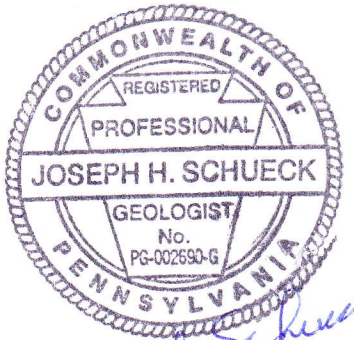
Geophysical Investigation of the H & D Coal Company
McIntyre Site
SMP 3078BC12
Marion Township
Butler County

Prepared by:
Joseph Schueck, P.G., P.E, Chief
Division of Acid Mine Drainage Abatement
Bureau of Abandoned Mine Reclamation
PADEP
December, 2002



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Geophysical Investigation
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Introduction

A geophysical investigation was completed on the forfeited H&D Coal Company's McIntyre site, MDP 3078BC12, in July for the purpose of delineating areas of acid mine drainage (AMD) generation and materials largely responsible for AMD production. Two geophysical techniques were employed, magnetics and electromagnetic terrain conductivity (EM). Field mapping was completed by employees of the Knox District Mining Office, the Bureau of Mining and Reclamation, and the Bureau of Abandoned Mine Reclamation. This report presents the findings of that investigation.

The purpose of the EM survey was the identify areas within the mine site where AMD production was likely occurring and to perhaps map the locations of the contaminant plumes. This identification is limited to the upper 20 feet of overburden. It is the area where oxygen concentrations are likely to be highest and AMD production initiated. The purpose of the magnetics was to locate specific piles of acid producing materials, specifically coal refuse or improperly handled pit cleanings. Both materials are characteristically rich in pyrite.

Background

Mining of this site resulted in a post mining AMD discharge that is especially difficult to treat. There are two ponds in the center of this site. Recent sampling of the treatment pond (first pond) indicated a pH of 2.8, hot acidity of 945 mg/L, iron of 316 mg/L, Mn of 96 mg/L and Al of 29.5 mg/L. A sample of the final pond effluent indicates that the pH drops to 2.6, hot acidity decreases to 626 mg/L, iron decreases to 60 mg/L, Mn decreases to 67 mg/L, but Al increases to 43 mg/L. Vertical flow reactor ponds have had little success in treating water with such high Al concentrations without significant maintenance. Space for passive treatment facilities is also limited on this site. It was felt that the geophysical survey might suggest alternative treatments to this site to improve the water quality.

Results of Field Investigation

The site was gridded by Jack Chamberlin, PLS, on 50 foot centers. For the EM work, readings were recorded every 10 feet along lines spaced 25 feet apart, following the grid that was established in the field. As a matter of note, it appears that the north arrow on the Chamberlin map should be rotated about 45 degrees in a clockwise direction to be more representative of true north. Field readings were converted into a spreadsheet along with their respective coordinates. The readings were then contoured using Surfer software with a kreiging algorithm. The greatest influence on the readings comes from materials located at depths of from 9 to 18 feet. The EM contour map is presented on the right half of the attached figure. This mapping should be compared to the Chamberlin map for the appropriate orientation.

Total field magnetic readings were collected continuously on lines spaced 25 feet apart. Note that the sign of the readings along the bottom or X-axis are opposite that of the EM. This was intentional and was necessary for the magnetometer to collect readings according to the established grid layout. The magnetic anomaly map is presented on the left half of the attached figure. Despite the reversal in the X-axis signage, it is apparent that both maps are oriented alike and matche the outline of the project area as shown on the Chamberlin map.

Survey Interpretation Basis

It is necessary to follow geophysical surveys with drilling in order to make interpretations "to a reasonable degree of scientific certainty". Drilling in not planned for this site. Based upon some basic assumptions about the site and experience mapping similar sites, interpretations will be at a level of "scientifically reasonable to expect to encounter". Assumptions or "knowns" about the site are as follows:

- The entire area under considerations was surface mined.
- The spoil should consist of an upper soil horizon and an underlying broken bedrock horizon.
- Both horizon should exhibit similar magnetic and electrical conductivity properties.
- Acid mine drainage is being produced on this site. AMD is an excellent conductor of electrical currents.
- Acid forming materials are likely to be buried within the spoil.
    - It is reported that tipple refuse was disposed of at this site.
    - It is unclear how pit cleanings were handled.
    - The Lower Kittanning coal seam was mined here. Although there was no overburden analysis performed for this site, the shale unit overlying the LK is notorious for having a high pyritic sulfur content.
- Gas well drilling was extensive in this area. Surface remnants include stacks of pipes and metal tripods. It is likely the some of these remnants were buried.
- Buried piles of acid producing material such as tipple refuse generally result in anomaly amplitudes of a few tens to a few hundreds of gammas. Metal remnants tend to produce anomalies on the order of several hundred to few thousand gammas.

