FILE

Reference 12

Memorandum

To: DEP staff
From: Fred Beck
Subject: Mining lecture and field trip to mine sites in Blue Hill and Brooksville, Maine.
Date: November 9, 1989

Introduction

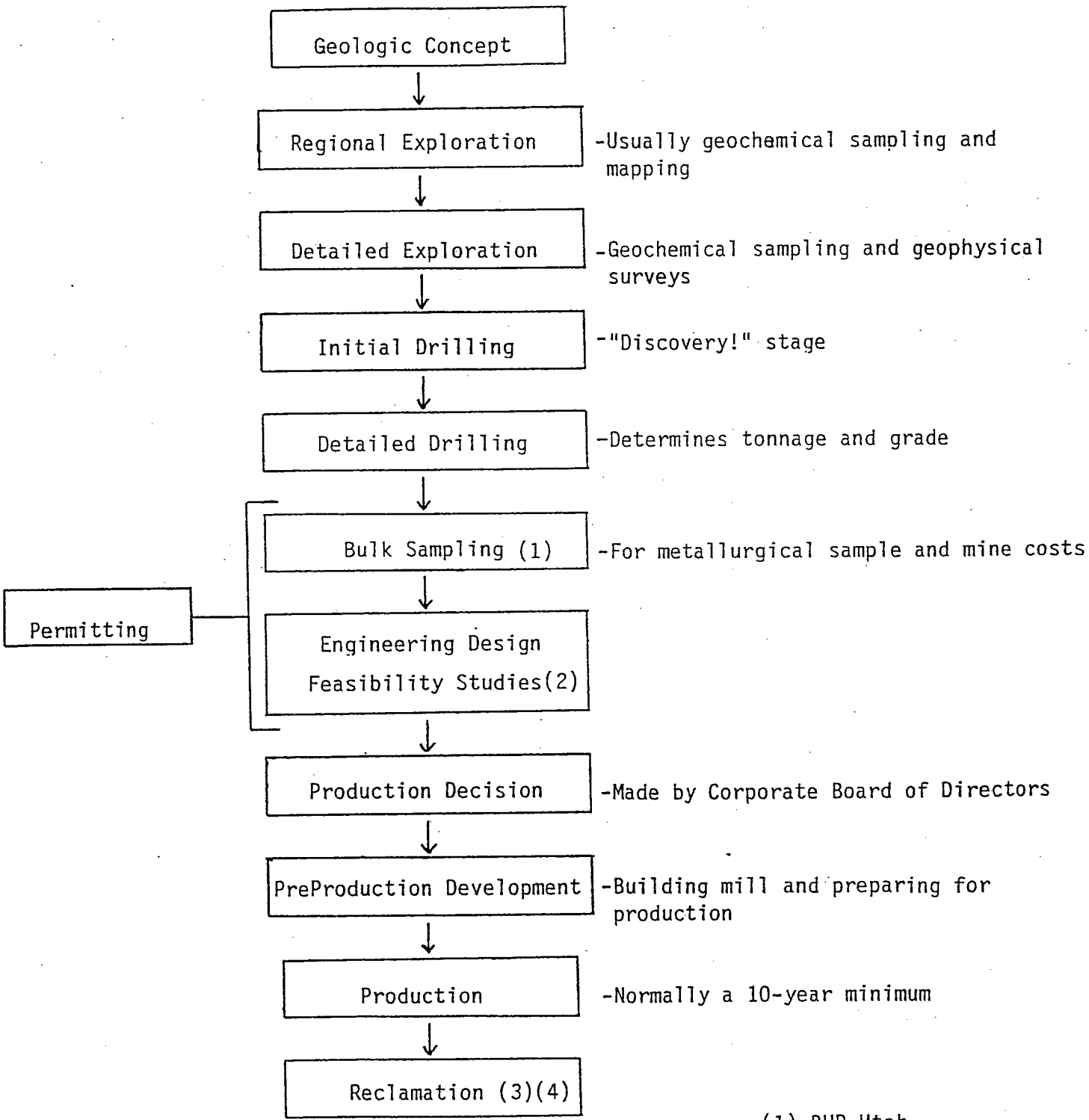
The purpose of today's lecture and field trip is to familiarize DEP staff members with mining methods and terminology and to visit two discontinued mine sites in Hancock County. These exhibit a number of features which will be of concern to the DEP in its review of proposed new mine sites in Maine. These two sites, the Kerramerican mine in Blue Hill and the Callahan mine in Brooksville, were operated most recently during the late 1960's and early to mid 1970's. They are the only recently operated metal mines in Maine.

This memo will outline the general subject matter of the initial morning lecture in Augusta and give brief descriptions of the two mine sites which will be visited in the afternoon. This memo is supplemented by copies of two reports describing some aspects of each mine as well as three copies of a booklet prepared by the U.S. Forest Service entitled "Anatomy of a Mine from Prospect to Production". I'm sorry I don't have more copies of this publication, but the three can be shared and placed in the DEP library for reference.

Morning Lecture on Mining

The mining process is a continuum which begins with exploration and ends with reclamation. The block diagram on the following page shows the usual steps. In the case of the two mine sites we will visit today, the earlier steps did not exist since both mine sites had been found and partially mined over 100 years ago.

The various stages outlined are usually followed in the order given although there can often be overlap and intermixing. Two activities which can span several stages ate reclamation and permit application preparation. Reclamation is an ongoing activity almost from the beginning; permitting would probably begin late in the detailed drilling stage and continue through the engineering design and feasibility study stage. A production decision would not be made until most major permits had been obtained. The morning discussion will elaborate on all of the above stages, but focus mostly on those stages following the detailed drilling stage.



(1) BHP-Utah
(2) Bald Mountain
(3) Kerramerican
(4) Callahan

Kerramerican Mine, Blue Hill

This mine, originally known as the Douglas Mine, began production in 1880 and shut down in the mid 1880's. It was operated again during the first world war. During the late 1950's and 1960's it was thoroughly explored by both drilling underground workings (shafts and drifts). During this period was known as the Black Hawk Mine. It was finally put into pro duction as the Kerramerican Mine in 1972, with the projected production rate being 1000 tons per day. The underground acce was by both shaft and decline (an inclined "tunnel").

In order to put the mine into production, the Kerramerica Company had to acquire permits from the EIS (predecessor to th DEP) and the Maine Mining Commission. It is my impression tha EIS permits related almost entirely to water discharge. The Mining Commission permit was strictly a reclamation permit se- cured by bond. The Mining Commission responsibilities were subsequently incorporated into those of the Land Bureau of the DEP.

The mine produced mostly rock containing the mineral spha erite, which is a zinc-iron-sulfide (ZnFeS2). There were alsc lesser percentages of chalcopyrite and galena, sulfides of cop and lead, respectively. Mining was done with rubber tired die vehicles and followed a pattern of drilling, blasting, loadinc and transporting up the decline to the nearby mill.

The milling process is done to separate the valuable mine als from the rest of the rock. In this case, the type of faci ty was a froth flotation mill. This milling process is a fai straightforward one. The raw ore from the mine is first crush in a jaw crusher to about 1 to 2 inches in size. It is then further crushed to approximately one half inch sized fragments Then it is fed by conveyor to a rotary mill. In the case of Kerramerican, I believe it was a rod mill. The rod mill is a rotating drum about 8 feet in diameter and 12 feet long which contains several long steel rods about 4 inches in diameter. the mill rotates, the rods pulverize the ore being fed to the mill so that the final product is very fine. The fineness of rod mill product is determined by the size of the individual mineral grains and the ease of separation of these grains from the rest of the rock. To this point, then, we have simply tak the raw ore and reduced it in size from a mine product to abou silt size.

The next step is the actual separation stage. The silt- sized product from the rod mill is fed in a water slurry to a bank of flotation "cells" which are circular tanks about 4 fee

in diameter and about 4 feet deep. In these flotation cells i mixture of reagents which act something like soap suds. The "froth" lifts (through surface tension) the mineral particles interest and depresses or allows to sink the remaining rock an mineral particles which are not of economic interest. The min al rich froth (containing sphalerite etc.) is skimmed off into trough where it is washed with water and sent to driers prior being stockpiled in a part of the mill where it awaits transpo tation to a smelter.

The unwanted depressed material is washed and stripped of most of the flotation reagents and then sent for disposal to a "tailings storage area", sometimes called a tailings pond sinc the tailings are transported in a slurry and the tailings stor area is generally always under water during deposition of the tailings. The tailings water is recycled back into the mill. Generally there is a net loss of water in the milling system d to permanent liquid retention by the tailings (about 25 percen by weight). This water loss was probably replaced by groundwa pumped from the mine workings.

The tailings are comprised of silt sized rock particles, pyrite (FeS2), pyrrhotite (FeS), and traces of zinc, copper an lead sulfides. In an oxidizing environment, the pyrite and ot sulfides change to the metal ions in solution, metal oxides an sulfuric acid.

If my memory serves me correctly, the only requirements f reclamation were that the tailings area (about 60 acres) be stripped of topsoil prior to placing the tailings on the groun When the mining was completed, the topsoil was to be respread over the tailings and appropriately seeded. Similarly, the mi dumps (comprised of unmineralized waste rock) were to be grade and reseeded. All of this was secured by a bond. I think the bond was in the amount of $600 per acre.

The present site includes the covered and seeded tailings area, graded and planted mine dumps, sealed and covered declin portal and shaft area, and a relict foundation of the mill. T tailings area was never protected from water and no provisions were made for drainage. Water sources include rain, surface runoff from surrounding hills and possibly spring activity fro below. The water draining the tailings area precipitates iron hydroxide for some distance below the tailings. There are alm certainly elevated amounts of metals in the runoff water as we These were treated during the operating years by a water treat ment system. Barry Mower can give a more detailed discussion this activity.

Callahan Mine site

There are some similarities between this mine and the Kerramerican mine and many differences. The milling operation was almost identical but smaller (600 tons per day compared to Kerramerican's 1000 tons per day). The mine, however, was an open pit operation. The other major difference from an environmental standpoint is that the tailings contained almost no pyrite and a fairly high percentage of carbonate rock.

The open pit was about 1000 feet in diameter and reached a final depth of 320 feet below sea level. An open pit operation is not nearly as selective as an underground operation and a large amount of unmineralized waste rock is generated. This is evident in the large rock piles around the property.

