Callahan Mining Corp

Brooksville (Cape Rosier), Maine

EPA Facility ID: MED980524128

Basin: Maine Coastal

HUC: 01050002

Executive Summary

The Callahan Mining Corp site [sic] operated an open-pit mine for zinc and copper, the Callahan Mine, from 1968 through 1972. The site is approximately 305 m (1,000 ft) east-southeast of Harborside Village within the minor civil division of Brooksville, Maine. Harborside Village is on the Cape Rosier Peninsula at Penobscot Bay. The mine property encompasses 61 ha (151 acres). The former open-pit mine filled with water after mining operations ceased and is currently under Goose Pond. Metals are the primary contaminants of concern, particularly cadmium, copper, lead, and zinc. The marine and estuarine waters surrounding the site (Goose Cove, Goose Pond, Penobscot Bay, and the Atlantic Ocean) support a wide range of NOAA trust resources, including fish, shellfish, and other invertebrates.

Site Background

The Callahan Mining Corp [sic] operated an open-pit mine for zinc and copper, the Callahan Mine, at the site from 1968 through 1972. The site is approximately 305 m (1,000 ft) east-southeast of Harborside Village within the minor civil division of Brooksville, Maine. Harborside Village is on the Cape Rosier Peninsula at Penobscot Bay. The mine property encompasses approximately 61 ha (151 acres) of coastline along Goose Pond (Figure 1).

Historically Goose Cove was connected to Goose Pond by Goose Falls, which was a tidally influenced, reversing waterfall. The reversing waterfall was created when at low tide stages the estuarine water flowed over the rock shelf toward Penobscot Bay and then at high tide stages the water flowed from Penobscot Bay into Goose Pond. When the mine was developed, Goose Pond was drained, and dams were built to prevent fresh and salt water from entering the area. When the mine was first in operation, water containing rock flour, silt, and high concentrations of metals was pumped directly from the mine pit to Goose Cove. As the mine expanded, Dyer Cove was converted into a settling pond by enclosing the cove with a causeway (Figure 2). After Dyer Cove was converted to a settling pond it was called Dyer Pond and water from the mine was pumped into it before being discharged into Goose Cove (Weston 2001). When the mine closed, the dams blocking the flow of fresh and saltwater into the mine area were removed, Dyer Cove was reconnected with the rest of Goose Pond, and Goose Pond was flooded. Goose Pond now covers the former location of the open-pit mine (Weston 2001).

During the four years that the mine operated, 730 million kg (800,000 tons) of ore-bearing rock were removed from the Callahan Mine. After the ore-bearing rock was removed from the mine it was loaded into a series of crushers and mills to reduce it to sand and silt sized particles. A flotation process, which employed chemical reagents, was then used to separate particles containing high concentrations of copper and zinc, known as concentrate, from particles containing lower concentrations of metals, known as tailings.