Survey Interpretation- EM

Reference should be made to the attached figure. The map on the right side of the figure represents the contoured field readings from the EM survey. Values are in mmhos/m and the contour interval is 2 mmhos/m. EM readings are influenced primarily by increasing clay content of the soils, degree of saturation, and electrolytic properties of the moisture (the higher the clay content, degree of saturation, and electrolytes, the higher the readings). The earth is a poor conductor of electricity and readings less than 10 mmhos/m over mine spoil generally indicate well-drained conditions and little AMD formation or presence. It is reasonable to expect that this statement applies to this site. Note that on the EM map in the figure, the values less than 10 mmhos/m are filled in

yellow. Note also that the contour interval is somewhat irregular and spread out. This is an indication of very gradual changes across this area.

Where values are above 10 mmhos/m the contours are closer together, indicating a fairly rapid change in conductivity laterally. In addition, as the values continue to increase (orange grading to red), the contours become closed until there are several "bullseyes" where the values are greater than 20 mmhos/m.

Based upon similar investigations at other AMD producing sites, these higher value, closed contours are characteristic of AMD source areas. These are areas where quite severe AMD production occurs. As the water migrates away from these source areas toward the discharge, the AMD becomes diluted resulting in lower EM values. Typically, the water quality within the source area is much worse than the quality of the final discharge. This is reflected in the close spacing of the EM contours.

Based upon the EM survey, it appears that the AMD production occurs in a relatively straight band approximately 200 feet wide and trends in a north-south direction. This band is delineated by a red outline on the figure. It is interesting to note that this band lies downslope of the Lower Kittanning crop line as shown on the Exhibit IV prepared for the mine drainage permit application. A seep was located at the edge of the mapped area at x = -250 and y = -400. Note the outline of a "contaminant plume" defined by readings of 12 mmhos/m to the north of this seep location. This seep has not been sampled by BAMR personnel.

In addition to two treatment ponds on this parcel, there are two ponds that were used for drying of the treatment pond sludge. Both of these exhibited high conductivities suggesting that the materials within the pond are contributing to AMD production.

Survey Interpretation – Magnetics

It has been determined that when buried piles of pyrite-rich materials react to form AMD, a magnetic mineral phase of iron is formed. As a result, these piles can be detected and delineated using a magnetometer. These piles normally appear as dipoles, i.e. on the contour map one side of the pile will exhibit positive readings and the opposite side will exhibit negative readings. The unit of measurement is in gammas. Typically, the magnitude of the readings for these piles will be on the order of a few tens to a few hundred gammas. The actual pile is smaller than the aerial extent of the anomalies and generally lies beneath the positive and negative intersection of the anomaly.

Interpretation of the magnetics on this site was clouded because of an abundance of steel pipes and other metallic cultural features resulting from extensive gas well drilling in this area. Because of the high magnetic susceptibility associated with the metal on the site, the resultant magnetic anomalies are on an order of magnitude of several hundred to a few thousand gammas. A stack of steel pipes can result in an anomaly from 200 to 300 feet in diameter, completely masking an anomaly that would result from a pile of buried coal refuse located within that area. Such a stack is located at x = 200 and y= -650. The locations of these cultural features appearing on the surface are indicated on the magnetics map.

A comparison of the EM mapping with the magnetics map will show that everywhere there is a conductivity high, there is a corresponding magnetic anomaly or grouping of anomalies. These have been outlined in red. Where metals on the surface

may be masking a buried anomaly corresponding to the conductivity high, a yellow box has been drawn.

Discussion

There is good correlation between the magnetics and the conductivity highs, thus it is reasonable to expect that the outlined magnetic anomalies indicate the presence of piles of acid forming materials high in pyrite concentration. Without drilling or excavation, the makeup of these piles is uncertain. It was reported that coal refuse was disposed of at this site and the resultant water chemistry is characteristic of AMD associated with coal refuse. Improperly handled pit cleanings could also be a source. Considering the location relative to the Lower Kittanning crop line, the dark shale layer overlying the LK could also be the culprit. Based upon an overburden analysis performed at the Sunbeam Walter site, the Lower and Middle Kittanning overburden is net alkaline, but the shale unit overlying the LK exhibits sulfur contents of nearly 1%. If there is a need to further investigate the subsurface, a magnetic gradiometer survey could be completed within the areas outlined in red on the magnetics map. This technique would provide for better definition of the buried AMD forming materials.

