CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD
CENTRAL VALLEY REGION

REGION 5
SACRAMENTO

WALKER MINE
ACID MINE DRAINAGE ABATEMENT PROJECT
PLUMAS COUNTY

OPERATIONS AND MAINTENANCE PROCEDURES

MAY 1997

TABLE OF CONTENTS

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OPERATIONS AND MAINTENANCE PROCEDURES

I. INTRODUCTION

In 1987, the Regional Board, as part of an enforcement action against the Calicopia Corporation, placed a mine seal in Walker Mine. The mine seal stopped the discharge of acid mine drainage from within the mine to Little Grizzly Creek, allowing restoration of about ten miles of prime trout habitat. This previously sterile stream is a valuable resource to this intensely recreated area of Plumas County. Subsequent to the installation of the seal the Regional Board won a $1.5 million judgment against Calicopia. This money has been used to maintain the seal and protect the water quality benefits that result from the seal. However, in the near future, these funds will expire. The purpose of these Operations and Maintenance Procedures is to document future costs of about $111,000 annually to maintain this water quality improvement. The mine seal has held back a pressure of 670 tons, well within the maximum working pressure of the seal. Continued maintenance is critical to the ability of the seal to continue to hold back polluted water from the mine.

II. BACKGROUND

The Walker Mine is an 800-acre inactive copper mine in east-central Plumas County about 15 miles northeast of Quincy. The mine is at an elevation of about 6,180 feet. Active mining took place between 1915 and 1941. The mine contained five major orebodies ranging from 600 to 1,400 feet long and 10 to 100 feet thick, with a typical thickness on the order of 50 feet.

The mine is estimated to contain about 13 miles of tunnels and 3,500 feet of vertical shafts. Total void volume in the mine has been estimated to be between 330 and 543 million gallons.

The mine is in the upper end of the Little Grizzly Creek Basin. The Walker Mine has surface drainage and portal drainage to Dolly Creek, a tributary to Little Grizzly Creek. Little Grizzly Creek is approximately 15 miles long.

Average annual precipitation ranges from 50 inches on the higher western mountains to 25 inches in Genesee Valley. The mine site is subject to heavy snowfall in winter and is generally inaccessible to motor vehicles from November through April. Dirt roads

traversing the drainage basin are closed throughout most of the late fall, winter, and early spring.

Since the Walker Mine closure in 1941, the site has discharged acid and heavy metals directly into Dolly Creek. The discharge to surface waters eliminated aquatic life downstream in Dolly Creek and Little Grizzly Creek for a distance of about ten miles. Only through dilution at the confluence with Indian Creek was the quality of these waters improved sufficiently for aquatic life. The Regional Board began investigating specific pollutants discharging from the Walker Mine Site in 1957. These investigations indicated that the mine portal was a primary source of pollution in Dolly Creek and Little Grizzly Creek.

A secondary source of pollution is the non-point surface run-off from springs, rainfall, and/or snowmelt that has passed through mine waste piles and an unlined settling pond that are immediately south of the portal. Oxidation of pyrite and other sulfide minerals resulted in the production of acid and mobilization of heavy metals. These Operations and Maintenance Procedures do not involve mine wastes outside of the underground mine. Due to the expense of remediating these materials and the low level of metals discharged from them, the waste piles have not been remediated.

In November 1987, the Regional Board installed an engineered concrete mine seal 2,675 feet from the 700-level adit portal (See Figure 1). This seal was installed to prevent direct discharge of acid mine drainage from the underground ore zone to the surface waters of Dolly Creek.

