

Maps: MS0 to MS9 are not in PDF report database and paper copy only. The paper copy is in Laurentian Library in Sudbury.

APPENDIX 6

EM SURVEYS MAPS - SOUTH BAY MINE SITE

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APPENDIX 6: INTERPRETATION OF EM SURVEY DATA FOR MINE SITE AND SOUTH OF TAILINGS.

MINE SITE

Introduction: The February 1995 survey was carried out over essentially the same grid as was established in March 1992. This year, two lines were added at both the east and west ends, and the complete grid surveyed with receiver - transmitter coil separations of 10 m, 20 m and 40 m. In the March 1992 survey, only 10 and 20 m coil separations were used. The 1992 results are presented on Maps MS-1 to MS-3 and the 1995 results on Maps MS-4 to MS-8. Differences between two sets of results are on MS-9 and MS-10.

Although the 1995 survey recovered the same 10 anomalies initially identified in 1992, differences in both horizontal and vertical positioning, as well as changes in the levels of conductivity, imply that significant changes have occurred in the groundwater regime in the area of the Mine Site. Some of these changes appear to be directly related to the presence of the **Backfill** Raise Diversion Ditch which was constructed shortly after the 1992 survey.

Review of Anomalies: The ten anomalies have been designated letters from " A to "J", and their sources, if known, are listed below. Except for Anomalies G, H and I, which likely represent portions of one anomalous trend, most other anomalies are one line, or point source, **Bull's Eye** type anomalies which rarely extend more than the 50 m distance to the adjacent grid line. The lettered anomalies are shown on Maps MS-1 and MS-4.

ANOMALY	SOURCE/COMMENTS
A	- directly at the shaft - may reflect contaminated groundwater or a cultural source
B	- directly at the concentrator - likely a cultural source

- C
 - concentrate loading area
 - likely reflects an accumulation of concentrate spilled during the loading of the concentrate trucks during the 12 year life of the mine.
- D
 - Mill Pond anomaly
 - metal precipitation at entry point of contaminated groundwater originating from the mine and mill areas.
- E
 - Warehouse Seep / Backfill Raise Cap anomaly (WHS & BRC)
 - contaminated groundwater discharging at surface at **two** locations.
 - survey too coarse to separate the *two* sources, or surface seeps are joined in the subsurface.
- F
 - probably the site where the mine core was buried.
 - likely acid mine drainage originating from the sulphides rich cores.
- G
 - Tailings Line Spill.
 - acid mine drainage originating from tailings spilled when the tailings pipeline broke during operations.
- H & I
 - probably portions of the same anomaly related to the Backfill Raise spill during operations.
 - Backfill Raise Diversion Ditch may have merged these waters from H & I with anomaly G
- J
 - Portal Raise anomaly (PRC)
 - acid mine drainage flowing out of the Portal Raise.

Discussion of Anomalies

Anomaly A: 1995 Results: The anomaly is strongest at 10 m with peak readings at 25 to 30 mS/m, while decreasing to 15 mS/m and 12 mS/m at 20 m and 40 m coil separations (MS-4, MS-5, MS-6). At both 20 m and 40 m, the anomaly is displaced approximately 25 m to the south suggesting a shallow plunging plume flowing south into Mill Pond.

In 1992, the anomaly was much stronger at both 10 m and 20 m coil separations with peak responses over 40 mS/m, and with no shift in the vertical dimension (MS-1, MS-2). These changes suggest that contamination is actively draining into Mill Pond.

Anomaly B: 1995 Results: The anomaly decreases in size and intensity with depth from over 40 mS/m at 10 m coil separation (MS-4), to 12 mS/m at 40 m coil separation (Mt-6). There is a slight shift of 20 m to the south with depth. Anomaly B appears to be connected to the Anomaly D, centred on Mill Pond, and also to Anomaly C.