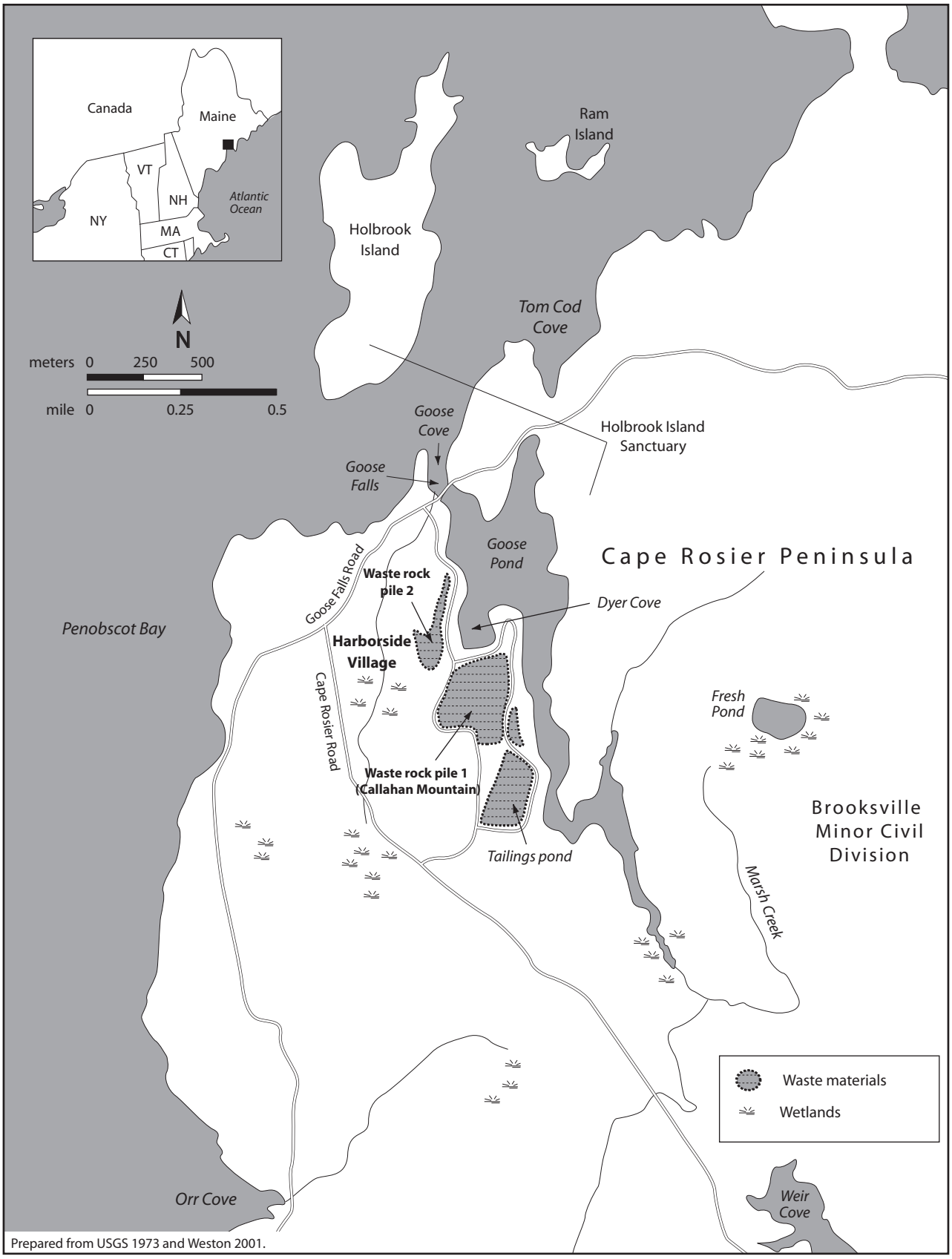

Figure 1. Location of the Callahan Mining Corp site in Brooksville (Cape Rosier), Maine.