Remediation Recommendations

Considering the difficulties that would be encountered with passive treatment of the discharges, three remediation alternatives come to mind. There may be others. These include removal of the source materials, pretreatment of water infiltrating the site, or isolating the source materials with an impervious cap. Cost evaluations of the various alternatives have not been evaluated.

Removal of the Source Material

Considering the correlation between the EM and the magnetic survey, additional magnetic surveying could be completed within the areas delineated in red on the magnetic map to better define the limits of the acid forming materials. These materials could then be excavated and disposed of in a manner that would prevent further contribution to the AMD loading. This is likely to result in improved water quality that would be treatable with passive technologies.

Pretreatment of Water Infiltrating the Site

It is possible to cause water infiltrating the site to become highly alkaline by placing a layer of waste lime beneath the topsoil horizon. This would be necessary only within the area outlined in red on the EM map. Infiltrating water percolating through the waste lime would pick up significant alkalinity. When it came into contact with the acid forming material, any AMD present would be immediately neutralized and further AMD production would be inhibited. This option may result in a net alkaline discharge that may not require any treatment.

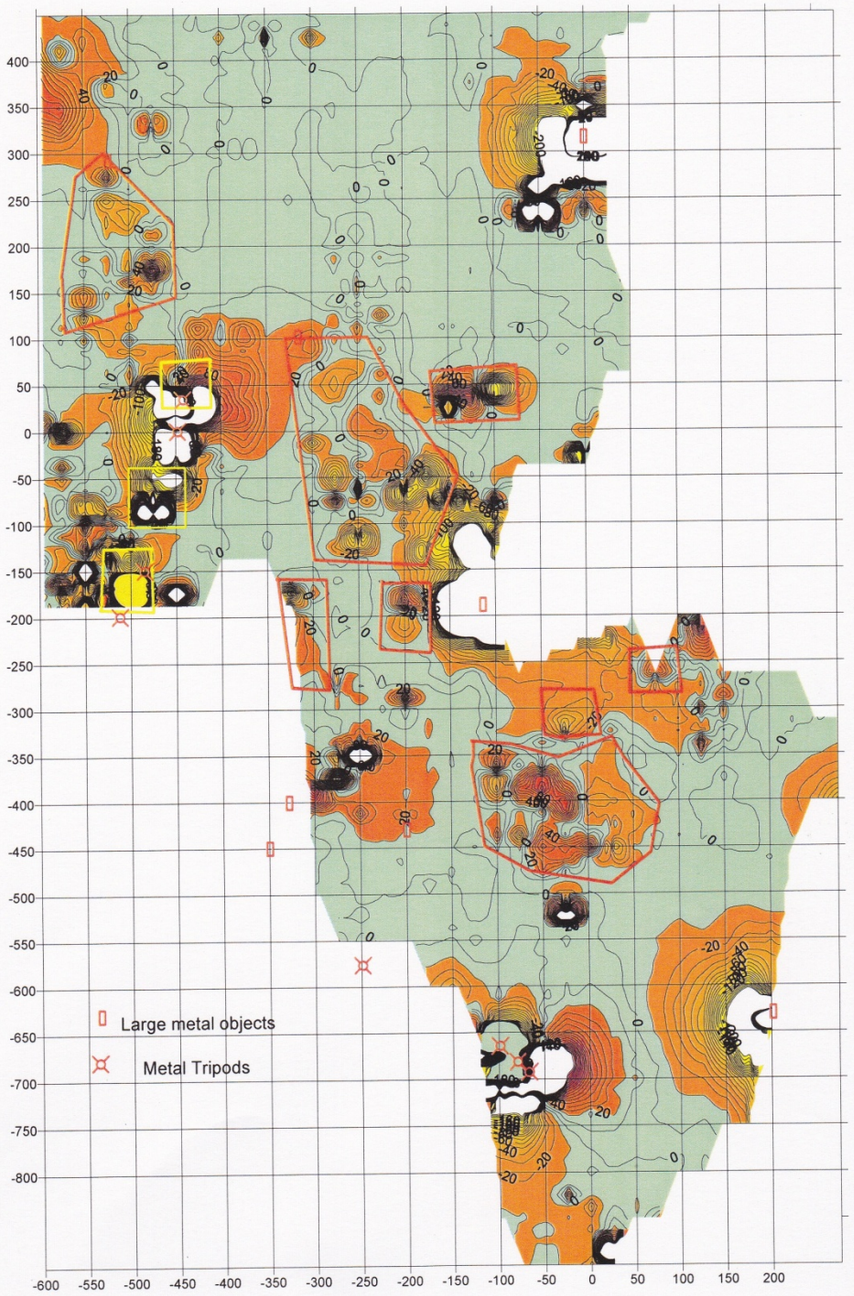
Isolation of Source Materials with and Impervious Cap