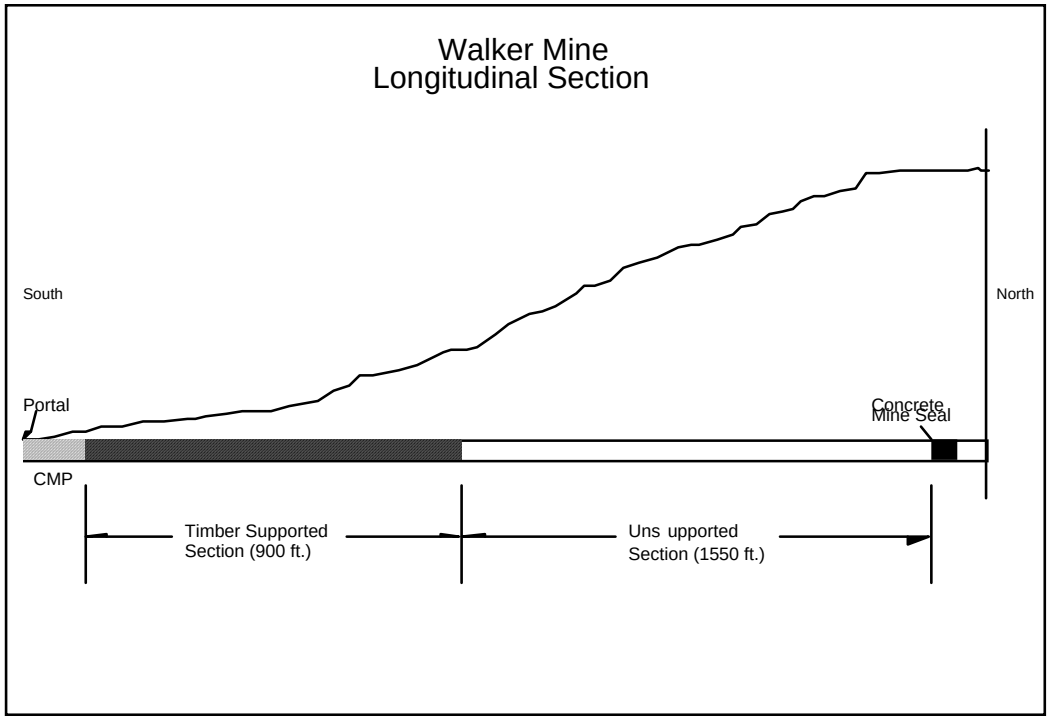

Figure 1: Walker Mine Longitudinal Section

Since construction, the mine seal has successfully eliminated the direct discharge of acid mine drainage from the underground ore zone. Prior to the mine seal construction, the portal discharge averaged 420 gpm. After the installation of the mine seal, there was no flow passing the mine seal. The post-1987 portal flows consists of minor surface water infiltration which enters and drains from the portal. The mine seal project resulted in a 98 percent reduction in copper loading in Dolly Creek. In addition to the reduction of acid mine drainage flow, copper concentrations from the portal have decreased to 0.25 mg/l after the seal installation, as shown in Figure 2.

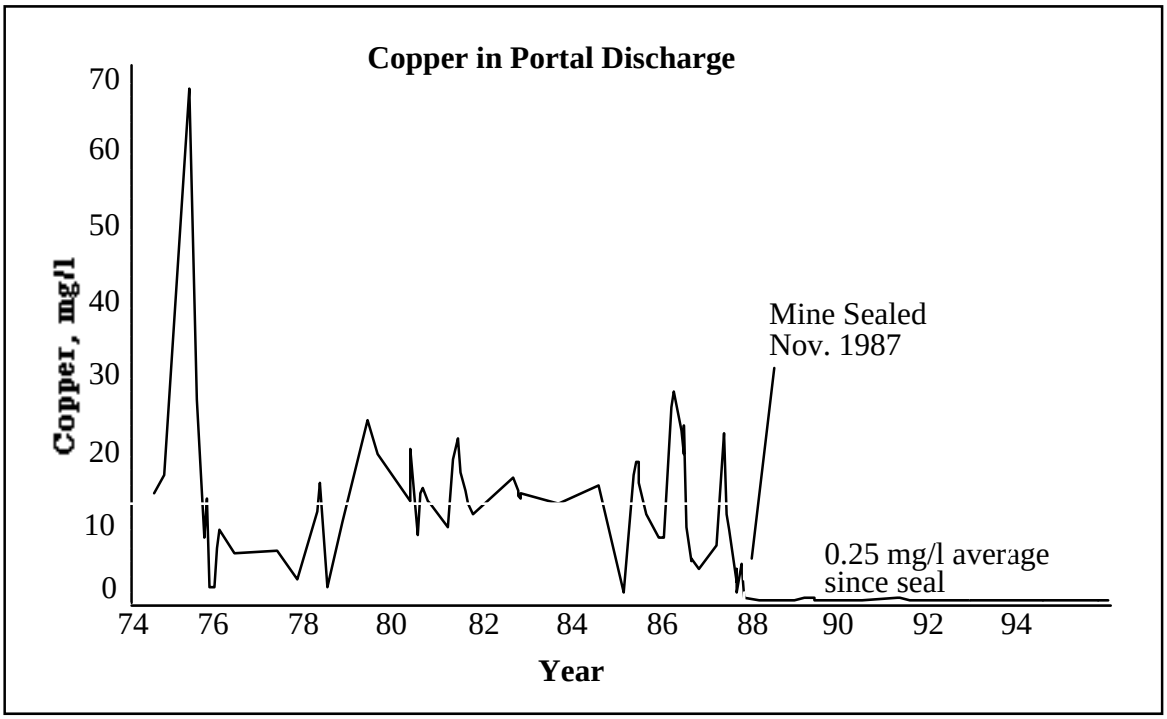

Figure 2: Walker Mine Copper Concentrations in Portal Discharge

The performance of the seal is and will be continually monitored for effectiveness and leakage. The hydrostatic pressure is continuously monitored with a pressure transmitter and data recording equipment. The hydrostatic pressure against the back of the seal since the installation of the concrete seal is shown in Figure 3. The dark line shows actual pressure data, while the light line shows inferred water elevations.