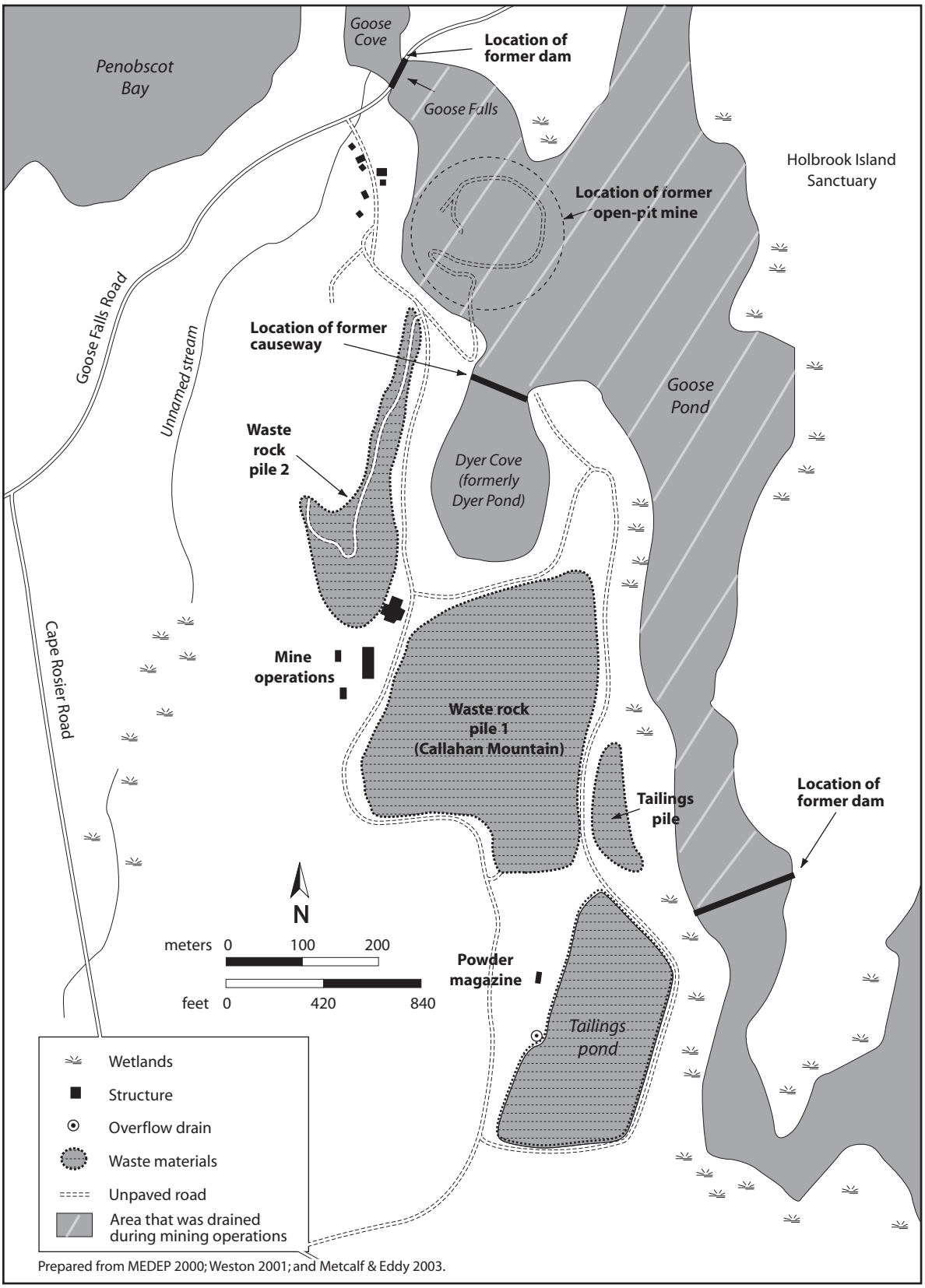

Figure 2. Detail of the Callahan Mining Corp property in Brooksville (Cape Rosier), Maine.

The tailings and residues of the chemical reagents were discharged to a 4.5-ha (11-acre) tailings pond. The tailings pond is in an area where the ground surface slopes down toward Goose Pond. A dike was constructed on three sides of the tailings pond to separate the tailings from Goose Pond. The tailings pond currently has slow leaks at several areas along the base of the dike (Weston 2001). When the mine was active, a canal was present adjacent to the tailings pond. The canal was used to divert fresh water to Weir Cove, away from the mine (Figure 1). The exact location of the canal could not be determined from the documents reviewed. No actions were taken to prevent metals and residual chemicals from leaching out of the tailings pond and into the canal or Weir Cove (Firth 1995).

Approximately 4.5 billion kg (5 million tons) of non ore-bearing waste rock were removed from the Callahan Mine. The waste rock was piled throughout the property; however, the greatest quantity of rock was piled south of Dyer Cove, in an area referred to as waste rock pile 1 or "Callahan Mountain." The second largest quantity of waste rock was piled in an area known as waste rock pile 2.

Surface water and groundwater are the primary pathways for the migration of contaminants toward NOAA trust resources. Surface runoff from the site enters Goose Pond, which is approximately 1 km (0.6 mi) in length. Goose Pond then spills over Goose Falls and into Goose Cove, which is connected to Penobscot Bay and the Atlantic Ocean. Although a quantitative analysis of groundwater depth and flow direction has not been completed at the site groundwater flow is likely towards Goose Pond (Metcalf & Eddy 2003).

Several studies of Goose Pond have been conducted to assess the environmental impact of operations at the Callahan Mining Corp site. The most recent study was conducted in October 1999. The U.S. Environmental Protection Agency is preparing to begin a remedial investigation of the site in 2004. The Callahan Mining Corp site was placed on the National Priorities List in September 2002.