In 1992, the anomaly showed very similar characteristics to the current survey. Since there have not been any noticeable changes, the anomaly source is likely cultural.

Anomaly C: 1995 Results: The anomaly is strong at both 10 m and 20 m coil separations and remains relatively strong at 40 m coil separation with a peak reading of about 20 mS/m. On the 20 m survey, it appears to connect well with Mill Pond Anomaly D (MS-4, MS-5, MS-6).

In 1992, the coverage of this anomaly was only partial, thus comparisons in position or shape cannot be made. Responses on the 20 m survey suggest that if the anomaly is related to contaminated groundwater, then the plume appears to be draining into Mill Pond. This interpretation is supported by the anomaly characteristics after the overburden responses have been reduced (MS-7). Responses on the 40 m survey suggest that the northern part of the anomaly on L350mN may be shifting to the north.

Anomaly D: 1995 Results: The anomaly is similar in intensity to Anomaly A, diminishing rapidly with depth. Its position along the north shore of Mill Pond suggests an entry point and precipitation of metals from the contaminated groundwater represented by anomalies A and C, and possibly B (MS-4, MS-5, MS-6).

The coverage in 1992 was only partial, however it is clearly evident that this anomaly was larger in areal extent at intensities of greater than 30 mS/m. The decrease in areal extent and intensity is likely a direct response to a reduction of intensity of Anomaly A, which appears to link up with Anomaly D.

Anomaly E: 1995 Results: The anomaly is positioned in the Warehouse Seep and Backfill Raise Cap area. It is a moderate to strong anomaly on both 10 m and 20 m surveys with a slightly higher peak at 30 mSI/m at the larger separation (MS-4, MS-5). At 40 m (MS-6) it diminishes to about 10 mSI/m with a slight shift to the south. The 10 mSI/m contour on MS-4 which extends to the NW suggests a link with Anomaly H, and in reality represents contaminated water in the ditch draining BRC.

In 1992, the anomaly was in exactly the same position, however, the intensity was much higher at well over 40 mSI/m on both the 10 m and 20 m surveys.

The decrease in intensity suggests significant removal of contaminated water is occurring via the Backfill Raise Drainage Ditch.

Anomaly F: 1995 Results: This anomaly is very strong at 10 m coil separation (MS-4) but even stronger and larger in areal extent to the north at 20 m coil separation (MS-5). Peak readings are well over 40 mSI/m at both separations. There is no evidence at all of this anomaly at 40 m coil separation (MS-6).

In 1992, this anomaly was small with peak responses at around 20 mS/m. The growth of this anomaly in both size and intensity supports the interpretation that this anomaly represents Acid Mine Drainage being generated from sulphides in mine cores which were buried at a shallow depth in this location during decommissioning.

This anomaly was tested with piezometer M-84. A sample of the groundwater returned an elevated conductivity of 2705 uS/cm and 3680

mg/L zinc confirming that AMD is the likely source of this anomaly.

Anomaly G: 1995 Results: This anomaly represents a material spilled from a break in the pipe carrying tailings to the tailings area. At 10 m coil separation (MS-4), it is moderate in intensity with peak readings in the 15 to 18 mS/m range. It diminishes in size and intensity at 20 m (MS-5) and is not evident at all on the 40 m survey (MS-6).

In 1992, this anomaly was smaller and weaker at 10 m (MS-1 and barely evident at 20 m (MS-2). The growth of this anomaly suggests continued generation and spread of Acid Mine Drainage from spilled tailing material. The position of the anomaly with respect to the Backfill Drainage Ditch suggests that contaminated water is draining into and is captured by the ditch.

Anomaly H: 1995 Results: Although not fully covered by the survey, Anomaly H appears to follow the extreme west portion of the Backfill Raise Drainage Ditch. The anomaly is moderate at 10 m coil separation (MS-4), barely evident at 20 m (MS-5, and absent at 40 m (MS-6).