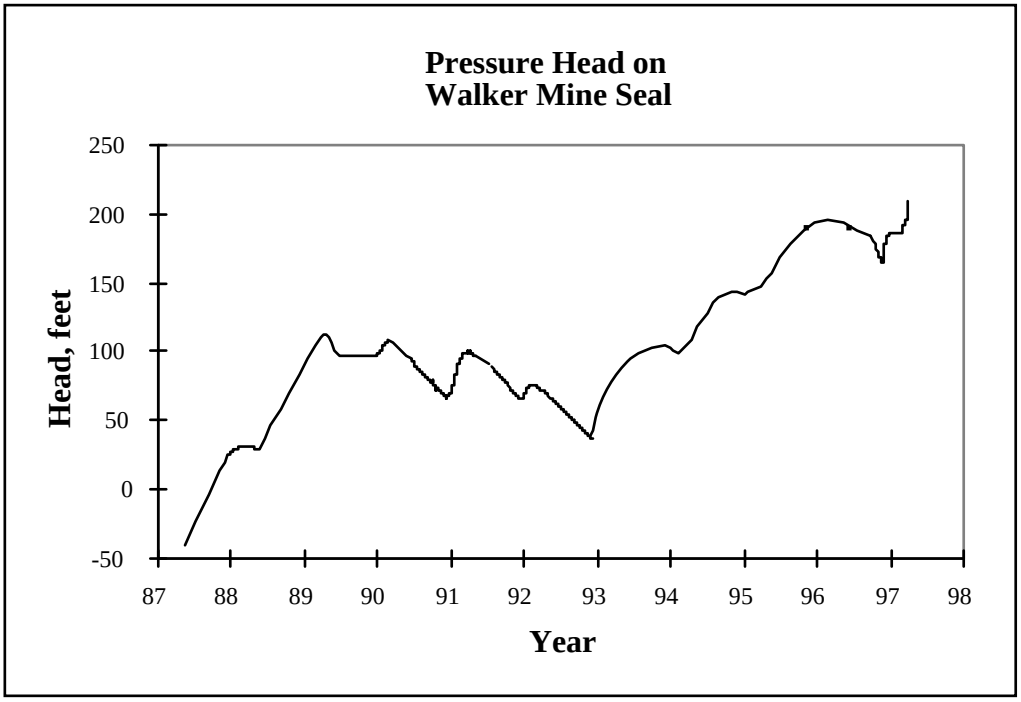

Figure 3: Pressure Head on Walker Mine Seal

The concrete seal is designed to hold back a pressure head of 500 feet. However, the maximum working pressure is 400 feet due to the possibility of discharges to surface waters. This maximum working pressure is derived from the elevation difference between the main portal and the Piute shaft portal (a higher elevation adit where the mine could discharge to surface waters). Should the water elevation within the mine reach 350 feet, the Board must consider the need to discharge and treat mine water to prevent degradation of the Ward and Nye Creek watersheds.

The purpose of these operations and maintenance procedures is to identify the work required to maintain the mine seal and prevent discharge of pollutants to surface waters. These operations and maintenance procedures cover the mine seal, the access tunnel, drainage structures, inspections, and water quality monitoring of Little Grizzly Creek and Ward Creek. An annual report shall be prepared for the Board by 1 February of each year summarizing water quality data, and the integrity of the mine seal and tunnel. The operations and maintenance procedures shall be revised and updated as necessary once every 5 years.

III. MINE STRUCTURES

There are various mine structures that must be maintained in order to successfully maintain the Walker Mine seal. These include the mine portal, corrugated metal pipe, and access tunnel, all three of which provide access to the mine seal. Figure 3 shows the relative locations of these structures. Additional features are surface water diversion structures which divert surface water from entering the mine.

Portal

The Walker Mine portal structure is at the main 700 level adit. The portal is an original structure constructed of concrete. The portal door is 3/8" steel plate and has two keyed locks to prevent unauthorized entry. Sections of the concrete and steel door show indications of damage from vandalism and forced entry. Railroad tracks begin outside the portal and continue to the mine seal. The tracks have been useful in providing a method for moving timbers, muck, and equipment into and out of the mine.