NOAA Trust Resources

The NOAA trust habitats of concern are the surface waters of Goose Cove, Goose Pond, and Penobscot Bay and wetlands associated with the Holbrook Island Sanctuary. Several NOAA trust resources, including fish and invertebrates, are found in Goose Cove and Penobscot Bay (Table 1). NOAA trust resources observed in Goose Pond during a 2003 site reconnaissance include, American eel, softshell clam, blue crab, blue mussel, and moon jellies (Metcalf & Eddy 2003). A complete list of NOAA trust resources present in Goose Pond was not available, but it is assumed that species distribution is similar to that of Goose Cove and Penobscot Bay.

Goose Pond is a tidally influenced saltwater estuary (Firth 1995). The Holbrook Island Sanctuary state park, is located both on Holbrook Island to the north and along the east shore of Goose Pond, opposite the Callahan Mining Corp site. The sanctuary provides habitat for numerous species of wildlife and plant life (Weston 2001). In addition, approximately 1.2 km (0.77 mi) of wetlands are adjacent to Goose Pond, and over 100 areas designated as sensitive environments by the state of Maine, are present within a 16 to 24 km (10 to 15 mi) radius of the site (Firth 1995; Weston 2001).

Alewife, American eel, American lobster, Atlantic herring, Atlantic rock crab, softshell clam, and blue mussel are all fished commercially in Penobscot Bay and Goose Cove. There is recreational fishing of Atlantic mackerel, bluefish, pollock, and striped bass in the Penobscot Bay area. No fish consumption advisories are currently in effect for Goose Cove, Goose Pond, or Penobscot Bay.

Table 1. NOAA trust resources found in Goose Cove and Penobscot Bay (Jury et al. 1994; Joule 2002; Metcalf & Eddy 2003).

Species		**Habitat Use**			**Fisheries**	
Common Name	Scientific Name	Spawning Ground	Nursery Ground	Adult Habitat	Comm.	Rec.
ANADROMOUS/CATADROMOUS						
American eel	*Anguilla rostrata*		◆	◆	◆	
Alewife	*Alosa pseudoharengus*		◆	◆	◆	
Atlantic herring	*Clupea harengus*		◆	◆	◆	
Atlantic tomcod	*Microgadus tomcod*	◆	◆	◆		
Blueback herring	*Alosa aestivalis*		◆	◆		
Rainbow smelt	*Osmerus mordax*		◆	◆		
Striped bass	*Morone saxatilis*			◆		◆
MARINE/ESTUARINE FISH						
American plaice	*Hippoglossoides platessoides*		◆			
Atlantic mackerel	*Scomber scombrus*		◆	◆		◆
Atlantic menhaden	*Brevoortia tyrannus*			◆		
Bluefish	*Pomatomus saltatrix*		◆	◆		◆
Cunner	*Tautogolabrus adspersus*		◆	◆		
Fourspine stickleback	*Apeltes quadracus*	◆	◆	◆		
Grubby	*Myoxocephalus aenaeus*	◆	◆	◆		
Mummichog	*Fundulus heteroclitus*	◆	◆	◆		
Ninespine stickleback	*Pungitius pungitius*	◆	◆	◆		
Northern pipefish	*Syngnathus fuscus*	◆	◆	◆		
Pollock	*Pollachius virens*		◆			◆
Red hake	*Urophycis chuss*		◆	◆		
Rock gunnel	*Pholis gunnellus*	◆	◆	◆		
Silver hake	*Merluccius bilinearis*		◆	◆		
Silversides	*Menidia spp.*	◆	◆	◆		
Smooth flounder	*Pleuronectes putnami*	◆	◆	◆		
Spiny dogfish	*Squalus acanthias*		◆	◆		
White hake	*Urophycis tenuis*		◆			
White perch	*Morone americana*		◆	◆		
Windowpane	*Scophthalmus aquosus*	◆	◆	◆		
Winter flounder	*Pleuronectes americanus*	◆	◆	◆		
INVERTEBRATES						
American lobster	*Homarus americanaus*		◆	◆	◆	
Atlantic rock crab	*Cancer irroratus*	◆	◆	◆	◆	
Blue crab	*Callinectes sapidus*	◆	◆	◆		
Blue mussel	*Mytilus edulis*	◆	◆	◆	◆	
Green crab	*Carcinus maenas*	◆	◆	◆		
Moon jelly	*Aurelia aurita*	◆	◆	◆		
Sevenspine bay shrimp	*Crangon septemspinosa*	◆	◆	◆		
Softshell clam	*Mya arenaria*	◆	◆	◆	◆	

