MT. WASHINGTON ACID ROCK

MINE RECLAMATION PROJECT

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D.M. Galbraith
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1. INTRODUCTION

In the 1970's fish returns to the Tsolum River experienced a severe decline. The suspected cause was elevated levels of dissolved copper from the abandoned Mt. Washington copper mine (Figures 1 and 2).

An inter-agency review committee was formed to review the situation, with membership drawn from: the Ministry of Energy, Mines and Petroleum Resources, Engineering and Inspection Branch (subsequently MEI), Ministry of Environment and Parks (subsequently MOE), Environment Canada, and Department of Fisheries and Oceans. The consulting firm of Steffen Robertson and Kirsten was subsequently commissioned to review available data and evaluate alternative abatement options. In July of 1987 the report entitled "Acid Mine Drainage Abatement Study, Mt. Washington", was submitted. The problem was confirmed as being the generation of acid at the minesite through the action of oxygen and water on sulphide rock, with subsequent leaching of metals, principally copper. Seventeen alternatives for control of acid mine drainage were evaluated. The recommended option proposed collection of piles of mine waste, recontouring of these over the dumps, application of a glacial till blanket, and construction of diversion ditching between pit and dumps (Figures 3 and 4). The object was to isolate the problematic dumps and waste from the effects of air and water, minimizing the production of acid, and the leaching of metals.

In 1988 the Ministry of Energy, Mines and Petroleum Resources allocated funding for the proposal based on the preliminary design concept and cost estimate. Tenders were subsequently called, but because of unexpectedly high bids received, work on the West Dump had to be eliminated from the program.
1988 CONSTRUCTION

Initially six gas/temperature wells were installed under separate contract by the federal Department of Environment. Two were located in the West Dump, three in the East Dump, and one in the South Pit Dump. Construction under the main contract proceeded according to the following timetable:

<table>
<thead>
<tr>
<th>Date Range</th>
<th>Task Description</th>
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<tbody>
<tr>
<td>August 12 - 7</td>
<td>Rebuild access road.</td>
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<tr>
<td>August 16 - 20</td>
<td>Clear glacial till borrow pit.</td>
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<tr>
<td>August 17 - 25</td>
<td>Clear dump toe area.</td>
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<tr>
<td>August 25 - 30</td>
<td>Install internal dump drains.</td>
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<tr>
<td>August 30 - 31</td>
<td>Regrade East Dump, apply limestone.</td>
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<tr>
<td>August 31 - Sept. 14</td>
<td>Strip, haul, place mine waste.</td>
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<tr>
<td>Oct. 5 - 18</td>
<td>Install lysimeters and weirs.</td>
</tr>
<tr>
<td>Oct. 6 - 18</td>
<td>Excavate diversion ditch.</td>
</tr>
<tr>
<td>Oct. 18</td>
<td>Work terminated by fall rains.</td>
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</tbody>
</table>

Installation of instrumentation was made possible by a grant from the federal/provincial Mineral Development Agreement.

Fall rains commenced in late September and by October 10 haulage and placement of till had to be stopped with approximately one-third in place.

Testing of the pit floor prior to start of construction of the diversion ditch showed that the apparently competent rock contained pockets and gullies of saturated mine waste compacted to a rock-like appearance on the surface, but highly porous underneath. Water table was within one meter of the surface in most areas. Bedrock was generally in a shattered state, and often difficult to distinguish from compacted waste. Both were difficult to excavate with the track mounted backhoe. Time permitted construction of only a temporary ditch which was lined with till and left to drain winter rain and snowmelt from the site.

In 1988, 7,560 cubic meters of till were placed at $9.75 per cu. m., 22,030 cubic meters of waste were excavated and placed at $4.81 per cu. m., and all other costs brought total expenditure to $428,000.00. To this amount must be added $75,690.00 for engineering costs.