A third option would be capping the area with an impervious cap of fbc ash. Based on monitoring of the Abel-Dreshman site, it is likely that this would reduce infiltration rates. However, little alkalinity appears to be derived from such a treatment and water quality may not improve significantly. Recmix may be a suitable material for this application as well, but I am unaware of any reports in the literature that discusses the effectiveness of this material.

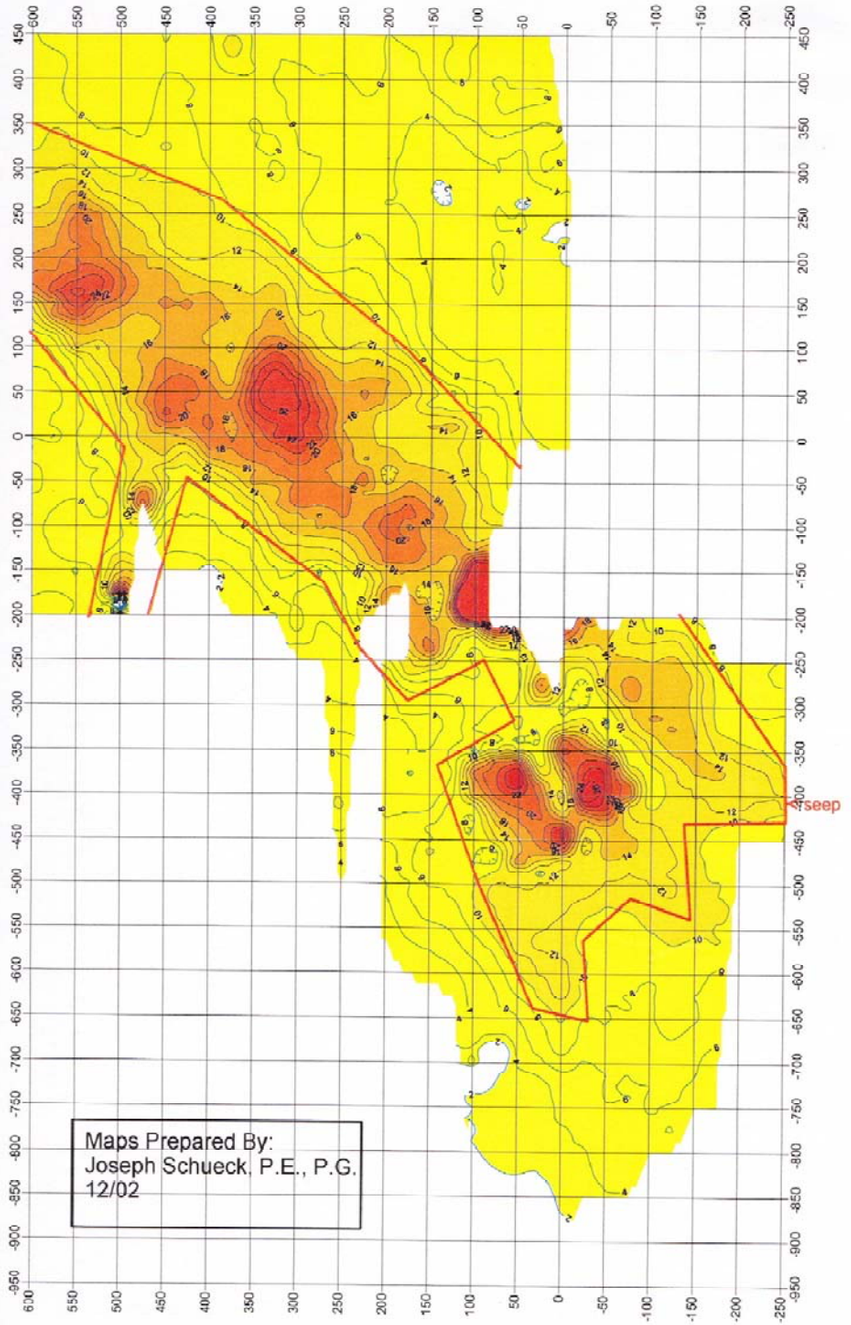
Conclusions

Despite the cultural features on the surface that interfere with the magnetic survey, there is good agreement between the findings of the two geophysical techniques on the site. Based upon the findings of this investigation and similarities to other sites, it is scientifically reasonable to expect that this report accurately describes the initial and primary source areas of AMD production on this site. If removal of the source material is selected as a remedial solution, additional magnetic mapping and soils exploration is recommended to better define the limits and character of these buried piles.