Goose Pond is classified as "closed and prohibited" to commercial and recreational shellfish harvesting and has been since 1969 (Goodwin 2002). This closure is due to high concentrations of metals and fecal bacteria counts. In 1975, the Maine Marine Environmental Monitoring Program (MMEMP) studied the bioaccumulation of metals in softshell clams in and around Goose Cove. The study found concentrations of cadmium, copper, lead, and zinc several orders of magnitude above concentrations found in reference samples collected from other mid-coastal and river locations in Maine (Weston 2001). A 1993 report by the MMEMP showed elevated concentrations of cadmium, lead, and zinc in blue mussels collected from Goose Cove (Metcalf & Eddy 2003).

Site-Related Contamination

Metals are the primary contaminants of concern at the site. Fifteen groundwater samples, five surface water samples, and eight sediment samples (three of which were background samples) were collected from the Callahan Mining Corp site and analyzed for contaminants. Samples have not been collected from the Holbrook Island Sanctuary or the wetlands that border Goose Pond to the east. The groundwater and surface water samples were analyzed for metals; the sediment samples were analyzed for metals, including selenium, volatile organic compounds (VOCs), and semivolatile organic compounds (SVOCs) (Firth 1995; Fuller 1987). Table 2 summarizes the maximum concentrations of contaminants of concern to NOAA that were detected in samples collected during the site investigation. The screening guidelines are the ambient water quality criteria (AWQC) for groundwater (USEPA 2002), and the effects range-low (ERL) for sediment (Long et al. 1998), with exceptions as noted in Table 2.

Samples were also collected directly from the two waste sources identified at the site: the tailings pond and the waste rock piles. These samples included seep water from the base of the tailings pond, soil samples from the tailings pond and the waste rock piles, and sediments from the seeps at the base of the tailings pond dike. The seep sediment and tailings pond soil samples were analyzed for metals, including selenium. The seep water samples were analyzed for metals. Table 3 summarizes the maximum concentrations of contaminants of concern to NOAA that were detected in seep water, waste source soil, and seep sediment samples during the site investigation. The screening guidelines are the AWQC for groundwater; the Oak Ridge National Laboratory final preliminary remediation goals (ORNL-PRGs; Efroymson et al. 1997) for soil, and the ERL for sediment, with exceptions as noted in Table 3.

Groundwater

A quantitative analysis of groundwater depth and flow direction has not been completed at the site. It is likely that groundwater flow is towards Goose Pond (Metcalf & Eddy 2003). In groundwater, copper, lead, nickel, and zinc were detected at maximum concentrations that exceeded the AWQC by one order of magnitude. The maximum concentration of cadmium, detected in the groundwater samples, just exceeded the AWQC. The greatest concentrations of cadmium, copper, and zinc were detected in groundwater samples collected from monitoring wells southeast of Dyer Cove. The maximum nickel concentration in groundwater was detected in a sample collected south of Callahan Mountain. Lead was detected at a maximum concentration in a drinking water well southeast of the tailings pond.

Surface Water

Maximum concentrations of copper, lead, and zinc in surface water exceeded the AWQC by one order of magnitude. Cadmium was detected at a maximum concentration that exceeded the AWQC by a factor of more than two. Cadmium and copper were detected at maximum concentra-

tions in surface water samples collected from Goose Pond north of the tailings pond. The greatest concentration of zinc was detected in a surface water sample collected from a ditch north of the tailings pond however; the exact location of the ditch could not be determined from the documents reviewed. Lead was detected at a maximum concentration in a surface water sample collected from Goose Pond, east of the tailings pond.