Drainage structures (primarily piping) exist both inside and outside the mine portal. The piping drains ground water and mine water from inside the mine to a discharge point that flows into a sedimentation basin. Inside the mine, the drainage system is a channel that flows on the western edge of the access tunnel. Mine debris can accumulate in the drainage structures which must be periodically cleaned to allow proper drainage.

Corrugated Metal Pipe

Immediately inside the portal is 187 feet of 10-foot diameter corrugated metal pipe (CMP). The CMP was installed in 1995 when the outer portion of the adit collapsed due to heavy snow loads. The CMP is installed between the existing concrete portal and the concrete arch of a fire door. The floor of the CMP is covered with gravel. Drainage pipes are imbedded in the gravel to convey ground water out of the portal.

Access Tunnel

The access tunnel from the portal/CMP to the mine seal consists of both 900 feet of tunnel supported by mining timbers and 1550 feet of tunnel that is competent rock that requires no support. The timbered section provides passive support of loose rock. The age of the mining timbers varies, with some of the supports being original timber sets.

When the mine was sealed in 1987, natural ventilation through the adit was restricted. Due to the very wet conditions in this section of the tunnel, the humidity in the adit increased, thus increasing decay rate of the existing untreated wood. This has shortened the life of the timber sets and accelerated their replacement schedule. In 1995, 380

contiguous feet of the timbered section of the adit were rehabilitated with new timber sets. New timbers sets are made with pressure treated mining timbers to resist rot and decay. The next 520 feet of timbers are being rehabilitated in 1997. Timber sets require periodic inspection and replacement as sets fail. The Board contracts with construction contractors for this work.

Mine Seal

A mine seal was installed in the main 700 level adit of Walker Mine to reduce the flow of acidic mine waters from the main portal. The seal is 2675 feet inward from the mine portal. This site was selected for the mine seal because it minimizes potential seepage around the seal, provides a structurally competent area for the concrete plug, and allows access to valves and instrumentation at the seal. The seal was designed for a pressure head of 500 feet. The seal is about 12 feet in diameter and 15 feet in length. The concrete mixture is composed of a type II Portland cement, pozzolan, plasticizers, sand, and aggregate with maximum size of 3/4".

Two 4-inch diameter stainless steel drainage pipes are installed in the seal. The flanged pipes are attached to stainless steel valves. An analog pressure gage connected to the pipe continuously measures the hydraulic pressure on the back of the seal. In addition, a pressure transducer is coupled to the pipe assembly, as shown in Figure 4. Four conductor wire from the pressure transmitter is routed to the portal area where it is connected to a series of batteries (four 12-volt, 34-amp-hour lead acid batteries) and data logging electronic instrumentation.

Subsidence Areas

The subsidence areas are above the Walker Mine and provide a direct pathway for rainfall and snowmelt to enter the mine workings. Two localized subsidence, or sinkhole, areas exist over the underground mine workings. The areas are north of portal area on a hillside at an elevation of about 6800 feet. The subsidence areas are identified as the Central and Piute areas, with numerous sink holes at each location. The approximate total sinkhole volume is 19,000 cubic yards.

In the 1980's and planned for 1997, the Regional Board retained contractor services to construct surface water diversion channels around much of the subsidence areas. The ditches divert surface water from entering the mine in order to lower the elevation of water stored behind the mine seal and reduce the possibility of an acid mine water discharge to surface waters.

The surface water diversion channels consist of unlined surface water diversion channels and subsurface drains. There are about 2350 feet of existing diversion structures. The diversion channels are mainly V-section ditches. An additional 1175 feet of diversion ditches and 2125 feet of subsurface drains are planned to be constructed in 1997. The

subsurface drains are to be constructed with perforated plastic pipe and drainage gravel enclosed with geofabric. The subsurface drains will be about 5-feet in depth and 2-feet wide. The subsurface structures will drain into the diversions channels.