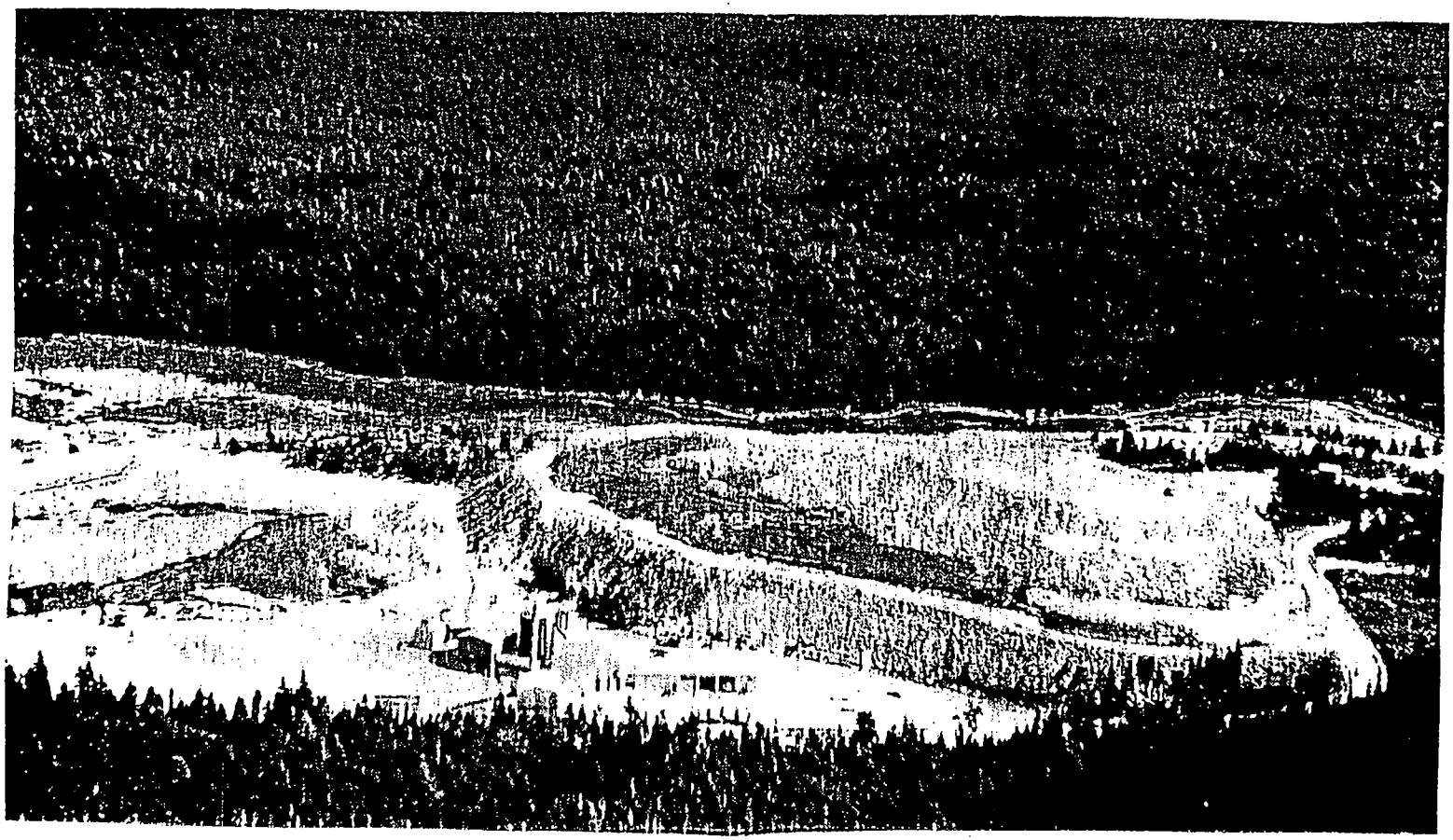
This mine was operated as an underground mine in the last century and again briefly in 1916. It was explored by drilling in the mid 1960's by Callahan Mining Corporation, a small well established mining company with operationg mines in the west. It was determined that the most efficient manner of extracting the ore was to use the open pit technique. There were no land use or reclamation laws on the books at the time and the only environmental permits required had to do with water discharge into Goose Cove. No baseline monitoring was required, of course, and Callahan later regretted that it had not been done since it had no base against which to compare it performance.

One of the handouts describes the impacts caused by the mine to the area during its operation, so no further mention will be made of those factors in this outline. Although reclamation was not required, the company made an effort to reclaim the area on two fronts; replacing the mine with a new industry, and cosmetic reclamation through grading and seeding.

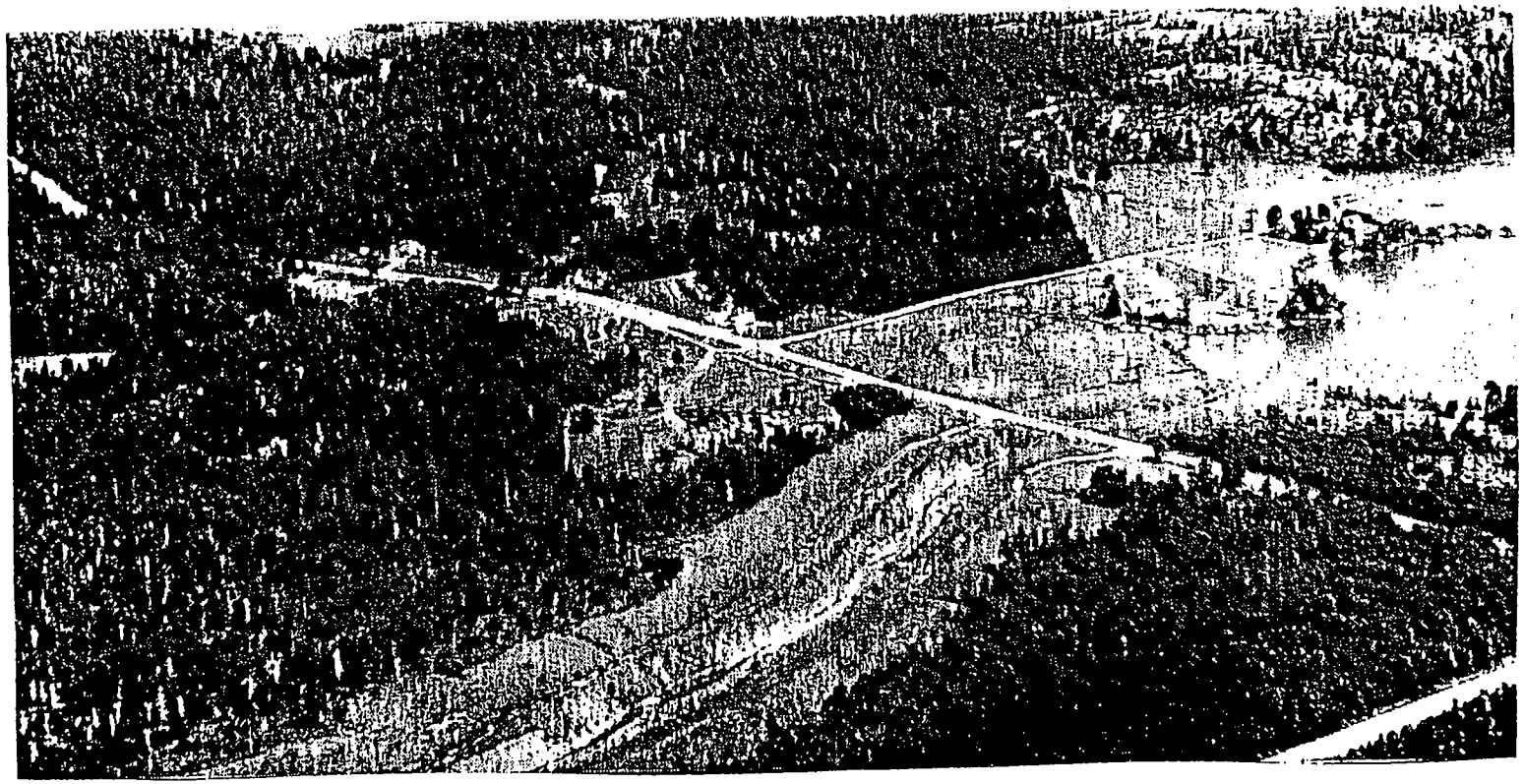
The reclamation effort was seriously hampered by lack of early planning. The tailings and mine dumps were placed directly on topsoil. There was no stored topsoil available for future covering of tailings or dumps. Furthermore, there were no sewage treatment plants in Maine at the time generating sludge which could be incorporated into the tailings and the dumps. Two years of intensive hydroseeding, University of Maine test plots, and use of special zinc tolerant red fescue from Wales yielded a fairly "green" appearance to the site. However, lack of an organic base eventually caused most of the reseeding to die out. There are some successful remnants of that early effort, but the most effective reclamation is being done by nature through volunteer species and in particular, cattails on the tailings pond.

Recent testing by the DEP has indicated that there are no serious environmental problems at the Callahan Mine site. We will have an opportunity to see some seeps from the tailings area and to discuss alternatives to the reseeding efforts.