In the winter of 1988/89 information collected during the construction season on the nature of surface and groundwater discharge and water quality regimes, mineralogy and surficial materials was reviewed. It was concluded that a significant amount of water was entering the site from above the pit, becoming contaminated, and exfiltrating the pit via groundwater flows to the East Dump.
It was decided that the diversion ditch should be completed as planned but at a higher level in the pit than originally designed to intercept incoming drainage.

1990 PROGRAM

Following release of funds in the new fiscal year and review of proposals, design and supervision of work on the diversion ditch was awarded to Robinson-SRK, and the piezometer program was awarded to Colder Associates. Engineering and Inspection Branch would supervise the project and provide engineering services for the completion of the glacial till blanket on the East Dump.

On May 12, 1989, snowplowing was started on the access road to the site and by May 17, the pit was reached. Snow in the pit area was one to three metres deep and melting rapidly. The pit floor was saturated and remained in this condition until all snow had gone in mid-June.

Testing of bedrock along the line of the proposed ditch in the pit indicated compacted mine waste averaging one metre in depth, over all the shattered bedrock. Observation in the exploratory trench showed that groundwater collected on the mine waste/bedrock interface and moved downslope towards the East Dump.

An upper branch was added to the proposed diversion ditch to intercept surface drainage along a route that allowed the invert of this section to be founded in bedrock.

A detailed design and cost estimate for the summer work program was subsequently prepared.

On July 21, 1989, following calling of public tenders, a contract for doing the work was signed with Gretslinger and MacDonald Construction of Campbell River in the amount of $310,475.00.

Construction of Diversion Ditch

Drilling and blasting on the ditch centerline commenced August 3. The desired rectangular shape for the ditch could not be obtained, and the ‘U’-shaped section resulting from blasting was accepted. Removal of smaller rock pieces and cleaning of the ditch invert was expedited through use of a compressor and air hose.
On August 21, shotcrete was delivered to the site by ready-mix truck. Application to the ditch invert went smoothly, requiring only two days for completion of three hundred and ten metres of ditch, covering 707 sq. m. Cost of this was $49,500.00.

Polypropylene fibres were selected by the consultant in preference to steel for reinforcement in the shotcrete. This not only eliminates rusting, but provides a safer surface for workers and the public.

Construction of Glacial Till Blanket

Specifications called for two layers of till of 0.5 m. depth to be placed in lifts not to exceed 0.25 m. compacted. The bottom layer to be of minimum density of ninety-three percent Modified Proctor, and the top one to be of minimum density of ninety percent. The less dense upper layer was designed to absorb and hold moisture and maintain the lower layer in a more saturated condition, reducing transmission of air and gasses.

Time constraints imposed by the short construction season and site configuration required lifts to be placed at thicker depths than planned. The only practical method for placement of the till was dumping at the top and drifting with a bulldozer towards the bottom. This resulted in multiple passes over the upper part of the dump, and a heavy compactive effort here. Also, pit run material contained many boulders larger than the specified 150 mm. maximum and it was not possible to separate anything less than 300 mm. Till was therefore spread and compacted in lifts approximately 400 mm. depth.

In all, 15,500 cu. m. of till were placed at a cost of $14.25 per cu. m.

Protective matting was placed over the lower half of the dump face to minimize erosion which occurred in the winter of 1988. Cost of purchasing and placing 4,500 sq. m. of rolled matting was $11,000.00.

Piezometer Program

Purpose of the piezometer program was to monitor and evaluate the physical and chemical hydrogeology of the pit and waste dump.
Golder Associates supervised the drilling of boreholes and installation of fourteen piezometers on the minesite September 21 and 22 by Drillwell Construction (Location is shown in Figure 5).

One piezometer per borehole was installed, plus one each in two exploration drillholes, one above the south side of the pit and one above the west side of the pit. Hydraulic conductivity at the piezometers was determined by pumping and timing of recovery. Water levels were read and water samples were obtained on October 7 and November 1.

Three layers of material in the pit were identified: mine waste; bedrock shattered from blasting; and competent bedrock. It was difficult to impossible to differentiate between the first two layers, and it was felt that they often were intermixed.