Table 2. Maximum concentrations of contaminants of concern detected in environmental media collected from the Callahan Mine site, Brooksville (Cape Rosier), Maine (F. M. Beck Inc. 1986; Fuller 1987; Firth 1995; Weston 2001). Bold values indicate contaminant exceeded screening guidelines.

	Water (µg/L)			Sediment (mg/kg)	
Contaminant	Groundwater	Surface Water	AWQC[a]	Sediment	ERL[b]
METALS/INORGANICS					
Arsenic	N/A	N/A	36	**56**	8.2
Cadmium	**20**	**25**	8.8	**43**	1.2
Chromium[c]	N/A	N/A	50	45	81
Copper	**250**	**80**	3.1	**2,200**	34
Lead	**100**	**90**	8.1	**1,500**	46.7
Nickel	**150**	N/A	8.2	**40**	20.9
Selenium	N/A	N/A	71	**6.9**	1[d]
Silver	N/A	N/A	1.9[e]	**5.8**	1
Zinc	**1,600**	**4,900**	81	**22,000**	150
PAH					
Pyrene	N/A	N/A	NA	0.1	0.665

a: Ambient water quality criteria for the protection of aquatic organisms (USEPA 2002). Marine chronic criteria presented.

b: The effects range-low (ERL) represents the 10th percentile for the dataset in which effects were observed or predicted in studies compiled by Long et al. (1998).

c: Screening guidelines represent concentration for $Cr.^{+6}$

d: Marine apparent effects threshold (AET) for amphipod bioassay. The AET represents the concentration above which adverse biological impacts would be expected.

e: Chronic criterion not available; acute criterion presented.

NA: Screening guidelines not available

N/A: Contaminant not analyzed for.

Sediment

In sediment, all of the metals, including selenium, for which the samples were analyzed were detected. The maximum concentration of zinc exceeded the ERL by two orders of magnitude, while cadmium, copper, and lead concentrations exceeded the ERL by one order of magnitude. Maximum concentrations of arsenic, nickel, selenium, and silver exceeded the ERLs by factors ranging from two to nearly seven times the guidelines. Chromium was also detected, but the maximum concentration did not exceed the ERL screening guideline. Arsenic, cadmium, chromium, lead, selenium, silver, and zinc were all detected at their greatest concentration in sediment samples collected from Goose Pond near the tailings pond. The maximum concentrations of copper,

nickel, and pyrene were detected in sediment collected from Dyer Cove. No SVOCs were detected at concentrations greater than the screening guidelines.

In the seep sediment samples, the maximum concentrations of cadmium and zinc exceeded the ERL screening guidelines by two orders of magnitude. The maximum concentrations of arsenic, copper, lead, nickel, and silver exceeded the ERLs by one order of magnitude. Chromium was detected at a maximum concentration below the ERL.

Table 3. Maximum concentrations of contaminants of concern detected in waste sources collected from the Callahan Mine site, Brooksville (Cape Rosier), Maine (F. M. Beck Inc. 1986; Fuller 1987; Firth 1995; Weston 2001). Bold values indicate contaminant exceeded screening guidelines.

	Water (µg/L)		Soil (mg/kg)		Sediment (mg/kg)	
Contaminant	Seep Water	AWQC[a]	Waste Source Soil	ORNL[b] PRG	Seep Sediment	ERL[c]
METALS/INORGANICS						
Arsenic	N/A	36	**100**	9.9	**270**	8.2
Cadmium	**60**	8.8	**150**	0.38[d]	**170**	1.2
Chromium[e]	N/A	50	**26**	0.4	38	81
Copper	**50**	3.1	**110,000**	60	**1,600**	34
Lead	3	8.1	**9,100**	40.5	**760**	46.7
Mercury	N/A	0.094[f]	**4.4**	0.00051	N/A	0.15
Nickel	N/A	8.2	**30**	30	**250**	20.9
Selenium	N/A	71	**77**	0.21	**7**	1[g]
Silver	N/A	1.9[h]	**70**	2	**12**	1
Zinc	**14,000**	81	**18,000**	8.5	**58,000**	150

a: Ambient water quality criteria for the protection of aquatic organisms (USEPA 2002). Marine chronic criteria presented.