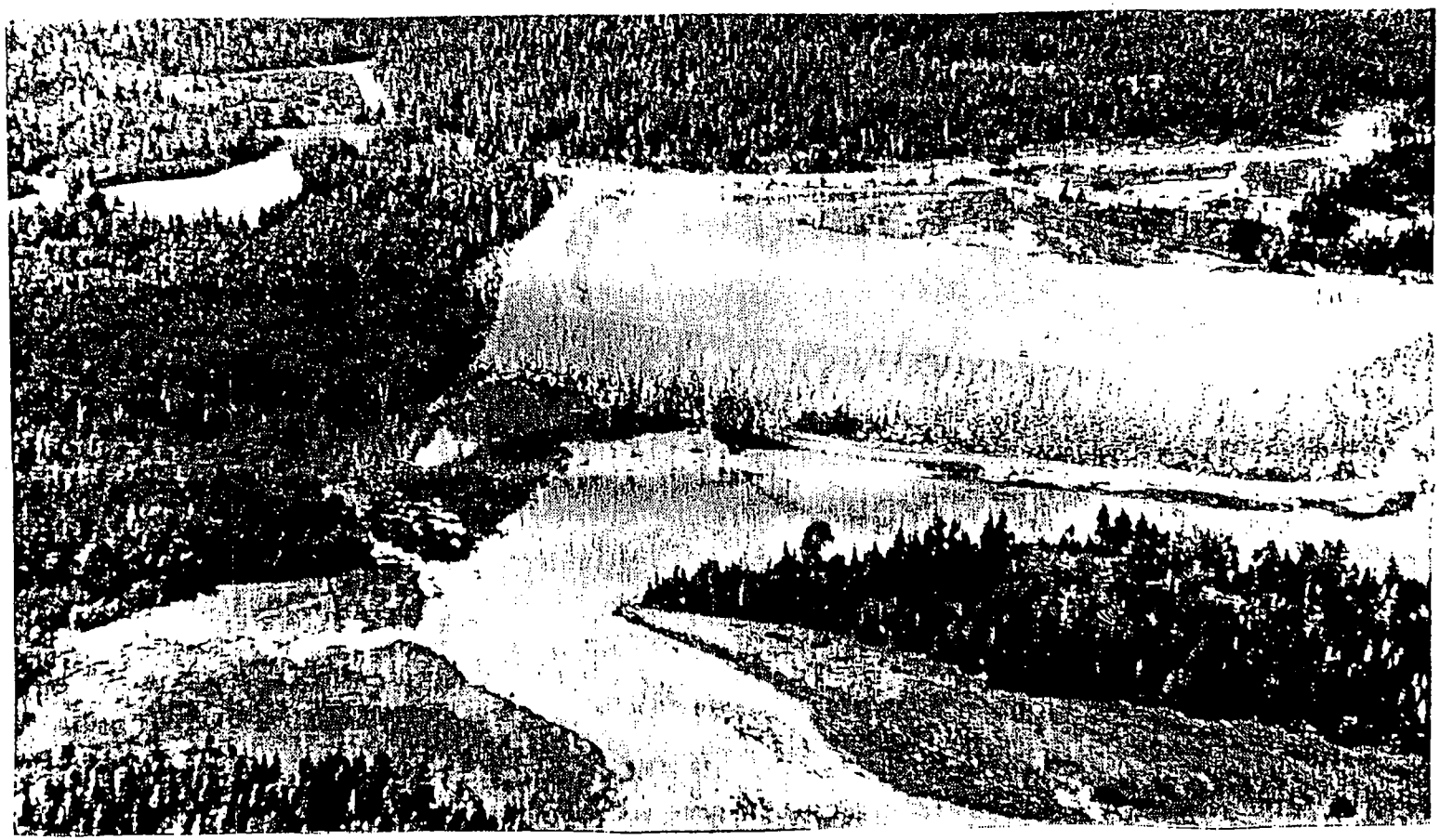
In 1972, Callahan initiated a salmon and oyster aquiculture project at the site patterned after similar projects in Puget Sound. Several hundred thousand dollars were invested over a period of 7 years, but the project eventually went bankrupt. Callahan sold the mine site and the aquiculture project to outside investors in 1974. The site is now owned by a Brooksville resident, Mr. James Benneson.



Mill and mine dumps at Callahan site on Cape Rosier, 1971.



Wier Cove Ditch at Cape Rosier during the mining operation. This ditch drained the area which normally would have drained into Callahan's open pit mine. This ditch area has since been planted.



1971, view looking west toward tailing pond at Callahan mine site during operation. Goose Cove tidal estuary in foreground.

View looking south at Callahan open pit mine, 1971. Goose Cove Harbor in foreground, Harborside village residences at lower right. Dam (now partially removed) under the road kept seawater from entering pit. Area of open pit is now totally under water as is adjacent area behind pit. This forms Goose Pond

WESTON MANAGERS DESIGNERS CONSULTANTS

Reference 13

Tom Campbell
Originator

PHONE CONVERSATION RECORD

Conversation with:

Name John Williams

Company Maine Marine Patrol II

Address _____

_____

Phone 207 - 667 - 3373

Date 7 / 17 / 00

Time 1000 AM/PM

☒ Originator Placed Call

☐ Originator Received Call

W.O. No. 2003-001-001-1150 TMDNo 00-06 0020

Subject Fin fish fisheries in the vicinity of Callahan Mine

Notes:

Mr. Williams stated that fisheries were present in Goose Cove and Penobscot Bay for lobster, urchin (fall), scallops (limited season), and mackerel and striped bass (recreational fishery only). Mr. Williams did not have any harvest information:

☒ **File** Callahan Mine

☐ **Tickle File** ___/___/___

☐ **Follow-Up By:** _____

☐ **Copy/Route To:** _____

Follow-Up-Action: _____

Originator's Initials Tom A. Campbell

WESTON
MANAGERS DESIGNERS CONSULTANTS

Reference 14

Tom Campbell
Originator

PHONE CONVERSATION RECORD

Conversation with:
Name Robert Goodwin - Marine Scientist
Company Maine Department of Marine Resources
Address _____
_____
Phone 207-667-5654

Date 7 / 17 / 00
Time 1000 AM/PM

☒ Originator Placed Call
☐ Originator Received Call
W.O. No. 20102-001-001-1150 TDD No 00-06-0

Subject Shellfish fisheries and Callahan Mine Site

Notes:

Mr. Goodwin stated that ME DMR closed the shellfish fishery in Goose Pond and Goose Cove because of microbiological pollution (fecal bacteria) from licensed overboard discharge facilities and heavy metal contamination from the Callahan Mine site. Species affected by this closure include mussels, soft clams, hard shell clams, and oysters.

☒ **File** Callahan Mine
☐ **Tickle File** ___/___/___
☐ **Follow-Up By:** _____
☐ **Copy/Route To:** _____

Follow-Up-Action: _____

Originator's Initials TAC

NOAA's Estuarine Eutrophication Survey

Volume 3: North Atlantic Region

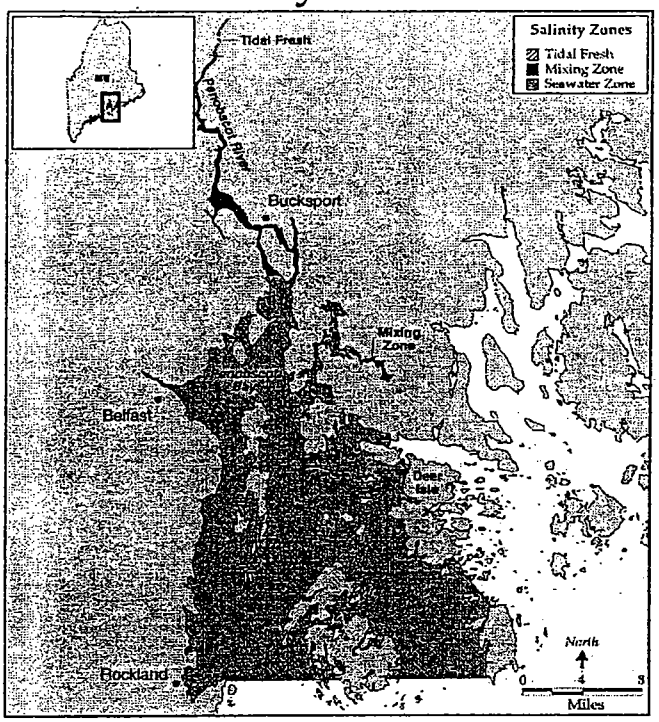
Reference 15

Office of Ocean Resources Conservation and Assessment
National Ocean Service
National Oceanic and Atmospheric Administration
Silver Spring, MD 20910

July 1997

This report should be cited as: National Oceanic and Atmospheric Administration (NOAA), 1997. NOAA's Estuarine Eutrophication Survey. Volume 3: North Atlantic Region. Silver Spring, MD: Office of Ocean Resources Conservation and Assessment. 45 p.

Penobscot Bay



In Penobscot Bay, chlorophyll *a* concentrations are low in all salinity zones, and turbidity concentrations are medium in the tidal fresh and mixing zones, and low in the seawater zone. Biological resource impacts from nuisance or toxic algal blooms are unknown in the tidal fresh zone, and do not occur in the mixing and seawater zones. Nitrogen and phosphorus concentrations are low throughout the estuary. There were no observations of anoxia or hypoxia reported. There is no SAV in the tidal fresh zone, and low spatial coverage in the rest of the estuary.

Most of the trends were either unknown or stable. However, there were decreases in nitrogen concentrations (speculative) in the mixing zone, and decreases in both anoxia and hypoxia in the tidal fresh and mixing zones. SAV trends are unknown.

Physical and Hydrologic Characteristics

Estuarine Drainage Area *(mi2)* **3,160** Avg. Daily Inflow *(cfs)* **16,100**

	Estuary	Tidal Fresh	Mixing	Seawater
Surface Area *(mi²)*	387.0	0.5	13.1	367.1
Average Depth *(ft)*	70.1	19.5	31.0	75.1
Volume *(billion cu ft)*	755.3	0.3	11.3	743.7

Consists of Penobscot Bay with several islands interspersed throughout the estuary. Seaward boundary is difficult to define. High salinities can occur in upper reaches of the Bay. Receives majority of freshwater from Penobscot River. During periods of high flow, vertical stratification is very apparent. Lower flow periods exhibit moderate salinity stratification. Tidal range is 9.6 ft near Rockland.

Algal Conditions

	Tidal Fresh		Mixing		Seawater	
Chlorophyll *a*	L	?	L	?	L	?
Turbidity	M 50-100%	?	M 50-100%	?	L	?
Nuisance Algae	?	?	N	---	N	---
Toxic Algae	?	?	N	---	N	---

Nitrogen is the limiting factor for chl-*a* in the seawater zone. Highest turbidity occurs persistently throughout the year.