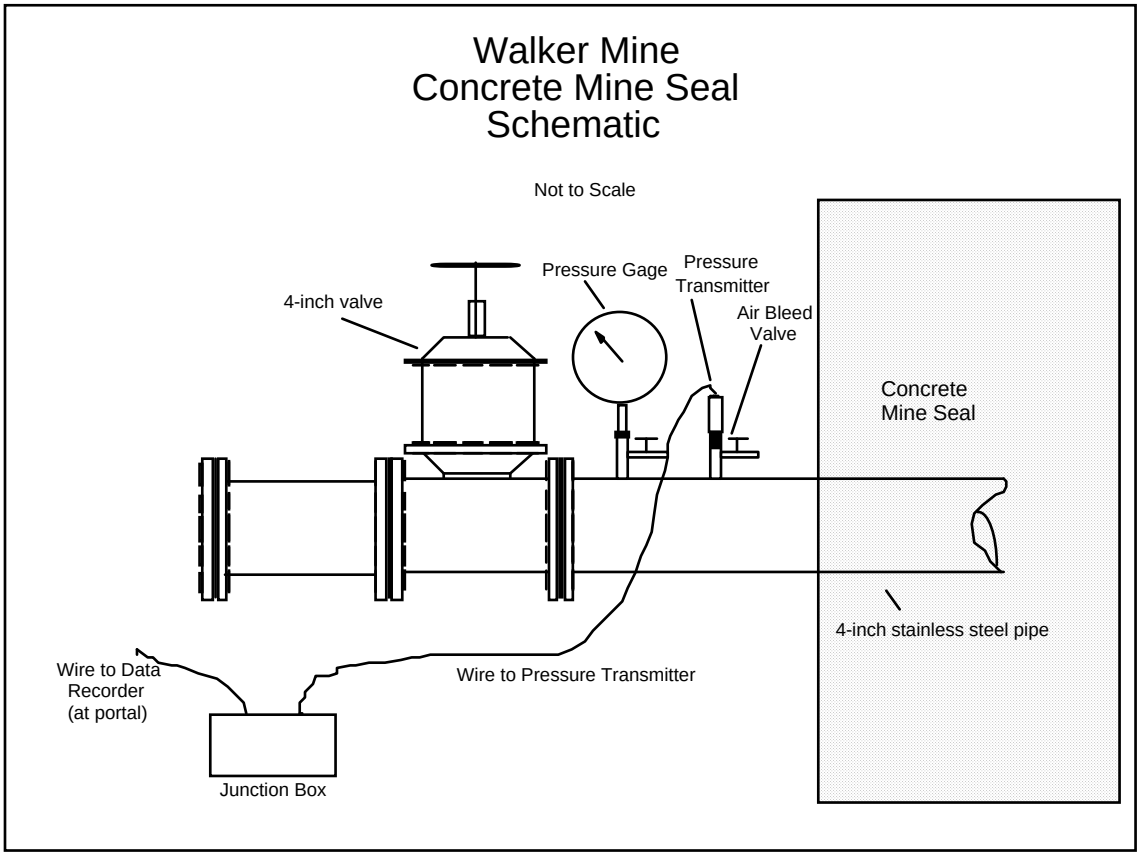

Figure 4: Walker Mine Valves and Piping at Mine Seal

The diversion channels accumulate debris and sediment from storm events and require periodic cleaning of the ditches so that surface water can be drained from the subsidence areas.

Monitoring Well

A mine water monitoring well will be installed above Walker Mine near Road 24N09 on the Walker Mine property. The monitoring well will intersects the mine workings about 2000 feet behind the mine seal. The monitoring well is about 900 feet deep and is screened in a mine stope. The monitoring well will be used to investigate water elevation and chemistry in the mine behind the seal.

The monitoring well installation is a joint project between the Regional Board and the U.S. Department of Energy. Originally the Board had worked with the U.S. Bureau of

Mines, however the U.S. Bureau of Mines has been absorbed within the Department of Energy. The U.S. Bureau of Mines has provided funding and stainless steel casing for the well project.

IV. MAINTENANCE PROGRAM

Regional Board staff shall continue to maintain the mine seal and surface water diversion structures at the Walker Mine site. This periodic maintenance program addresses safe mine entry, mine seal accessibility and integrity, surface water quality monitoring, surface water erosion, and vandalism. Regional Board staff shall conduct site inspections, monitor water quality, identify problems, and develop and manage contracts for repair and replacement of site structures.

A. Inspection Schedule

Regional Board staff shall inspect the Walker Mine twice per year. The inspections shall include seal, access tunnel, and drainage structure inspections as required above. Both inspections shall include water quality monitoring. The first inspection shall be made soon after access to the site is available in late Spring. The second inspection shall be made in the fall before snow limits access to the site. Additional inspections may be required to meet with the Board's contractors and observe any work being done on the mine.

Vandalism damage shall be repaired as soon as possible to maintain security of the portal door.

B. Monitoring Program

Concrete Seal

The performance of the seal shall be continually monitored for effectiveness, leakage, and hydrostatic pressure.

1. Concrete

   The concrete seal has a 100-year design life span. Due to the exposure of the seal to acidic conditions, Board staff must periodically check the competency of the concrete. Tests may be by non-destructive methods or by coring the concrete as determined by the Engineer. Board staff shall review the competence of the concrete in the seal at least once every ten years. Staff shall make visual inspections of the concrete seal annually. Staff shall note

locations of water seepage and discoloration along the roof and walls of the tunnel.