In 1992 this anomaly appears to be the eastward extension of Anomaly I, and only evident at 10 m (MS-1).

In 1992, and prior to the construction of the Backfill Raise Drainage Ditch, this anomaly likely represented the eastward flow of Anomaly I, which in turn, represented a major surface seep of acid mine drainage. The 1995 results indicate the flow of contaminated water in the Backfill Raise Drainage Ditch.

Anomaly I: 1995 Results: This anomaly is very small and weak, represented by a single peak reading of 10 mS/m on L100mE at 10 m coil separation (MS-4, and about the same at 20 m separation (MS-5). It is absent at 40m (MS-6).

In 1992, this was a significant anomaly peaking at over 25 mS/m at 10 m and 15 mS/m at 20 m coil separation.

The changes from 1992 to 1995 suggest that the source of contaminated water has been severely curtailed, or that the Backfill Raise Drainage Ditch is effectively removing the contaminated water from this area, or some combination of both scenarios. This is evident from the reduction in anomaly strengths at both 10 m and 20 m soil separation. A weak surficial seepage remains.

Anomaly J: 1995 Results: This anomaly extends over two grid lines and shows a peak response of about 23 mS/m on LO and 15 mS/m on L50E at 10 m coil separation (MS-4), and 15 mS/m and 5 mS/m respectively at 20 m coil separation (MS-5). It is not evident at 40 m (M6-5).

In 1992, this anomaly was very strong at over 25 mS/m and 40 mS/m at 10 m (MS-1) on the same lines and in the 20-25 mS/m range at 20 m coil separation (MS-2).

Since 1992, the anomaly has diminished significantly in both intensity and size, especially on L50E, suggesting a reduction of contamination generated in the source area. A change in flow direction is not evident in the current survey results.

Anomaly Summary

- Anomalies A, E and J have significantly diminished in intensity and in some cases areal extent.
- Anomaly B appears to have changed very little.
- Anomaly C may have spread laterally to the north at depths of below 20 m, and to the south west, to Mill Pond at shallower depths.
- Anomaly D may have diminished slightly in intensity.
- Anomaly F has increased dramatically in both intensity and size, and appears to be migrating northward to the Backfill Raise Drainage Ditch.
- Anomaly G has increased in both extent and intensity, but at least in part appears to be captured by the Backfill Raise Ditch. Movement northward away from the

ditch, but still towards Boomerang Lake, is suggested by the responses on the 10 m survey.

- Anomaly H appears to be contaminated water captured in the western portion of the Backfill Raise Drainage Ditch, and is being drained towards Boomerang Lake. Anomaly I has almost been eliminated. Some contaminated water may still be draining westward into Mine Bay, while most appears to be draining to Boomerang Lake via the Backfill Raise Drainage Ditch.

Recommendations

Anomaly F is a known source of AMD that appears to be spreading northward. the present coverage is inadequate to the north, and requires an additional 100 m of surveying to the north, A fall 1995 survey would not only define the plume under fall conditions but may identify any noticeable plume migration since the February 1995 survey. Total geophysical coverage would be on the order of 300 m to 400 m.

Resurveying of the complete grid for monitoring purposes within the next 3-4 years to monitor the remedial work.

SOUTH OF THE TAILINGS/ TOWN SITE

A small grid was established through the former South Bay Mine town site. It extended from the southwest corner of the Tailings southward to the shores of Mine Bay. The survey plan indicates 6 apparently separate "bull's eye" type anomalies (Appendix 2: ML29, 31, 33, 35, 37).

The strong anomaly adjacent to the Tailings is referred to as the SOUTH TAILINGS ANOMALY. It was tested at two levels with 2 piezometers. M-78A tested the basal aquifer and returned a conductivity of 3084 uS/cm in the groundwater. The accompanying piezometer M-78B tested a shallower aquifer, and returned a lower

conductivity of 1150 uS/cm. The zinc concentrations were 198 mg/L and 1.14 mg/L respectively.