Nutrients

	Tidal Fresh		Mixing		Seawater	
Nitrogen	L	?	L	↓	L	---
Phosphorus	L	---	L	---	L	---

Dissolved Oxygen

	Tidal Fresh		Mixing		Seawater	
Anoxia	N	↓	N	↓	N	---
Hypoxia	N	↓	N	↓	N	---

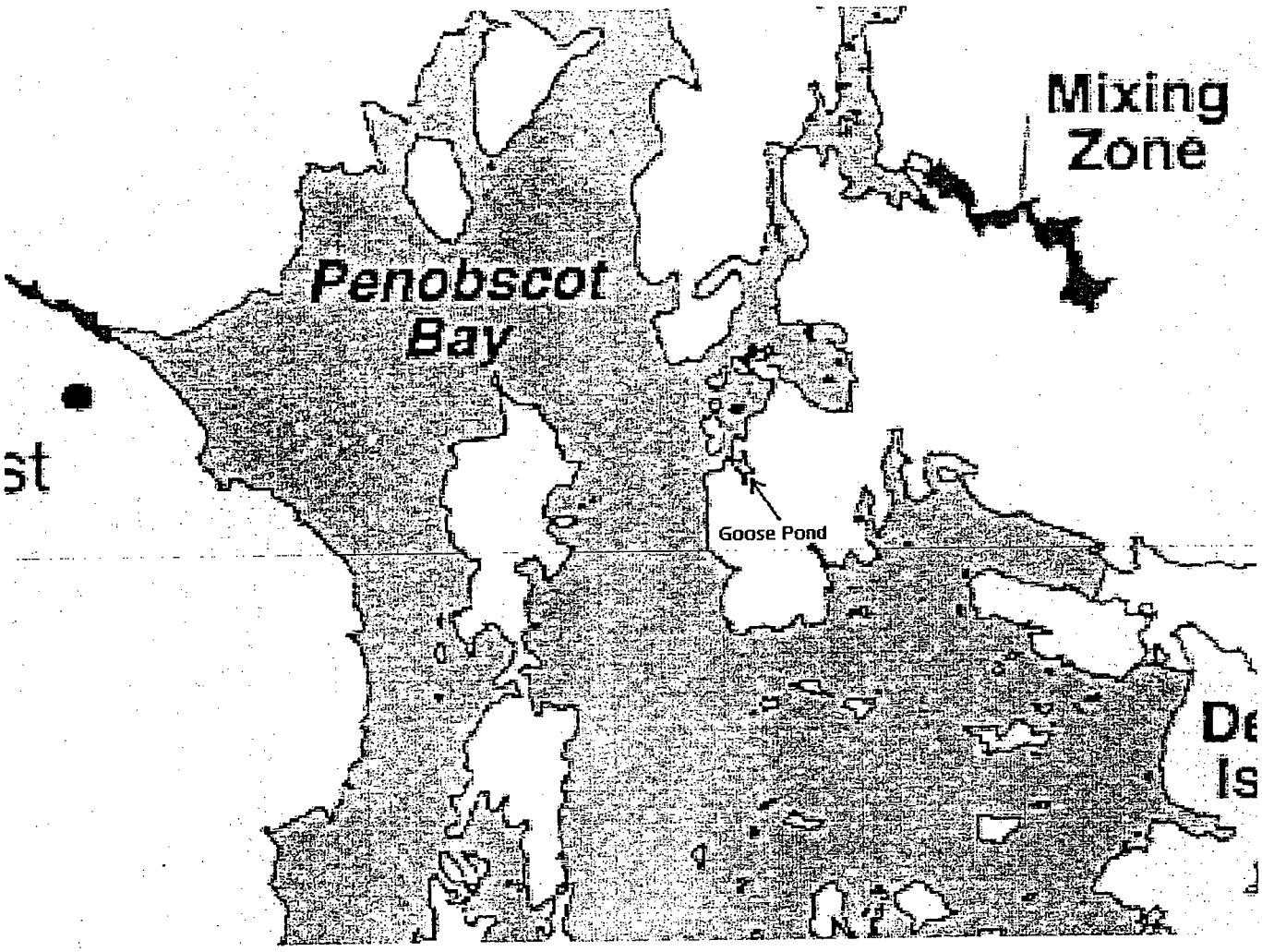
High magnitude increase in bottom dissolved oxygen concentrations occurred 1970-1990. All trends attributed to point source changes.

Ecosystem/Community Responses

	Tidal Fresh		Mixing		Seawater	
SAV	NS	?	L	?	L	?

Primary productivity is dominated by the pelagic community. Planktonic community is predominantly diatoms in the tidal fresh zone, and a diverse mixture in the mixing and seawater zones. Benthic community is dominated by mollusks in the tidal fresh and mixing zones, and is diverse in the seawater zone.

Key on page 19


Mixing
Zone
Penobscot
Bay
Goose Pond

Reference 16

FINAL SITE INSPECTION PRIORITIZATION
FOR
CALLAHAN MINING CORP.
BROOKSVILLE, MAINE

CERCLIS NO. MED980524128

Prepared by: Jean Firth, Maine DEP

March 30, 1995

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

1.0 INTRODUCTION

Under authority of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) as amended, the Maine Department of Environmental Protection (MEDEP) has prepared this Site Inspection Prioritization (SIP) for the Callahan Mine Site located in Brooksville (Harborside) Maine, CERCLIS No. MED980524128. The purpose of the SIP is to update the Site Inspection (SI) completed for the Site on June 8, 1987.

2.0 SITE DESCRIPTION, OPERATIONAL HISTORY & PREVIOUS INVESTIGATIONS

2.1 Site Description

The Callahan Mine Site (Site) is located approximately 1000 feet east and southeast of Harborside Village in the Town of Brooksville, Maine (Latitude N 44° 20' 53"; Longitude W 68° 48' 22") as shown on Figure 1. The mining operation and facilities were developed adjacent to and beneath the Goose Pond tidal estuary (7:pp3-4). The Callahan Mine was operated as a open-pit zinc/copper mine and was perhaps the only inter tidal mine in the world at the time of it's operation (8:p1).

2.11 Physical Features

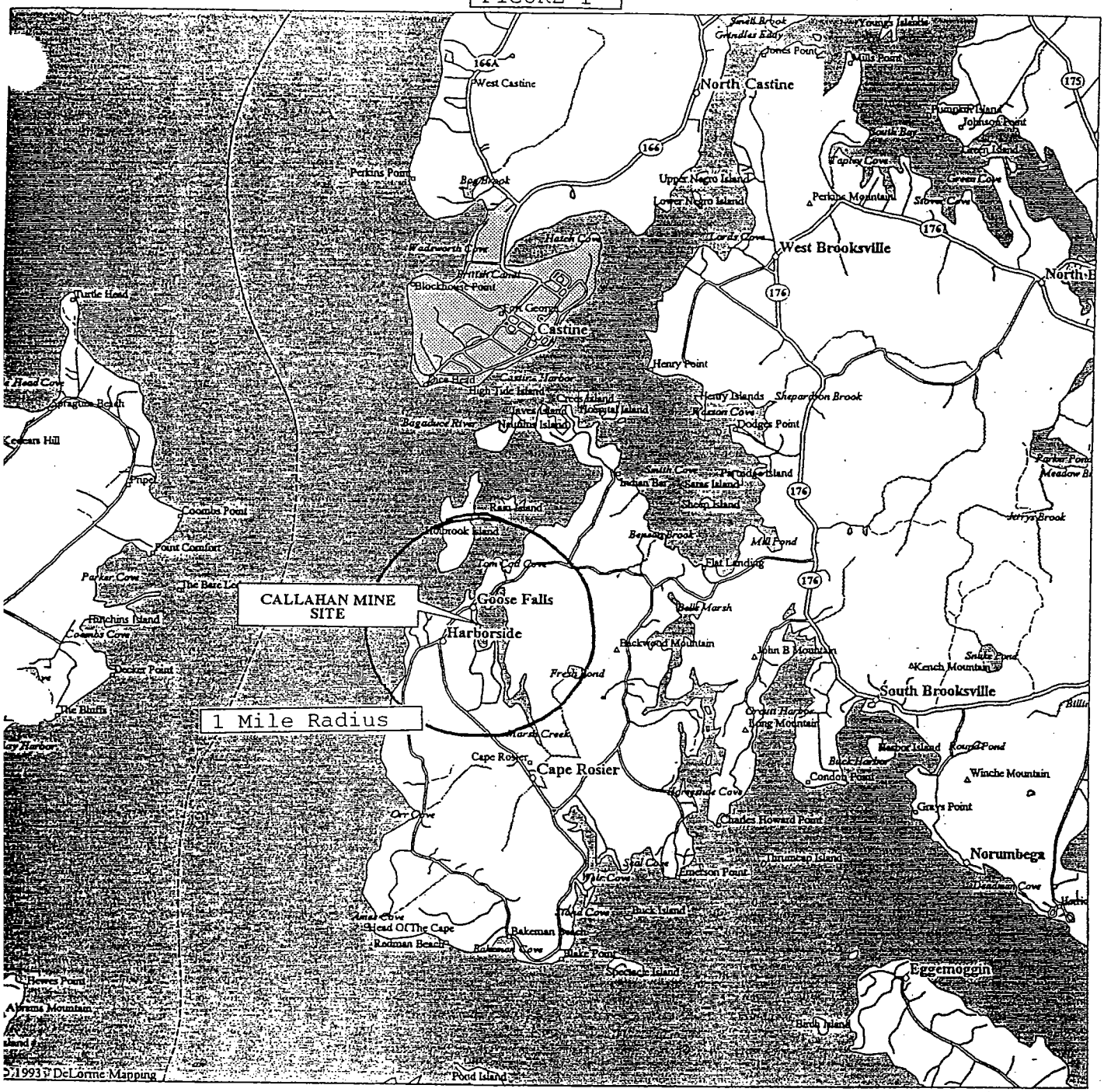
The approximately 150-acre Site is located in a coastal rural setting on the Cape Rosier peninsula. The Site property abuts and extends into Goose Pond Estuary to the east, and private properties to the south, west, and north. The developed portion of the Site extends about 5,000 feet south-southeast from the Goose Falls Road, and approximately 1000 to 1500 feet west from Goose Pond Estuary. The Holbrook Island Sanctuary, a State owned nature preserve, is located on the east shore of the estuary opposite the Site (26).

The developed portion of the Site includes the following areas associated with the operation of the Callahan Mine, as shown on Figure 2.