2. Piping and Valves

   The piping and valves in the mine seal are stainless steel. Board staff shall inspect all exposed piping and valves at least annually to detect any visible corrosion. Seepage around the piping shall be noted. Components that are not stainless steel shall be properly protected to prevent corrosion.

3. Rock Support

   Board staff shall visually inspect the rock surrounding the seal annually. Water Seepage from around the seal shall be noted and its location recorded. The size and color of mineral deposits around the seal shall be noted.

4. Seal Pressure

   Pressure monitoring equipment shall continuously monitor the seal pressure. The pressure monitoring equipment consists of a pressure transmitter and data recording computer. The pressure data recording computer shall be kept near the inside of the mine portal. Staff shall download the data during the spring and fall inspections and evaluate the seal pressure upon returning to the Regional Board office. Staff shall bring fully charged batteries to each inspection and return the used batteries for recharging.

Access Tunnel

1. Unsupported Rock

   A mining safety person, under contract to the Board, shall examine and scale the unsupported rock section prior to access by Board staff. Since Board staff or their representatives will be accessing the mine seal on a yearly basis, mining safety person shall examine the unsupported section annually. This examination shall include sounding and scaling of loose or dangerous rock. Any rock scaled to the floor of the access tunnel shall be left in place until it becomes hazardous or impairs access to the seal. At that time, all loose or fallen rock shall be removed. Staff shall note locations of water seepage from the roof and walls of the tunnel.

   The railroad tracks in the access tunnel shall be maintained in working order by efforts to avoid damage. Any damage occurring due to rockfalls or corrosion will not be repaired as a routine operations and maintenance procedure.

2. Timbered Section

   Regional Board staff shall inspect the timbered support section of the access tunnel annually. The inspection shall consist of noting damaged and fallen timbers, coring of suspect timbers to determine depth of decay, and noting seepage locations in roof and walls. Visual inspections shall note: 1) crushing of footblocks beneath posts, 2) splitting of the post bottoms, 3) splitting or crushing at the post-to-cap junction, 4) splitting or crushing of the cap, 5) movement of the set out of alignment, and 6) splitting or crushing of lagging. Timbered supports shall be replaced when it is determined that they will not provide sufficient overhead and lateral support for the following year. The design life of timbers installed in the mine is 15 years. It is anticipated that one-third of the timber sets will be replaced every 5-years. Staff shall inspect timbers annually to determine the extent of decay and to ensure that the current replacement schedule is adequate. Regional Board staff shall contract with underground construction contractors for replacement of timbers.

3. Corrugated Metal Pipe

   Board staff shall inspect the corrugated metal pipe annually to detect any corrosion, seepage, deflection, physical damage or structural failures occurring in the metal pipe. Progressive deflection of the CMP usually precedes pipe failure. Staff shall monitor and record the pipe height (diameter) at joint locations between CMP sections to measure deflections. Measurements shall be made to the nearest 0.1 foot. Subsequent measurements shall be compared to monitor pipe deflection.

4. Ventilation Fan

   Board staff shall run the ventilation fan at least once per year during the mine seal inspection or more often if needed to determine its status. The fan shall be stored in the mine and shall be protected from moisture to the extent possible. A portable rental generator will be used to power the fan. The generator shall be capable of providing 3-phase, 240 volts, with a minimum power 12 kilowatts.

Drainage Structures

1. Mine Portal Area

   Board staff shall inspect the drainage structures inside and outside the mine portal annually to determine if they are in working condition and are capable

of carrying design flows. Staff shall note any areas where drainage backs up and is not able to freely flow. Drainage structures shall be cleaned as required to ensure capability of carrying design flows.

2. Subsidence Areas

The diversion channels will require periodic maintenance to maintain the flow capacity for which they were designed. They will require maintenance periodically or after a large storm event deposits soil and debris in the channels. Some years will require more maintenance than others. Board staff shall inspect drainage ditches constructed around the subsidence areas annually to review their ability to divert surface water away from subsidence areas. Board staff shall inspect for erosion and sedimentation problems. Diversion ditches shall be cleaned and reshaped as required to ensure their ability to carry design flows.

C. Water Quality Monitoring Program

Board staff shall monitor drainages in the Ward Creek and Nye Creek twice per year to determine if water stored in the mine has seeped to these watersheds. Board staff shall also monitor Dolly Creek watershed below the mine portal and above and below the Forest Service Tailings to track metal concentrations from the onsite and offsite tailings area. Historic water quality data will be maintained and reviewed annually for trends.