Both these piezometers are located south of the previously constructed Tailings Diversion Trench, and extend to an elevation below the bottom of the trench excavation.

Although the South Tailings Anomaly does not appear immediately south on the adjacent line located 100 m to the south, the fact that both holes were drilled 35 m south of L450mS indicates that the plume extends at least 45 m and as much as 90 m south of L450mS. Alternatively, the plume may be trending SSW, connecting with other bull's eye type anomalies on L550mS and L650mS. A better definition of this anomaly/plume could be achieved through fill in lines at 50 m or 25 m spacing.

The L650mS ANOMALY is centred at station 100mE on this line. The anomaly is of moderate strength and was tested with M-82 which returned a moderate conductivity of 1086 uS/cm from groundwater immediately above the bedrock. The zinc value in this water was 4.08 mg/L.

The origins of this contaminated water is uncertain as geophysically there does not appear to be a link to the South Tailings Anomaly. It is possible that this linkage does exist, however, possibly at a depth that is below the depth penetration capabilities of the EM34 survey. Alternatively, a locally buried pile of AMD generating waste rock may be the source of this anomaly.

The 750mS ANOMALY is a geophysically weak allocated immediately north of an area of iron precipitate observed on the shores of Confederation Lake in the vicinity of the old dock.

Two piezometers, M-77A and M-77B tested this anomaly and returned conductivities of only 241 and 480 uS/cm in the groundwater. However, the zinc concentrations are noticeably elevated at 3.77 mg/L and 23.4 mg/L respectively. The anomaly source may reflect AMD seepage from a nearby waste rock that was used as

fill to stabilize the back yards in this area. In addition, iron cables were encountered in the drilling.

The L550mS ANOMALY is located at the eastern end of the line and adjacent to the former tailings pipe line to the pond and road. This anomaly is thought to be the result of seepages generated during a break and spill of tailings at this location.

The strong anomaly at the eastern end of L700ms may be cultural cables and other mine debris present at this site besides road construction.

The two weak anomalies on L500mS and L650mS are as yet unexplained but may be either cultural or as previously suggested, linked with the South Tailings Anomaly.

Recommendations

Additional EM34 surveying on 50 m and 25 m line spacing for a better definition/linkage of the 6 "bull's eye" anomalies in this area. Anomaly testing as required. Best conducted in the summer months so that any possible cultural sources may be identified. Total lines/ surveying that would be required is estimated at 3-4 km.

Although it appears that the main areas where plumes of AMD are suspected to be present have been covered by the existing surveys, it is recommended that the South Tailings/Town Site Grid be extended to the east and southeast to tie into the Mine Site Grid for both continuity and assure that there are no plumes in the unsurveyed area between the two grids. Total lines/surveying is estimated at 3-4 km.

List of EM maps for Mine Site

Map #	Area	Date	Scale 1: [m]	Instrument	Mode	Coil Separation [m]	Conductivity Scale [mS/m]
MS1	Mine Site	March, 1992	2500	EM34	H	10	1 - 40
MS2	Mine Site	March, 1992	2500	EM34	H	20	1 - 40
MS3	Mine Site	March, 1992	2500	EM34	H	10&20	1 - 40
MS4	Mine Site	February, 1995	2500	EM34	H	10	1 - 40
MS5	Mine Site	February, 1995	2500	EM34	H	20	1 - 40
MS6	Mine Site	February, 1995	2500	EM34	H	40	1 - 40
MS7	Mine Site	February, 1995	2500	EM34	H	10&20	1 - 40
MS8	Mine Site	February, 1995	2500	EM34	H	20&40	1 - 40
MS9	Mine Site	Difference Feb, 95 - Mar, 92	2500	EM34	H	10	-12 - 12
MS10	Mine Site	Difference Feb, 95 - Mar, 92	2500	EM34	H	20	-12 - 12