- Tailings Pond:

  Located in the southern portion of the Site, the 11 acre tailings pond received waste rock materials and residual chemical reagents discarded during the ore-milling process. During mining operations, fresh water was retained behind a dam adjacent to the tailings pond and diverted to Weir Cove via a canal dug by the mining company. At that time, no apparent controls were installed to prevent leaching of metals and residual

FIGURE 1



LEGEND

- Population Center
- State Route
- Geo Feature
- Town, Small City
- Hill
- County Boundary
- Street, Road
- Trails
- Major Street/Road
- State Route
- River
- Land Mass
- Open Water

Scale 1:75,000 (at center)

1 Miles

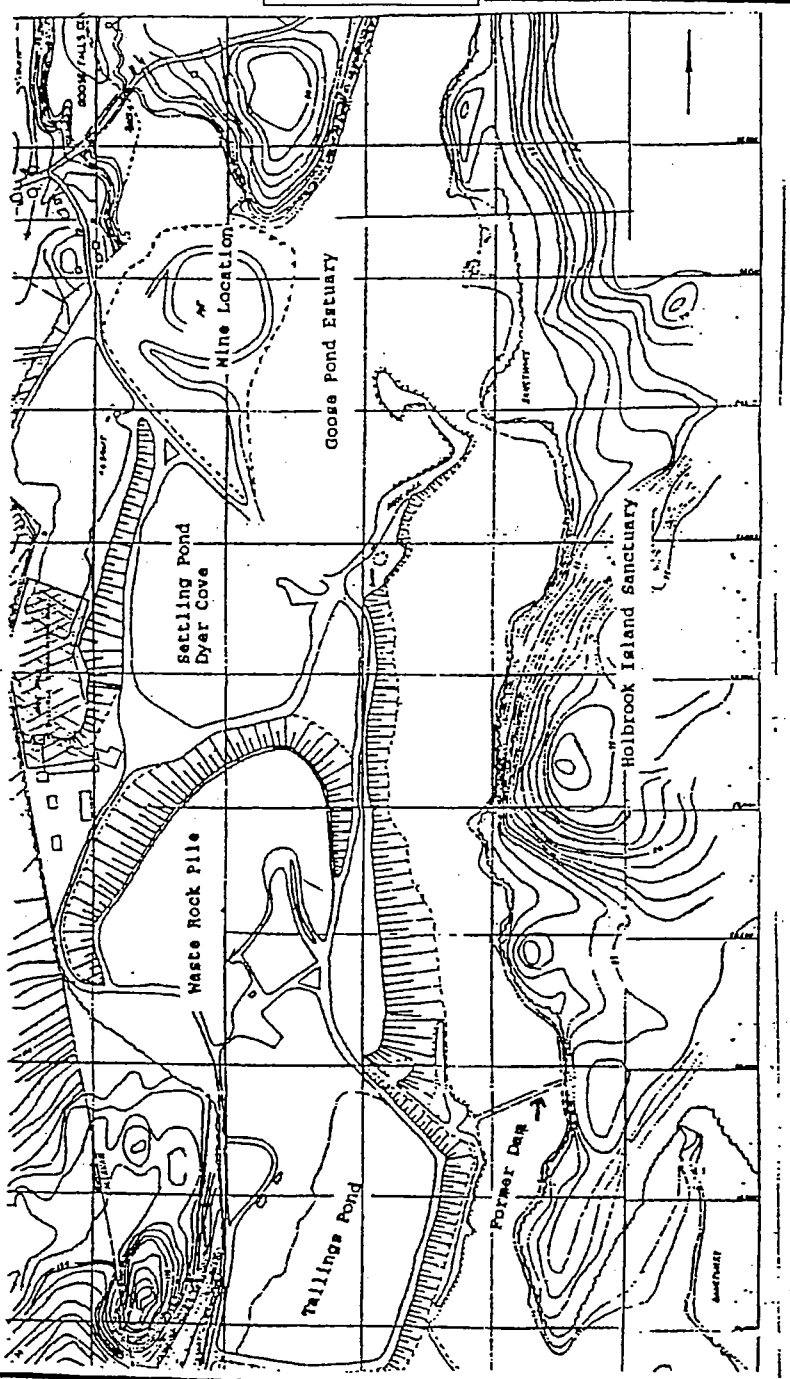
2 KM

Mag 13.00
Thu Nov 03 12:19:33 1994

⇧N

Callahan Mine Site, Brooksville
Site Location Map

FIGURE 2



Callahan Mining Corporation
Penobscot Unit
Industrial Area
May 1972

Site Diagram
Callahan Mine, Brooksville

Not to Scale

chemicals from the tailings pond area to the fresh water canal and Weir Cove (7:pp4, 5, 6, 10-13).

- Waste Rock Dumps:

  Located in the southern to central portion of the Site, the dumps consist of approximately 5-million tons of non-metal bearing waste rock removed from the mine to access the ore-bearing rock. Approximately 200,000 tons of marine clay removed from the open-pit mine after a mud slide is reportedly deposited on the lower portion of the rock dumps (7:p5, 14, 15).

- Dyer Cove:

  A shallow cove within the central-west portion of Goose Pond Estuary during operation the cove was separated from the open pit mine by a causeway (25). Dyer Cove was used as a settling pond for water pumped from the open-pit while the mine was operational. In 1986, elevated levels of zinc and copper were found in the sediments. (7:p15).

- Goose Cove:

  Goose Cove, a salt water cove, was connected to Goose Pond prior to development of the mine by a tidal influenced reversing falls (Goose Falls). A dam was constructed at the tidal entrance to Goose Pond to prevent intrusion of salt water during mining operations. The dam was removed some time after 1978 (7:p4). Initially, water containing rock flour and silt was pumped directly from the mine-pit to Goose Cove. Due to excess siltation of Goose Cove, a settling pond (Dyer Cove) was constructed to receive water pumped from the mine prior to discharge to Goose Cove (7:p15, 17, 16).

- Open Pit Mine:

  Located in the northwest corner of Goose Pond, the roughly circular, 600-foot diameter by 320-foot deep, pit was allowed to fill with water after mining operations ceased. Between 1968 and 1972 approximately 5-million tons of non-metal bearing and 800,000 tons of ore-bearing rock was removed from the mine(7:pp5, 18).

- Relict facility buildings and structures:

  A pump house, metal shop building, foundations of the former assay laboratory, a concentration mill, and a primary crusher are located southwest of Dyer Cove. A powder magazine is located in the area between the tailings pond and the waste rock dumps. Four abandoned underground storage tanks were removed from the vicinity of the metal shop building in 1987 (7:p19).

2.2 Operational History

2.21 Mining History and Operations

Limited underground mining was performed in the vicinity of the Site from the late 1800's through the 1900's. The Site was operated by the Callahan Mining Corporation as an open-pit mine from 1968 through 1972 (7:pp2-5).

As part of the development of open-pit mining operations, Callahan dammed both the fresh and salt water inlets to the estuary and drained Goose Pond Estuary. The fresh water stream that originally entered the estuary from the south was diverted, via a dug canal, southeast to Weir Cove (fig. 1) (7:p4). Approximately two-thirds of the mine was located in an area beneath the original extent of Goose Pond Estuary. At the time mining operations ceased, the mine consisted of a roughly circular open pit approximately 600 feet in diameter and 320 feet deep (7:p5). Roughly 5 million tons of non-metal bearing waste rock and 798,000 tons of ore-bearing rock were removed from the ground during the mining process (7:p5).

Ore-bearing rock (consisting primarily of sphalerite (ZnS), chalcopyrite ($CuFeS_2$) and minor occurrences of galena (PbS), was processed at an on-site separation mill prior to shipment to smelting facilities. The milling processing included crushing the rock into a fine sand to silt, then separating the ore concentrate from waste rock material using flotation cells. Approximately 18% of ore-bearing rock processed was recovered as copper/lead and zinc ore concentrates. Waste rock materials (the remaining 82% of processed rock) and residues of chemical reagents used in the flotation cells were discharged to the tailings pond (7:pp5, 11). Based on a review of Material Safety Data Sheets (MSDS), chemical compounds used in the flotation cell process included (7:(A)D):

- dithiophosphate salts;
- aryl phosphorodithioate.
- cyclohexanol; and
- cresol

Sediment laden water containing high concentrations of metals was pumped from the mine-pit and discharged directly to Goose Cove during the initial phases of the mining operations. Due to excess siltation of Goose Cove, Dyer Cove was used as a settling pond to remove a portion of the sediment (rock flour and silt) prior to discharging the mine water to Goose Cove (7:p15).

2.22 Reclamation History

Mining and milling operations ceased in June of 1972 and a reclamation program was begun which included the following (7:pp6-9):

- draining of surface water from the tailings pond and seeding surface;
- grading, seeding and planting of the waste piles;
- removal of the fresh water dam;
- flooding of the 320 foot deep open-pit mine by opening the sluice boards in the salt water (Goose Falls) dam.

In the period between the mine closure and 1980 an aquaculture facility was operated at the Site for the cultivation and sale of Coho Salmon (7:p7, 8). During this period restricted tidal flow into Goose Pond was maintained by the dam located at the tidal entrance to the pond. No other operations have been located at the site since 1980 (7:p7).

Permission for removal of the remaining portion of the dam was issued by the Maine DEP in 1987 to allow unrestricted tidal flow into the pond as occurred prior to the development of the mine (7:p17).

2.3 Previous Environmental Studies and Regulatory History

2.31 Previous Environmental Studies (1967 - 1986)

Several studies have been conducted by State and federal agencies to assess the environmental impact of mining operations in the vicinity of Goose Pond. A brief summary of these studies are included in the following paragraphs.

Investigations included the assessment of metal concentrations in groundwater, sea water, benthic marine flora/fauna, and sediments. Investigations conducted from 1967, prior to the beginning of full operations at the mine, through 1979 concluded that mining operations had a major and significant effect on metal concentrations in bottom sediments, rockweed, and softshell clams in Goose Cove (4; 8).

Record high concentrations of Mn, Cd, Cr, Ni, Zn, Pb, Fe, and Co for Atlantic Coast soft shell clams were detected at Goose Cove sampling stations under direct influence of effluents of the Callahan Mine (6:p7). During operation of the mine, sea water samples collected up to one mile from the mine effluent discharge point in Goose Cove contained

metal concentrations at levels toxic to uni-cellular algae (6:p9).

Sampling conducted several years after the mining operation had ceased indicated metal contamination was contained near the source area (i.e. Goose Pond Estuary, Dyer Cove, and Goose Cove) and declined markedly away from the source. Many marine species were living with no obvious ill effects in high metal sediments in Goose Cove (8:p4, 5).

There have been isolated occurrences of excessive lead concentrations in wells located in the area, however, sampling of drinking water wells have detected metals below Maximum Contaminat Levels (MCL's).

Several seeps were identified and sampled at the base of the tailings pond as part of an 1986 environmental site assessment (7:p13). Zinc, Pb, and Cd were detected in water samples collected from the seeps. Analyses of sediment samples collected from Dyer Cove (settling pond) and Goose Cove were reported with maximum concentrations of the following metals: Cu, 3760 ppm; Zn, 8600 ppm; Pb, 740 ppm; and Cd, 33 ppm (7:p15).

The 1986 site assessment identified four abandoned underground storage tanks in the area of the former metal shop building (7:p2). Removal of the tanks was required by State regulations. The tanks were removed in 1987 (7:p19).

2.32 MEDEP Site Investigation (SI) and Monitoring Program (1986 - 1991)

The MEDEP completed an initial SI package on the Site in 1987. Sampling associated with the SI package was performed in 1986 and included water samples collected from the following locations (17):

- seeps at the base of the tailings pond (Seep #1 & Seep #2);
- a seep at the head of Dyer Cove, downgradient of the facilities' former operations buildings and USTs.
- six (6) overburden and bedrock residential drinking water wells located within approximately one mile of the Site and one (1) on-site well;
- Goose Pond Estuary;
- Weir Cove Ditch; and
- Shallow Surface water located on the top of the tailings pond.