Cost of installing the piezometers was $9,800.00. Engineering costs including design, field supervision, monitoring, analysis and reporting was $18,000.00.

MONITORING AND ANALYSIS

Knowledge of copper concentrations and loadings is central to analysis of the acid generating mechanism and therefore development of corrective measures. Copper loading is calculated by multiplying discharge by copper concentration, and an accurate evaluation therefore requires accurate records of both these variables.

Critical Points of Measurement

The sump at the toe of the East Dump:

This has a moderate flow pattern consistent with that of groundwater discharge. There appears to be a direct relationship between discharge and loading. During summer dry periods, loading from the sump, although at a seasonal low, contributes up to one hundred percent of loading from the minesite. Maximum discharge was estimated at 16 L/s, with maximum copper loading at 25 kg. per day.
Weir No. 3 at the lower end of the diversion ditches:

This measures drainage from the pit and areas above. It is a typically ‘flashy’ surface drainage which in 1989 peaked at an estimated 50 L/s, with a copper loading of 225 kg/day. The amount of loading which can be attributed to construction disturbance is unknown. The pit area contributed possibly ninety percent of total loading during the 1990 fall rainy season.

Branch 126:

The permanent weir installed by Ministry of Environment downstream on Pyrrhotite Creek at Branch 126 logging road crossing (subsequently Br. 126) has proven to be critical to evaluation, as records here date from 1986. An examination of loading pattern does not indicate reduction in copper levels, although again, the effect of construction disturbance is not yet established.

Significance of Results

It is concluded that the pit is presently the major contributor of copper to the system. It is not known if this condition prevailed prior to corrective measures being undertaken. There are several reasons for this: encapsulation of the dump may have moderated the output of acid and metals from this source; disturbance from construction may be responsible for higher readings; and relatively little information is available on pre-reclamation condition of the site. Also unknown is the degree to which contaminated groundwater from the pit affects the quality of sump water.

A model of acid generation has been proposed for the better understanding of the acid generating mechanism and for evaluation of corrective measures (Figure 5).

If the relationships between discharge and copper loading indicated in the model are confirmed in the 1990 testing, several implications will be confirmed with respect to corrective measures. Firstly, the straight line configuration would suggest that reduction of groundwater flow through the mine wastes would result in a similar reduction in output of copper. As the objective of control is to reduce acid production to an innocuous level, as opposed to nil, then perfect encapsulation of all of the mine waste may not be required. Therefore the use of a sealing material, or till cap may still provide adequate control for the pit area.

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Future Program

Further monitoring and analysis will be done before additional major corrective measures are attempted on site. Specifically, the relationship between water level and copper concentration in the mine waste will be clarified. This will be done by the installation of stand pipes in the waste. Also an attempt will be made to determine the extent of transport of metals from the pit to the sump, and the possible improvement that might be possible from cleaning of the pit. This will be done through test-cleaning of a portion of the pit area. Should time and finances permit, soil amendments will be tested for design of sealing material.

A joint program has been developed by the Ministries of Energy, Mines and Petroleum Resources, and Environment, and Environment Canada for purposes outlined, and to determine relationships between the water quality at the site and in the Tsolum River.

Summary

Indications are that the problem at the Mt. Washington site could have been considerably reduced, had the following criteria been followed prior to mine closure:

1. Process waste left in the pit.
2. Contour the pit bottom to a free draining configuration.
3. Separate pit and dump; and
4. Place dump on a convex area of slope as opposed to one which collects water.

Further work on the site will improve the ability to extrapolate lessons learned.
Figure 2
SECTION A-A THROUGH EAST DUMP

Figure 4
MODEL FOR COPPER LOADING

COPPER LOADING kg/day

Cu loading from Pit Weir

Cu Loading from Weir No. 2

Maximum permissible loading for Tsolum River

Cu loading from Sump

DISCHARGE AT PIT WEIR L/S

Figure 8