The monitoring program shall consist of 25 surface water monitoring locations (as shown on Figure 5) and one mine water monitoring well. The surface water monitoring locations and sampling frequency are listed in Table 1. Surface water locations shall be sampled and analyzed for the monitoring parameters listed in Table 2. Portal discharge (gpm) shall be estimated.

The mine water monitoring well is located north of the portal. The elevation of the mine water shall be measured. The mine water shall be collected from the screened interval of the monitoring well. The monitoring well shall be sampled and analyzed for the monitoring parameters listed in Table 2.

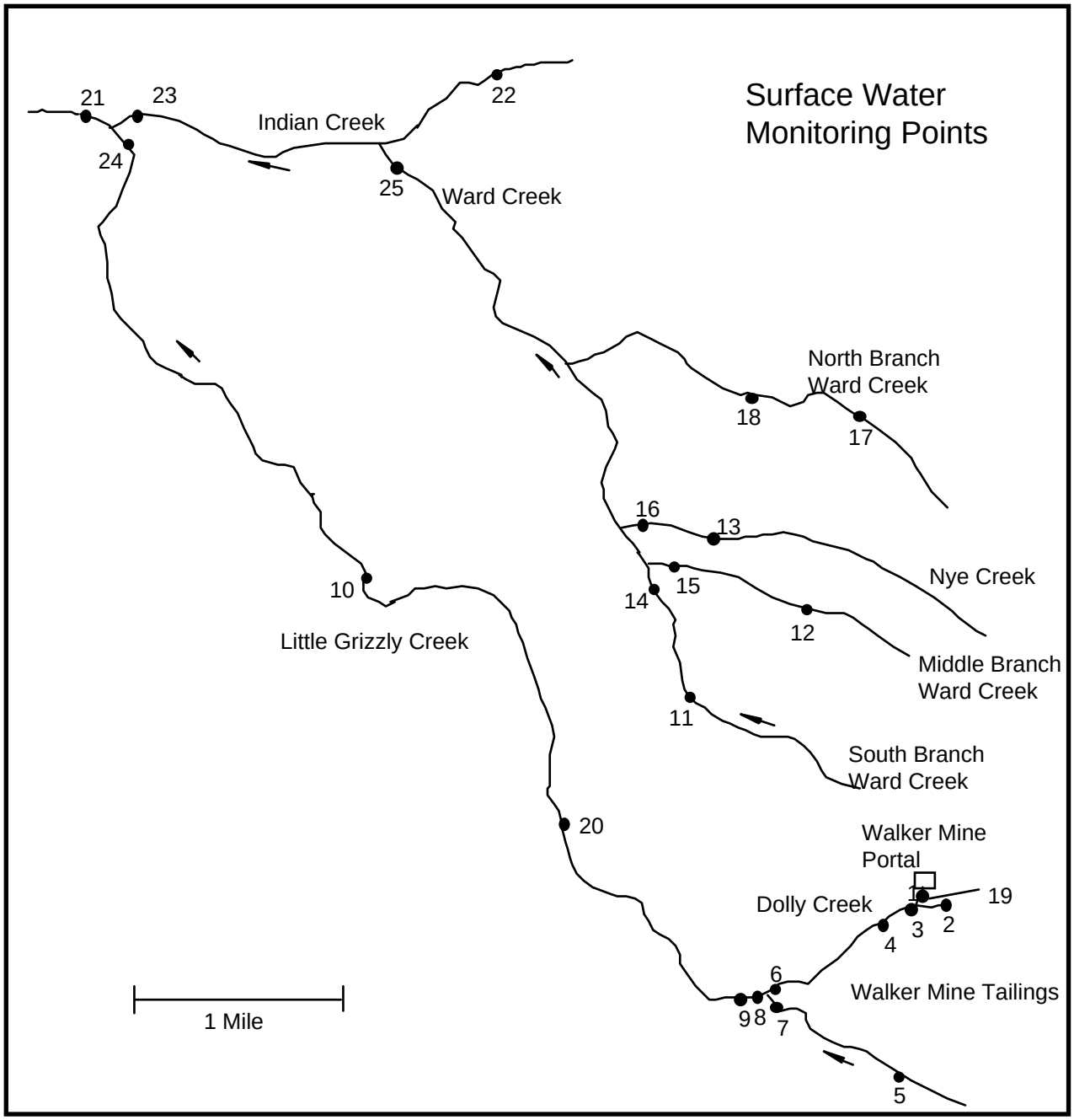

Figure 5: Walker Mine Surface Water Monitoring Points

Table 1
MONITORING STATIONS AND DESCRIPTIONS

Semi-Annual

Sample ID	Description/ Location
1. Portal	Mine Discharge at Portal
2. DC Upstream	Dolly Creek upstream of mine at Road 24N09
3. DC Downstream	Dolly Creek below mine access road
4. DC @48" culvert	Dolly Creek - 100 feet above 48" culvert on Road 112 (Walker Mine Road)
5. LGC upstream	Little Grizzly Creek upstream of tailings at Road 24N60
6. USFS dam	USFS dam on Dolly Creek
7. LGC above DC	Little Grizzly Creek 50 feet above confluence with Dolly Creek
8. LGC below DC	50 feet below confluence of Little Grizzly Creek and Dolly Creek
9. LGC @ Browns Cabin	Little Grizzly Creek at Browns Cabin
10. LGC @25N05Y	Little Grizzly Creek upstream of Road 25N05Y
11. S. Br. Ward Creek @ 25N42	South Branch Ward Creek at Road 25N42
12. Mid. Br. Ward Creek @ 25N42	Middle Branch Ward Creek at Road 25N42
13. Nye Creek @ 25N42	Nye Creek at Road 25N42
14. So. Br. Ward Creek @ 25N32Y	South Branch Ward Creek at Road 25N32Y
15. Mid. Br. Ward Creek @ 25N32Y	Middle Branch Ward Creek at Road 25N32Y
16. Nye Creek @ 25N32Y	Nye Creek at Road 25N32Y
17. No. Br. Ward Creek @ 25N42	North Branch Ward Creek at Road 25N42
18. No. Br. Ward Creek @ 25N32Y	North Branch Ward Creek at Road 25N32Y
19. Settling Pond Discharge	Settling Pond Discharge downstream portal

Table 1
MONITORING STATIONS AND DESCRIPTIONS
(Continued)

Annual

Sample ID	Description/ Location
20. LGC @ Far West	Little Grizzly Creek at the Far West townsite
21. IC downstream of LGC	Indian Creek downstream of confluence with Little Grizzly Creek