The DEP continued sampling the tailings pond seeps, Dyer Cove seep, and four of the residential drinking water wells through 1991 as part of a monitoring program. Selection of the drinking water wells included in the monitoring program was based on the presence of metals reported from the SI samples. A summary of the analytical results associated with the SI and monitoring program are provided in Appendix 1 (31). Detected parameters are discussed briefly in the following paragraphs.

Metals

The following parameters were detected in samples collected between 1986 and 1991:

- cadmium (Cd) was consistently detected in samples collected at the two tailings pond seeps (Seep #1 & #2, water) and the Dyer Cove Seep;
- cadmium (Cd) was detected in a water sample collected directly from Goose Pond Estuary in 1987;
- lead (Pb) was detected in a water sample collected at Seep #1 in 1987; and
- zinc (Zn) was detected in a water sample collected at Seep #2 and Dyer Cove Seep in 1986 and all three seeps in 1990 and 1991;

Volatile Organic Compounds (VOCs)

Low concentrations of VOCs were detected at Seep #2 in 1986 (1,1,1-trichloroethane, toluene, ethyl benzene, xylene) and 1990 (butane thiol).

Semi-Volatile Organic Compounds (SVOCs)

The semi-volatile organic compounds (SVOCs), o,o,-diethyl-s-ethyl phosphorothioate and o,o,-diethyl-s-methyl phosphorothioate were detected in Seep #1 from 1986 to 1991, in Seep #2 from 1987 to 1991, and in Dyer Cove Seep in 1991. Trace concentrations of o,o,-diethyl phosphorodithioic acid were detected in each seep in 1991. Dioctyl adipate and dioctyl pthalate were detected at the Dyer Cove Seep in 1986 (31).

2.33 Pertinent Regulatory History

In 1980, the Goose Pond Reclamation Society (GPRS) received approval from the MEDEP to remove the remainder of the dam located at the tidal entrance to Goose Pond Estuary, and to dredge Goose Pond Cove (Goose Pond). The approval was not acted on and reapplication for the same projects was

submitted to the MEDEP in 1987. Approval for the removal of the dam was granted; however, the MEDEP indicated that thorough sampling and analysis of sediments within the pond would be required prior to any approval for dredging (7:p17, 18). Other attempts to gain approval to dredge Goose Cove were denied by State authorities to prevent mobilization of metals and further impacts to the marine environment (7:p15, 16).

The four underground storage tanks located in the vicinity of the metal shop building were removed in 1987 (32). No indication of releases or contaminated soil were observed during the tank removals (31).

3.0 WASTE SOURCE SAMPLING

There are two sources on this site. 1) The tailings pond located in the south east of the site, and 2) the waste rock dump which takes up most of the rest of the site (fig. 2) (25).

TABLE 1
Potential Sources
Callahan Mine Site, Brooksville

Source	Containment	Hazardous Substance	Evidence
Waste Rock Pile	none	Metals, VOCs	ref. 11, 18
Tailings Pond	none	Metals, VOCs	ref. 11, 18

Since 1986 the DEP has been sampling at the Callahan Mine Site. Locations regularly sampled include the tailings Pond and several seep locations. The seep areas are considered soil contamination/ source samples for this report. A summary of data from 1986 to 1991 can be found in Appendix 1 (31).

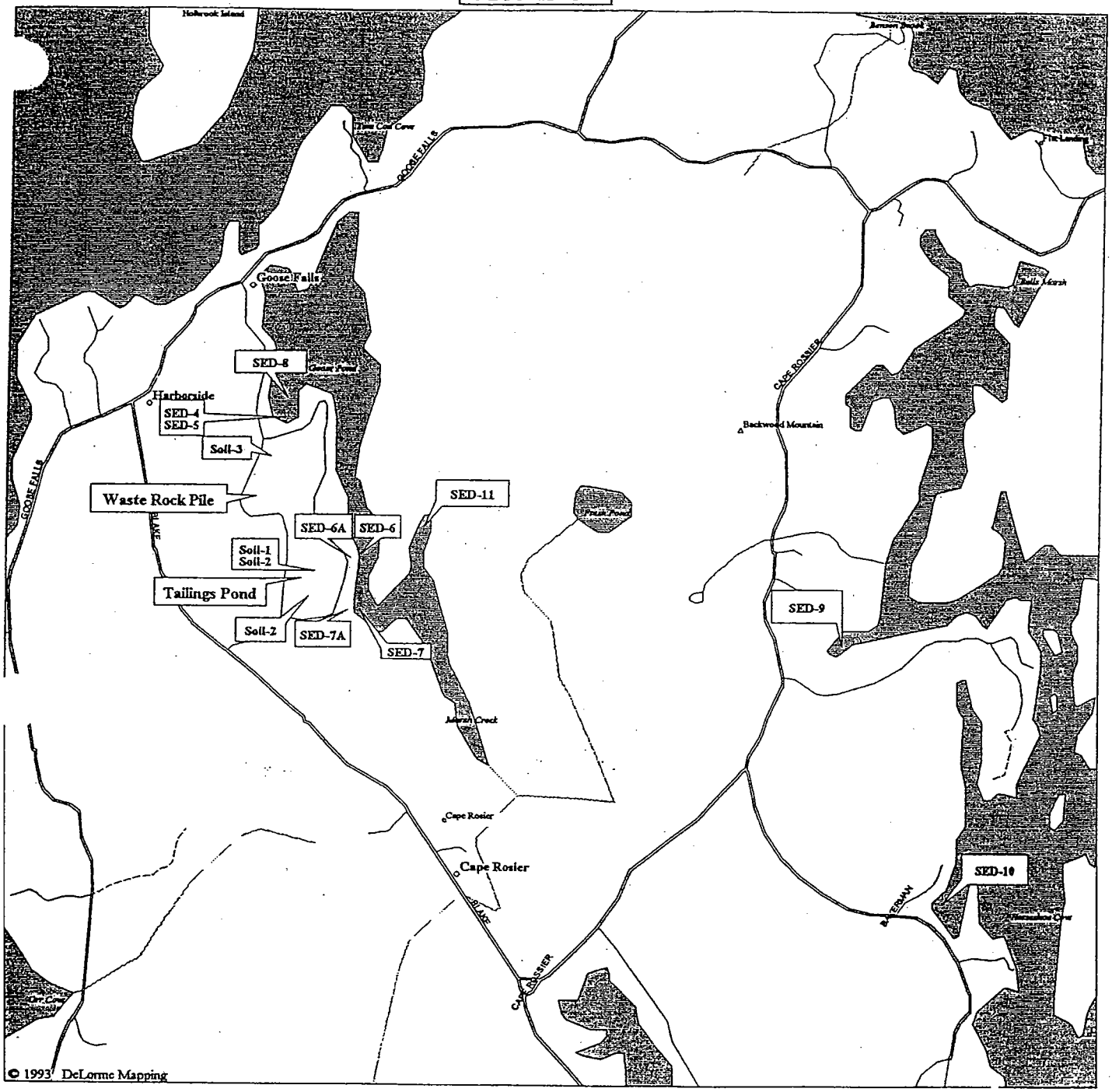
In September 1994 personnel from the DEP conducted a sampling round for the SIP report. Data from the sources for this event is listed in the following tables (10; 11; 18). Locations can be found on Figure 3.

TABLE 2
Metals Results SIP Sampling 9-8-94

Sample #	location	AS	AG	BA	CD	CR	CU	NI	PB	SE	ZN
02236	TP Soil#1	54	2.7	24	20	25	670	20	560	6	15000
02235	TP Soil#2	55	3.4	36	32	16	1900	12	510	9	17000
02230	SM Soil#3	100	70	3	150	26	110000	30	9100	77	18000
02226	TPS#1 SED#6A	27	12	50	28	38	1500	39	550	4	15000
02225	TPS#2 SED#7A	270	1	230	170	30	1600	250	760	7	58000

All metal sample #'s have a prefix of 94E-DIN TP - Tailings Pond SM - Separation Mill
TPS - Tailings Pond Seep Results reported in PPM

FIGURE 3



LEGEND

- Geo Feature
- Town, Small City
- Hill
- Street, Road
- Trails
- Major Street/Road
- River
- Land Mass
- Open Water

⇧N

Scale 1:21,875 (at center)

2000 Feet

500 Meters

Mag 15.00
Tue Dec 27 16:05:29 1994

Callahan Mine Site, Brooksville
Soil and Sediment Sample Locations
SIP Sampling Round September 8, 1994

TABLE 3
VOC Results SIP Sampling 9-8-84

Sample #	Location	Acetone	DCM	11TBE	TMO	DEB	34DTH
03396	trip blank						
03387	TP Soil #1						
03312	TP Soil #2	0.033				J1.27	J0.10
03389	SM Soil #3	0.017	0.056				

TP - Tailings Pond SM - Separation Mill
DEP - Di(2 ethylhexyl) Phthalate 11TBE - 1,1 Thiobisethane TMO - Trimethyloxepane
TPS - Tailings Pond Seep 34DTH - 3,4 Dithiohexane DEB - Diethylbenzene
DC - Dyer Cove DCM - Dichloromethane
All organic sample #'s have a prefix of 94E-DOR Results reported in PPM

4.0 GROUND WATER PATHWAY

4.1 Site Geology and Hydrology

Bedrock geology in the vicinity of the Site consists of the Devonian to Silurian mafic to felsic volcanic rocks of the Castine Formation. Bedrock exposures of sulfide mineralization, primarily copper, zinc, and lead minerals, occur throughout the formation (7:(A)ApII-281). Surficial geology consists primarily of bedrock outcrop and thin glacial till deposits (generally less than 10 feet thick) at the upper elevations. Marine clay and swamp deposits consisting of peat, silt, clay, and sand are located in the stream valleys and lower elevations (14). No sand and gravel aquifers have been located on the peninsula were the Site is located (16).

Site topography includes two knolls with approximate elevations of 160- and 220-feet (mean sea level), respectively (26). Within the boundaries of the Site the knolls slope moderately to steeply to the east toward Goose Pond Estuary. Based on topography, all surface water runoff from the Site discharges to Goose Pond Estuary. Goose Pond is tidally influenced and flushes into Goose Cove and Penobscot Bay approximately 500 feet north of the Site during the low tide cycle (26). Wetland areas and a small unnamed stream are located approximately 500 to 1,000 feet west of the developed portion of the Site, in a separate surface water drainage area (15).