McIntyre Magnetics



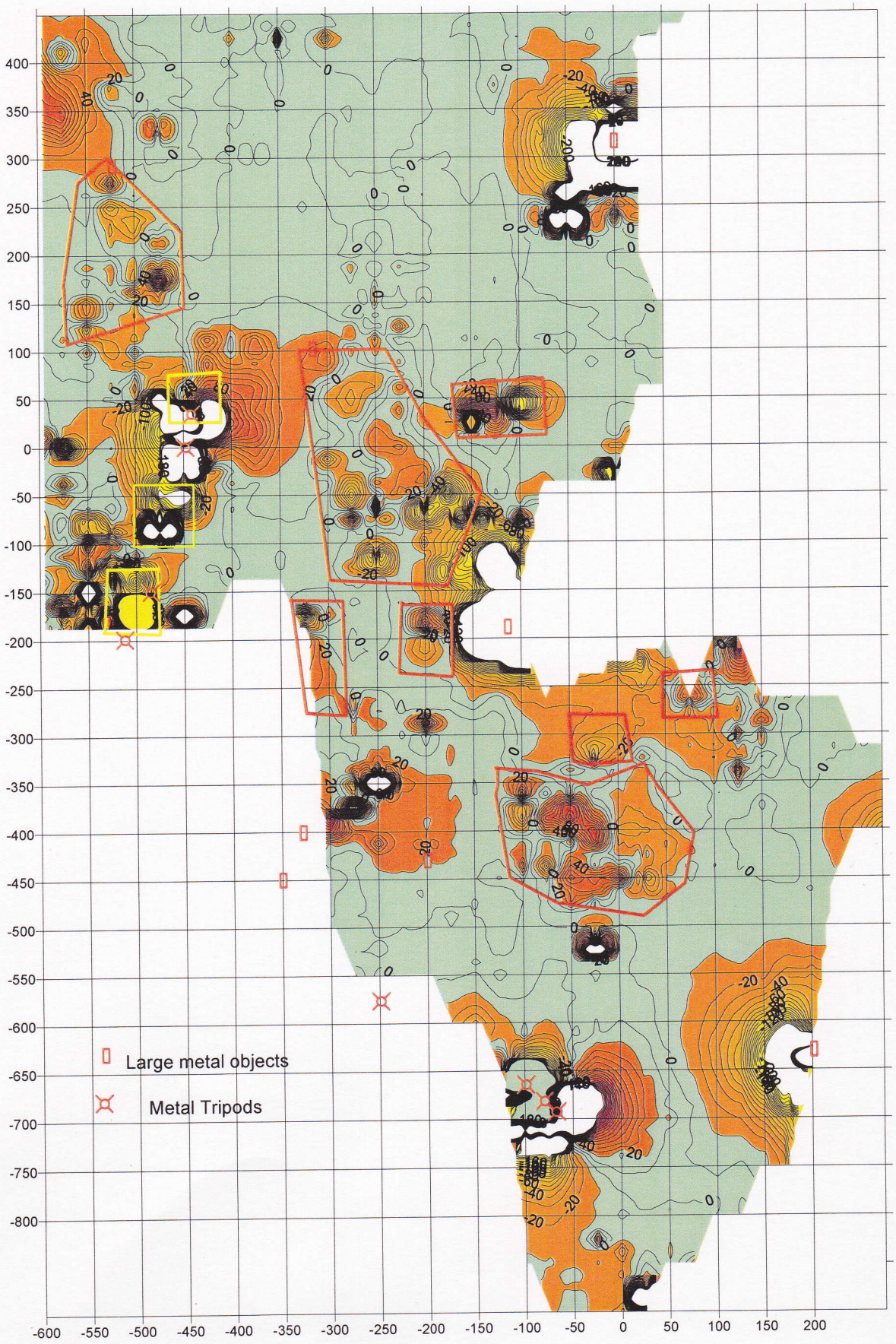
McIntyre - EM 31 Survey- Deep readings (10-18')



