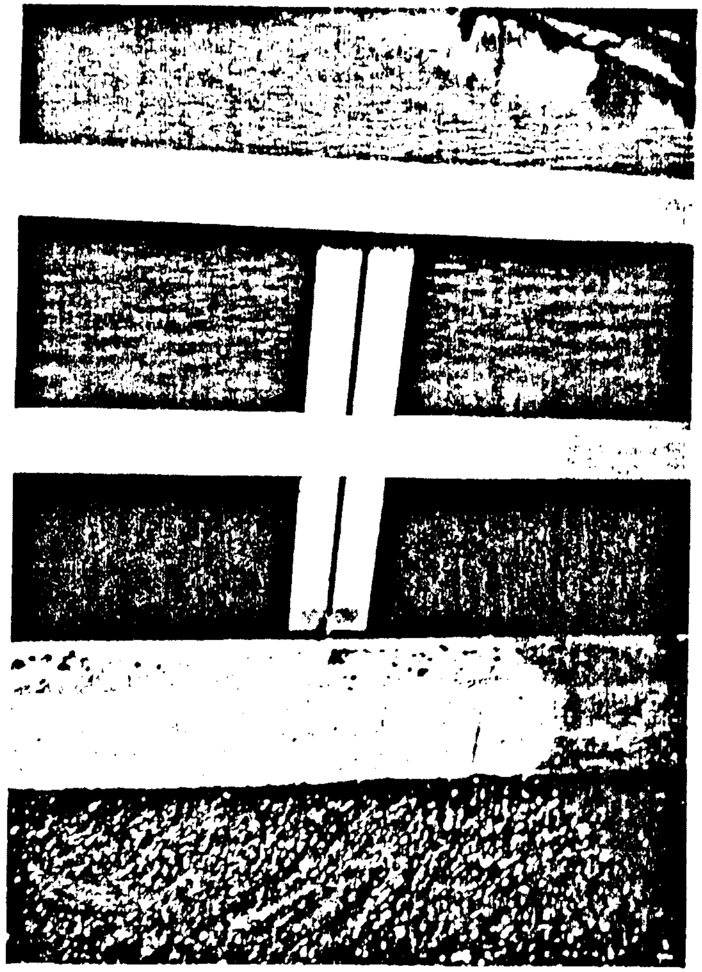

Figure B-16. Location of sampling site on State Highway 97 bridge across the Coeur d'Alene River.