Groundwater flow in the vicinity of the Site may occur primarily within the bedrock aquifer based on the presence of extensive bedrock outcrop in groundwater recharge areas (i.e. higher elevations) and the relative impermeability of surficial deposits (14). Assuming groundwater hydrology at the Site is controlled by topography, groundwater would be expected to discharge to Goose Pond Estuary. However, groundwater flow within bedrock is controlled by fractures

and other bedrock structure which does not necessary coincide with topography. Generally, a certain degree of unpredictability is associated with assessment of groundwater flow within bedrock aquifers.

4.2 Ground Water Targets

The towns of Brooksville, Castine, and Isleboro are located within four miles of the Callahan Mine site (26; 28; 29). All residences within three miles of the site (Brooksville and Islesboro) obtain drinking water from ground water wells located on or near their property. Castine is located in the three to four mile radius of the site. Castine has a public water district; both ground water, and surface water are utilized by the district for castines water supply. Both sources are located in the 3-4 mile radius from the site. Eleven hundred people are served from the water district, and including the Maine Maritime Academy, which has a population of about 600 (28; 29; 30). Also, Brooksville Elementary School is located approximately 3.5 miles north of the site. The population attending the school is 103 students (29).

TABLE 4

Population Drinking Ground Water
Within Four Miles of
Callahan Mine Site, Brooksville

Distance (miles)	Population
onsite	0
0 - 0.25	1
0.25 - 0.5	5
0.5 - 1	38
1 - 2	68
2 - 3	769
3 - 4	1550*
TOTAL	**2431**

* - this number includes the students at Brooksville Elementary School and the Castine Water District

4.3 Ground Water Sampling and Analysis

Since 1968, gound water on and near the site has been sampled and analyzed for contaminants associated with the site, (5:p13, 34; 31). The most recent samples were collected for this report in September 1994. No levels of contaminants related to the site have ever been detected over maximum contamination levels (MCLs) (11).

4.4 Ground Water Conclusions

The total population using ground water within four miles of the site is 2431. However, no impacts to ground water from the Callahan Mine Site have been observed.

5.0 SURFACE WATER PATHWAY

5.1 Hydrologic Setting

The topography of the site is relatively steep. The waste rock pile which dominates the site is over 200 feet in elevation from the estuary (25; 26). Surface run-off is primarily toward Goose Pond Estuary, with multiple probable points of entry (PPEs).

The estuary was drained for the development of the mine (3:p174). After the mine was abandoned the dam which controlled flow in the estuary was removed and the estuary was flooded again (7:p4-7). Currently, the abandoned mine pit is located in the estuary as well as the former settling pond, which is now called Dyer Cove (7:pp7, 15;25).

The fifteen mile surface water pathway begins in Goose Pond Estuary, which is approximately 1.25 miles long. The remainder of the surface water pathway is in the Atlantic Ocean (fig. 4) (26). The entire surface water pathway is in salt water.

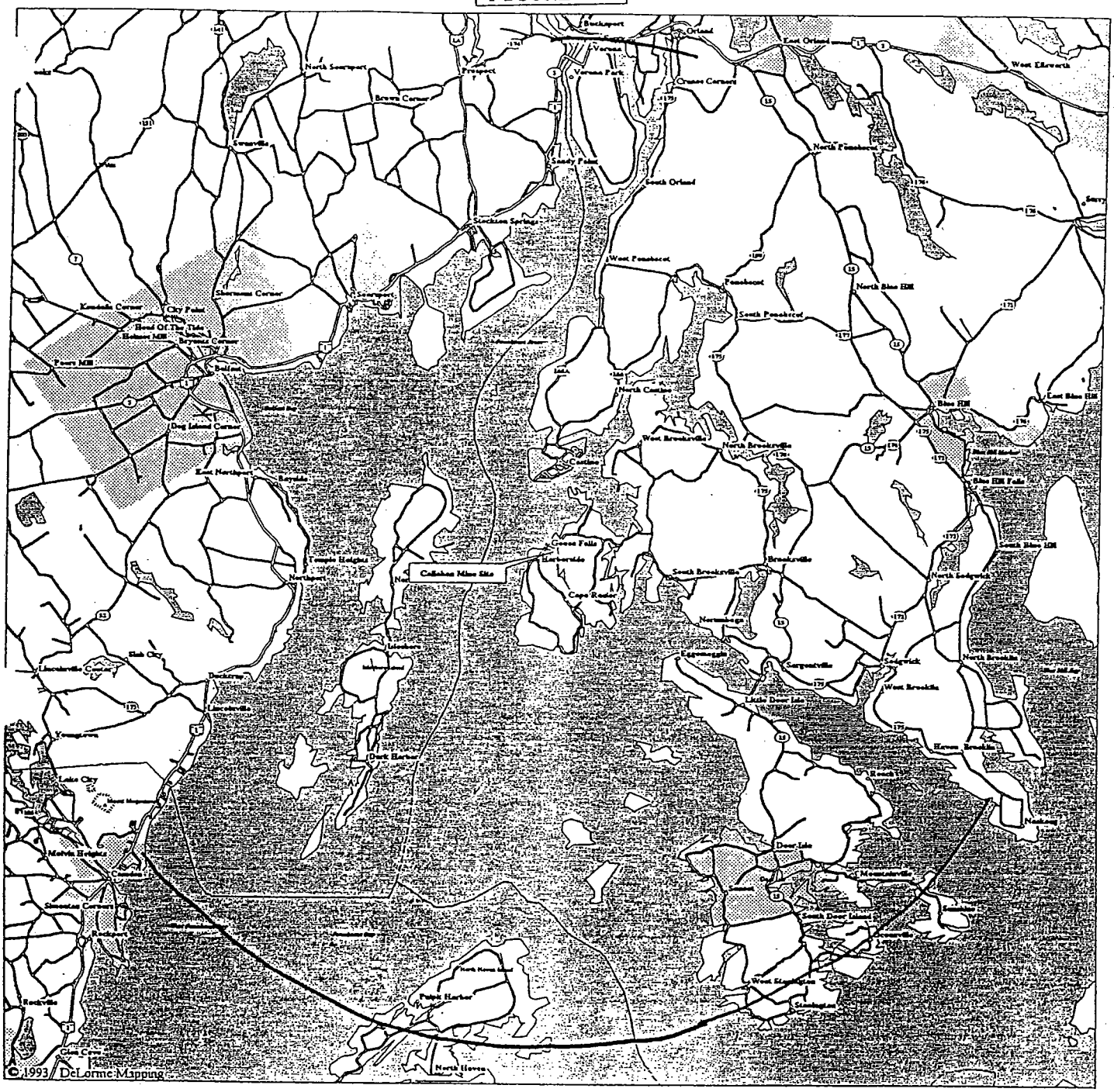
5.2 Surface Water Targets

The surface water pathway for the Callahan Mine site is considered a fishery for mackerel, shag, alewives, Atlantic Salmon, scallops, and lobsters (27; 34). As of 1968 clams were harvested from Weir Cove and marketed. Weir Cove is influenced tidally by Goose Pond (4:p14). A 1993 report by the Maine Marine Environmental Monitoring Program shows that there are elevated levels of cadmium, lead, and zinc in blue mussels collected from Goose Cove (33:p7).

In the period between the mine closure and 1980 an aquaculture facility was operated at the Site for the cultivation and sale of Coho Salmon (7:p7, 8).

There are over 100 sensitive environments located within the surface water pathway (Appendix 2) (12; 13). Most are State designated sensitive habitats for seabird nesting and feeding. Also, 11 bald eagle nests are located within fifteen miles of the site (12; 13). The closest eagle nest is located approximately 0.25 miles north of the site in the Holbrook Island Sanctuary (12:p8map6). These eagles would use Goose Pond Estuary as part of its habitat (23).

FIGURE 4



LEGEND

- Population Center
- State Route
- Geo Feature
- Town, Small City
- Hill
- US Highway
- County Boundary
- Major Street/Road
- State Route
- US Highway
- Airfield
- Land Mass
- Open Water
- Contour

Scale 1:250,000 (at center)

5 Miles

5 KM

Mag 12.00
Tue Oct 25 11:26:28 1994

⇧N

Callahan Mine Site, Brooksville
Fifteen Mile Surface Water Pathway
Target Distance Limit

There are over 25 miles of vegetated wetland located within a 7 mile radius of the site mostly onisland and mainland shore frontage (15). One wetland, a paulstrine/scrub-shrub/evergreen/saturated/acid, is located within the area of surface water contamination (10:p2; 15).

5.3 Surface Water Pathway Sampling and Analysis

Samples have been collected from the surface water pathway near the Callahan Mine site since the beginning of the Mine's operation in 1968 (7:(A)ApII-282). The DEP periodically sampled several seeps which flow into Goose Pond (Appendix 2). The most recent sampling was done in 1994. Sample locations can be seen on Figure 3 ; results are listed on Tables 5 and 6 showing elevated levels of metals and VOCs.

TABLE 5
Metals Results Callahan Mine, Brooksville
SIP Samples September 8, 1994

Sample #	location	AS	AG	BA	CD	CR	CU	NI	PB	SE	ZN
02232	DCS Sed#4	14	0.6	55	3.6	32	990	35	210	ND	2600
02229	DCS D Sed#5	23	0.7	110	4.9	40	660	40	260	ND	4000
02228	TPS#1 SED#6	36	2.9	64	33	45	970	35	550	ND	16000
02227	TPS#2 SED#7	56	5.8	64	43	41	1400	35	1500	6	22000
02233	DC SED#8	22	2.9	70	11	40	2200	34	400	ND	6200
02237	bk HSC SED#9	17	ND.2	22	ND	21	45	29	12	ND4	54
02224	bk HSC SED#10	10	ND.1	21	ND	15	11	22	10	ND4	41
02234	bk GP SED#11	8	ND.2	69	0.8	34	28	26	36	ND2	110

Results reported in PPM All metal sample #'s have a prefix of 94E-DIN

GP - Goose Pond
TP - Tailings Pond
SM - Separation Mill
DC - Dyer Cove
TPS - Tailings Pond Seep
BK - background
DCS - Dyer Cove Seep
HSC - Horse Shoe Cove

TABLE 6
Volatile Organic Analysis Results
Callahan Mine, Brooksville SIP Samples September 8, 1994

Sample #	Location	Acetone	DCM	11TBE	TMO	DEB	34DTH
03390	DCS SED 4		0.32				
03391	DCS D SED 5	0.032	0.039				
03388	TPS #1 SED 6	0.033	0.075	J2	J0.035		
03395	TPS #2 SED 7						
03392	Bk HSC SED 9						