COMMONWEALTH OF
REGISTERED
PROFESSIONAL
JOSEPH H. SCHUECK
GEOLOGIST
No.
PG-002690-G

12/19/02

McIntyre Magnetics



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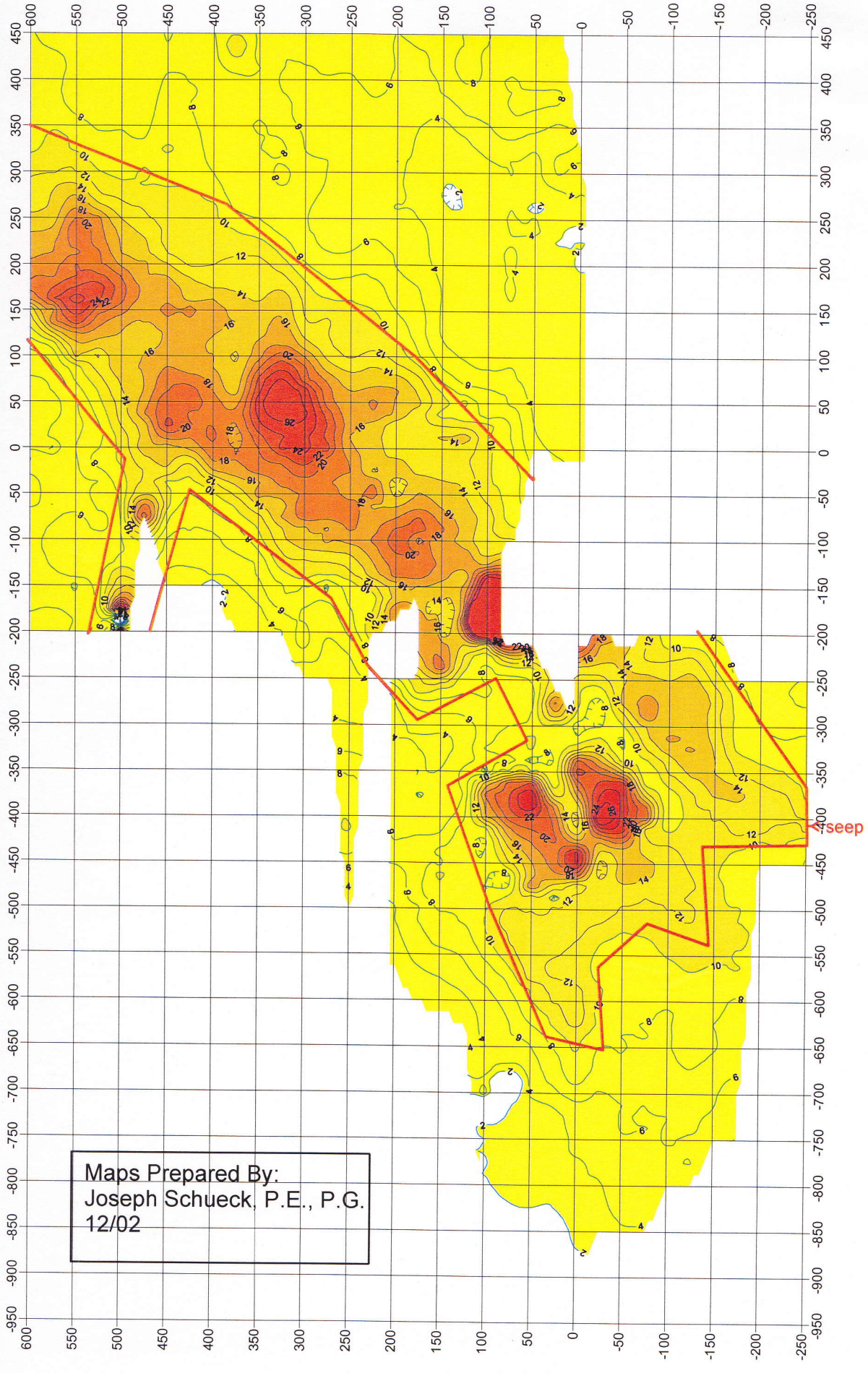

Maps Prepared By:
Joseph Schueck, P.E., P.G.
12/02

COMMONWEALTH OF
REGISTERED
PROFESSIONAL
JOSEPH H. SCHUECK
GEOLOGIST
No.
PG-002690-G

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