b: Oak Ridge National Laboratory (ORNL) final preliminary remediation goals (PRG) for ecological endpoints (Efroymson et al. 1997).

c: The effects range-low (ERL) represents the 10th percentile for the dataset in which effects were observed or predicted in studies compiled by Long et al. (1998).

d: Ecological soil screening guidelines (USEPA 2004).

e: Screening guidelines represent concentration for $Cr.^{+6}$

f: Derived from inorganic, but applied to total mercury.

g: Marine apparent effects threshold (AET) for amphipod bioassay. The AET represents the concentration above which adverse biological impacts would be expected.

h: Chronic criterion not available; acute criterion presented.

N/A: Contaminant not analyzed for.

Seep Water

In seep water, the maximum concentration of zinc exceeded the AWQC by two orders of magnitude; copper exceeded the AWQC by one order of magnitude, and cadmium exceeded the AWQC by a factor of six. Other metals were not detected in the seep water samples.

Soil

In soil samples collected from the tailings pond and waste rock piles, the maximum concentrations of copper, mercury, and zinc exceeded the ORNL-PRGs by three orders of magnitude. Maximum concentrations of copper, lead, and selenium were at least two orders of magnitude greater than the PRGs, while the maximum concentrations of arsenic, chromium, and silver exceeded the PRGs by one order of magnitude. The maximum concentration of nickel was equal to the screening guideline.

References

Efroymson, R. A., G. W. Suter II, B. E. Sample, and D. S. Jones. 1997. Preliminary remediation goals for ecological endpoints. August 1997. Prepared for U.S. Department of Energy, Oak Ridge, TN. Available at: Environmental Sciences Division, Oak Ridge National Laboratory, http://www.esd.ornl.gov/programs/ecorisk/documents/tm162r2.pdf (accessed August 12, 2004).

F. M. Beck Inc. 1986. Minesite environmental review, Harborside, Maine. Yarmouth, ME: Prepared for Arrowhead Holdings Corporation.

Firth, J. 1995. Final site inspection prioritization for Callahan Mining Corp., Brooksville, Maine. Augusta, ME: Maine Department of Environmental Protection.

Fuller, G. 1987. Memorandum to Susan Svirsky, EPA Region I: Site inspection report, Callahan Mine, Harborside, Maine. Augusta, ME.

Goodwin, R. Fisheries biologist for the Maine Department of Marine Resources, Shellfish and Public Health. Augusta, ME. Personal communication March 26, 2002.

Joule, B. Recreational fisheries biologist for the Maine Department of Marine Resources. Augusta, ME. Personal communication March 8, 2002.

Jury, S. H., J. D. Field, S. L. Stone, D. M. Nelson, and M. E. Monaco. 1994. Distribution and abundance of fishes and invertebrates in North Atlantic estuaries. ELMR Rep. 13. Silver Spring, MD: NOAA/NOS Strategic Environmental Assessments Division. 221 pp.

Long, E.R., L.J. Field, and D.D. MacDonald. 1998. Predicting toxicity in marine sediments with numerical sediment quality guidelines. Environmental Toxicology and Chemistry 17(4):714-727.

Maine Department of Environmental Protection (MEDEP). 2000. Site location map, Callahan Mine, Brooksville, Maine. 1:24,000. Augusta, ME.

Metcalf & Eddy. 2003. Conceptual model and remedial investigation/feasibility study statement of work. Wakefield, MA: Prepared for USEPA.

Roy F. Weston Inc. (Weston). 2001. Final hazard ranking system package, Callahan Mine, Brooksville, Maine. Wilmington, MA: Prepared for USEPA.

U.S. Environmental Protection Agency (USEPA). 2002. National recommended water quality criteria: 2002. Washington D.C.: U.S. Environmental Protection Agency, Office of Water.

U.S. Environmental Protection Agency (USEPA). 2004. Ecological soil screening levels. June 2004. Available at: U.S. Environmental Protection Agency, ECOTOX Database, http://www.epa.gov/ecotox/ecossl/ (accessed August 10, 2004).

U.S. Geological Survey (USGS). 1973. Topographic map, Cape Rosier, ME, 7.5 minute series. 1:24,000. USGS. Denver, CO.