All organic sample #'s have a prefix of 94E-DOR

TP - Tailings Pond
SM - Separation Mill
DCS - Dyer Cove Seep
TPS - Tailings Pond Seep
DC - Dyer Cove
BK - background
HSC - Horse Shoe Cove
DEP - Di(2 ethylhexyl) Phthalate
34DTH - 3,4 Dithiohexane
DCM - Dichloromethane
TMO - Trimethyloxepane
DEB - Diethylbenzene
11TBE - 1,1 Thiobisethane

TABLE 7
ABN Results Callahan Mine, Brooksville
SIP Samples September 8, 1994

Sample #	Location	BBP	DEP	Pyrene	Phen
03403	TP Soil 1				
03401	TP Soil 2	0.11			
03400	SM Soil 3	0.13			
03397	TPS #2 SED 7	0.19	14.65		
03406	DCS D SED 5	0.20	4.63		
03405	DCS SED 4	0.10	0.43	J0.10	
03398	TPS #1 SED 6		0.74		
03404	BK HSC SED 9	0.11	3.45	0.39	J0.10

All organic sample #'s have a prefix of 94E-DOR

TP - Tailings Pond
SM - Separation Mill
DCS - Dyer Cove Seep
TPS - Tailings Pond Seep
DC - Dyer Cove
BK - background
BBP - Butyl Benzyl Phthalate
DEP - Di(2 ethylhexyl) Phthalate
Phen - Penanthrene
HSC - Horse Shoe Cove

5.3 Surface Water Pathway Conclusions

Goose Pond Estuary, located adjacent to the site, has been impacted by contaminants from the site. No drinking water intakes are located along the surface water pathway; however, there are over a hundred sensitive environments in this area. A bald eagle nest is located less than 0.25 miles from the site. Fisheries in Goose Cove have been directly impacted by contamination from the site.

6.0 SOIL EXPOSURE and AIR PATHWAYS

6.1 Physical Condition

The site is primarily covered by blasted rock with sparse soil cover (20). The only vegetation on the site are a few small trees growing near the edge of the estuary (20). Three relict buildings, a pump house, a metal shop and a powder magazine, are located on the site. The foundations of other buildings can also be seen around the site (7). Access to the site is unrestricted (20).

6.2 Soil Exposure and Air Pathway Targets

The area near the site is extremely rural. Year round population on Cape Rosier is small, however, in the summer the population increases.

The entrance to the site is located at the end of a small road which is located in neighborhood of summer residences (20). The nearest residence is approximately 200 feet from the sites entrance. Table 8 shows the population within four miles of the site (9).

TABLE 8
Population Within Four Miles of
Callahan Mine Site, Brooksville

Distance (miles)	Population
onsite	0
0-0.25	1
0.25-0.5	5
0.5-1	38
1-2	68
2-3	769
3-4	347
TOTAL	1227

There is a two acre wetland located on the site (15). There are no other known sensitive environments located onsite (12; 13). Within a quarter mile of the site to the northeast there is a bald eagle nesting site (12, 23).

6.3 Soil Exposure and Air Pathway Samples and Analysis

Several soil samples were collected and analyzed this fall for metals, VOCs, and SVOCs. Tables 9 and 10 show the results (fig. 3). No background samples were taken for the soil pathway (10).

TABLE 9
Metals Results SIP Sampling 9-8-94

Sample #	Location	Acetone	DCM	11TBE	TMO	DEB	34DTH
03387	TP Soil #1						
03312	TP Soil #2	0.033				J1.27	J0.10
03389	SM Soil #3	0.017	0.056				

TP - Tailings Pond SM - Separation Mill
TPS - Tailings Pond Seep Results reported in PPM
All metal sample #'s have a prefix of 94E-DIN

TABLE 10
VOC Results SIP Sampling 9-8-84

Sample #	location	AS	AG	BA	CD	CR	CU	NI	PB	SE	ZN
02236	TP Soil#1	54	2.7	24	20	25	670	20	560	6	***15000***
02235	TP Soil#2	55	3.4	36	32	16	1900	12	510	9	***17000***
02230	SM Soil#3	100	70	3	150	26	110000	30	9100	77	***18000***
02226	TPS#1 SED#6A	27	12	50	28	38	1500	39	550	4	***15000***
02225	TPS#2 SED#7A	270	1	230	170	30	1600	250	760	7	***58000***

TP - Tailings Pond SM - Separation Mill
DEP - Di(2 ethylhexyl) Phthalate 11TBE - 1,1 Thiobisethane TMO - Trimethyloxepane
TPS - Tailings Pond Seep 34DTH - 3,4 Dithiohexane DEB - Diethylbenzene
DC - Dyer Cove DCM - Dichloromethane
All organic sample #'s have a prefix of 94E-DOR Results reported in PPM

The air pathway has not been sampled.

6.3 Soil Exposure and Air Pathway Conclusions

Contamination of the soil on site has been documented. There are no onsite targets for this pathway; however, access to the site is not restricted.

The air pathway has not been sampled. Several targets exist within 0.25 miles of the site.

7.0 SUMMARY

Mining at the Callahan Mine site, primarily for copper and zinc, began in the 1800's. Since then mining has occurred periodically onsite; the latest mining effort was from 1968 to 1972. At that time the Goose Pond Estuary was drained to allow for excavation of an open pit mine in the estuary.

No impacts to ground water from the Callahan Mine Site have been observed. The total population using ground water within four miles of the site is 2431.

Goose Pond Estuary, located adjacent to the site, has been impacted by contaminants from the site. No drinking water intakes are located along the surface water pathway, however, there are over a hundred sensitive environments in this area. A bald eagle nest is located less than 0.25 miles from the site. Fisheries in Goose cove have been directly impacted by contamination from the site.

Contamination of the soil on site has been documented. There are no onsite targets for this pathway; however, access to the site is not restricted.

The air pathway has not been sampled. Several targets exist within 0.25 miles of the site.

References

1. 40 CFR Part 300 Appendix A the Hazard Ranking System {55 FR 51583, December 14, 1990.}

2. United States Environmental Protection Agency (USEPA). Superfund Chemical Data Matrix, Office of Solid Waste and Emergency Response. June 1994.

3. Private and Special, 1965, Chapter 243, An Act Relating to Mining Activity Under Goose Pond, Town of Brooksville, Hancock County. January 1, 1965.

4. United States Department of the Interior (USDI), Federal Water Pollution Control Administration. Interim Report on Chemical Characterization of Water and Sediments From Cape Rosier, Maine. April 1968.

5. USDI Federal Water Quality Administration. Effects of Strip-Mine Discharges on the Marine Environment Cape Rosier Maine. August 1970.

6. Dow, Robert, and John W. Hurst Jr., Department of Sea Shore Fisheries. Rehabilitation Problems of the Cape Rosier Open Pit Mine. November 1971.

7. F. M. Beck Inc. Minesite Environmental Review Harborside Maine. July 1986.

8. Hurst, John et. al., Department of Marine Resources. Bioaccumulation of Trace Elements in Selected Marine Organisms; An examination of mined and unmined areas in mid-coastal Maine. 1979.

9. Duffy, Bill. Memo to Richard Heath (MEDEP) RE: Methodology Used to determine Populations for DEP Division of Site Investigation and Remediation Sites. August 11, 1994.

10. Heath, Richard (MEDEP). Memo to Callahan Mine File RE: SIP Sampling Round-September 8, 1994. September 13, 1994.

11. Maine DHS Health and Environmental Testing Laboratory. Sample Results for Callahan Mine. September 8, 1994.

12. Hall, James (IF&W). Letter to Richard Heath (MEDEP) RE: Habitats near the Callahan Mine Site. June 20, 1994.

13. Kemper, G. Keel (IF&W). Memo to Richard Heath (MEDEP) RE: Callahan Mine. July 20, 1994.

14. Maine Geological Survey (MEGS). Surfical Geology of the Castine Quadrangle, Maine. Open File #86-9. 1986.

15. USDI. National Wetland Inventory Cape Rosier, Maine. 1992.

16. MEGS. Sand and Gravel Aquifers Map 20. Open File #81-53. 1981

17. Fuller, Gordon (MEDEP). Memo To Susan Svirsky, EPA Region I RE: Site Inspection Report Callahan Mine Harborside, Maine Site Number-MED980524128. May 28, 1987.

18. Firth, Jean (MEDEP). Memo to the File Callahan Mine RE: SIP Sample Summary. December 8, 1994.

19. Deed for Callahan Mine property. Hancock County Registry of Deeds Book 1671 page 326 -330. December 4, 1987.

20. Firth, Jean (MEDEP). Memo to File Callahan Mine Site, Brooksville RE: Site Visit November 2, 1994. November 10, 1994.

21. Firth, Jean (MEDEP). Memo to DSIR RE: Well Head protection areas in the State of Maine. September 21, 1993.

22. Firth, Jean (MEDEP). Memo to the File Callahan Mine Site RE: Sensitive Environments within the Fifteen Mile Surface Water Pathway. December 12, 1994.

23. Firth, Jean (MEDEP). Memo to File Callahan Mine Site Brooksville RE: Bald Eagle Nest Site at Tom Cod Cove. December 12, 1994.

24. Mower, Barry (MEDEP). Memo to John Moulton (MEDEP) RE: Impacts from previous mining projects. April 10, 1991.

25. Map Callahan Mining Corporation Penobscot Unit. May 1970.

26. USGS. 7.5' topographic Map of the Cape Rosier, Maine Quadrangle. 1973.

27. Firth, Jean (MEDEP). Memo to File Callahan Mine Site, Brooksville RE: Clam Flats in Goose Pond Estuary. December 15, 1994

28. USGS. 7.5' topographic Map of the Castine, Maine Quadrangle.

29. Firth, Jean (MEDEP). Memo to the File Callahan Mine Site, Brooksville RE: DHS Drinking Water Data Base. December 13, 1994.

30. Firth Jean (MEDEP). Memo to the File Callahan Mine Site, Brooksville RE: Telecon with Dan Levit Castine Water District. December 13, 1994.

31. MEDEP Files. Analytical Data.

32. Fuller, Gordon (MEDEP). Letter to Clifford Leach, First Selectman Town of Brooksville. December 23, 1987.

33. Maine Marine Monitoring Program. Marine Monitoring Baseline Data Final Report. June 1993.

34. Firth, Jean (MEDEP). Memo to the File Callahan Mine Site, Brooksville RE: Fisheries in the Atlantic Ocean. December 15, 1994.