22. IC @ Road 112	Indian Creek at Road 112
23. IC upstream of LGC	Indian Creek upstream of confluence with Little Grizzly Creek
24. LGC upstream of IC	Little Grizzly Creek upstream of confluence with Indian Creek
25. Ward Creek @ Genesee Valley	Ward Creek at Genesee Valley floor

Table 2
MONITORING PARAMETERS

Field Parameters	Temperature pH Specific Conductance
Laboratory parameters	General Minerals[1]: alkalinity, calcium, sodium, chloride, sulfate, total hardness, total dissolved solids Dissolved metals : copper, zinc, arsenic[2], iron, aluminum Total metals: copper, zinc, arsenic[2], iron, aluminum

[1] Annual Monitoring Parameters
[2] Portal discharge only

V. ESTIMATED COSTS

Following are cost estimates for annual and periodic maintenance activities described in the Operations and Maintenance Plan.

Annual Maintenance/Monitoring:

Task	Annualized Staff Hours[1]	Costs[2]	Contract Costs	Annualized Costs[3]
Report reviews, contract preparation, report preparation, other overhead (e.g., annual reports, funding..	1000			
Staff Inspection	80	$ 500		$ 500
Safety inspection	40		$ 1,500	$ 1,500
Site Security (steel entrance door/locks/gates/signs)	20	$ 500		$ 500
Generator rental	10	$ 1,000		$ 1,000
Water Quality Monitoring (sampling, equipment, lab analytical costs)	16	$ 4,000		$ 4,000
Total	1166			$ 7,500

As Required Maintenance (2-3 years):

Removal of fallen rock inside timbered and unsupported sections	50		$ 8,000	$ 4,078
Diversion ditch maintenance	25		$10,000	$ 5,098
Drainage structures at portal area	25		$ 2000	$ 1,020
Data logger (batteries)	10	$ 750		$ 382
Total	110			$ 10,578

5-Year Maintenance

Timber support replacement	100		$ 300,000	$64,796
Pressure transducer replacement/ data logger replacement (and associated piping)	10	$ 3000		$ 648
Seal/concrete testing (Non-destructive)	40		$15,000	$ 3,240
Ventilation fan/ducting replacement/rehabilitation	30		$10, 000	$ 2,160
Total	180			$70,844

Long Term Maintenance

Concrete seal replacement	10		$ 500,000	$ 22,380
Total Annualized Hours/Costs	1466			$ 111,302

Notes:

1 Staff time (in hours) is time required to complete tasks, including field time and contract preparation.

2 Costs for equipment, supplies, fuel, etc. for the corresponding task. Does not include staff costs.

3 Annualized cost computed using 4% annual inflation factor.