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Kennecott Eagle Minerals
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November 21, 2008

Rebecca L. Harvey
United States Environmental Protection Agency
Underground Injection Control Branch
Region 5
Attention Mail Code WU-16J
77 West Jackson Boulevard
Chicago, Illinois, 60604-3590

Subject: **Response to EPA's Request for Additional Information, dated October 30, 2008 Kennecott Eagle Minerals Company (KEMC), UIC Permit Application Number MI-103-5W20-0002**

Dear Ms. Harvey:

Consistent with our correspondence to you dated November 14, 2008, please find attached a response to item #1 in your October 30, 2008 letter. The attached document provides additional information to support the degree of discontinuity and permeability of the silty-sand layer within the TWIS area.

KEMC has already provided information to address item #2 and as stated in our November 14, 2008 letter, information to address item #3 will be submitted no later than December 19, 2008.

Should you have any questions, please contact me at 906-486-1257.

Sincerely,

Jon Cherry

Jonathan C. Cherry, P.E.
General Manager

cc: Gene Smary, Warner, Norcross & Judd, LLP
Dennis Donohue, Warner, Norcross & Judd, LLP
Steve Donohue, Foth Infrastructure & Environment, LLC

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Technical Memorandum

November 18, 2008

To: Victoria Peacey, Kennecott Eagle Minerals Company

From: Dan Wiitala, North Jackson Company

CC: Steve Donohue, Foth and Van Dyke; Dennis Donohue, Warner Norcross & Judd

RE: **Eagle Project, Michigan; Additional Information in Response to Request from US EPA, Underground Injection Control (UIC) Permit Application Number MI-103-5W20-0002**

1. Introduction

North Jackson Company has prepared this technical memorandum (memo) on behalf of Kennecott Eagle Minerals Company (KEMC) in response to certain technical review comments from the US EPA Underground Injection Control (UIC) Branch and its contracted hydrogeologists with The Cadmus Group. Specifically, the information contained in this memo is intended to address Comment 1 (comment) in the letter from Rebecca L. Harvey, restated below:

Proper characterization of the infiltration rate is dependant on the continuity and permeability of the clay layer. However, the continuity of the clay layer in the immediate area of the Treated Water Infiltration System (TWIS) has not been established. If the clay layer is continuous, the flow would be dominated by the lower-permeability clay-rich units, and therefore a design infiltration rate of only two orders of magnitude less than the average measured rate (62 ft/d) may not be conservative enough. Submit additional information to support the degree of discontinuity and permeability that you have asserted.

In addition to the hydrogeological data presented for the Quaternary alluvium deposits in the Supplemental Hydrogeologic Study for Groundwater Discharge (North Jackson Company, January 2006) (HS Report), data associated with the installation of additional TWIS area monitoring wells have also now been collected (North Jackson Company, July 2008).

The area of the proposed TWIS (approximately 9.6 acres) has now been characterized by additional data obtained from 17 continuous (sonic core drilling method) soil boring locations and 9 monitoring well locations (Figure 1), and contained within KEMC's UIC permit application (MI-103-5W20-0002). The additional data provided by these new monitoring wells and soil borings is consistent with the data generated from the other soil borings and monitoring wells shown in Figure 1.

Local and regional groundwater elevations were measured and potentiometric surfaces were mapped as part of this additional groundwater assessment (North Jackson Company, October 2008), which was required under the Michigan Department of Environmental Quality (MDEQ) Groundwater Discharge Permit GW180162.

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We understand the reviewers are concerned that the clay-rich, low permeability material identified in the unconsolidated deposits may impart control on movement of infiltrated groundwater in a manner that has not been considered in site characterization or flow modeling performed to date. In order to address this concern, we are presenting hydraulic head and stratigraphy data from recent monitoring and soil investigations performed in 2008.

The data and analyses presented in this memo are as follows:

- Summary of hydrostratigraphic units;
- Summary of potentiometric (water level) data and interpretation of groundwater flow; and,
- Enhanced visualization model to address continuity of hydrostratigraphic units.

2. Summary of Hydrostratigraphic Units

The primary aquifers within the Quaternary deposits on the Yellow Dog Plains are glacial outwash units composed mostly of fine- to medium-grained sand and defined as the A and D hydrostratigraphic units (Table 2 in HS Report). The measured saturated hydraulic conductivity for the A and D zone material is typically within a range of 20 to 60 ft/d (7×10^{-03} cm/s to 2×10^{-02} cm/s). As measured by ASTM standard infiltration test methodology in the TWIS discharge area, this material has an average unsaturated infiltration rate of 62 ft/d. These rates are consistent with regional hydrogeological reports that characterize these types of outwash plains as having very rapid (> 20 ft/d) infiltration rates (Twenter, 1981).

Over much of the Yellow Dog Plains, the A and D zone outwash deposits are separated by fine-grained deposits (greater than 50% silt and clay) of proglacial lake origin. The proglacial lake extended from the glacier's terminus, which ran northwest-southeast (roughly coinciding with the northern edge of the Yellow Dog Plains), southward towards the bedrock highlands that create the southern boundary of the Yellow Dog Plains.

The lacustrine deposit (C zone) is predominantly silt and clay and it is the only consistently "clay-rich" material (up to about 40% clay) found in this sequence. The saturated hydraulic conductivity of the lacustrine deposits is estimated to be between 10^{-05} to 10^{-02} ft/d (3.5×10^{-09} cm/s to 3.5×10^{-06} cm/s). Of the 17 TWIS area soil borings, the lacustrine deposit (clay-rich material) is absent within the unsaturated outwash at ten locations: QAL008, QAL031, QAL036, QAL037, QAL041, QAL050, QAL052, QAL053, QAL056, and QAL057. This finding indicates a significant lack of continuity of a clay-rich horizon in the unsaturated zone.

In the area of the TWIS, and also regionally, there is a "fining downward" pattern in the outwash sand (A zone), so that the material becomes more dominated by fine sand at depth, and in many cases grades conformably into a transitional fine sand to silty sand.

This transitional deposit (B zone) contains appreciable fine sand (typically 50%) and silt with very little clay (typically less than 10%). The transitional deposit is absent at locations QAL030, QAL040 and QAL051.

The transitional zone deposits are significantly more transmissive than the lacustrine deposits with a hydraulic conductivity of 10^{-03} to 1 ft/d ($3.5x10^{-07}$ to $3.5 x10^{-04}$ cm/s).

Towards the north edge of the Yellow Dog Plains, the lacustrine deposit thins and eventually pinches out (please refer to Section 2.1 of the HS Report for a complete discussion of the depositional model associated with this area distribution of the confining unit). This is displayed in the B and C zone isopach map in the HS Report, and modified for this memo with more recent soil boring and sampling data collected in 2008 (Figure 1). The pinch-out of the lacustrine deposit is hydrologically significant in the TWIS area because the clay-rich C zone confining unit is present only in northwest portion of the proposed discharge area, and absent elsewhere.

3. Summary of Potentiometric Data and Interpretation of Groundwater Flow

Where the lacustrine deposit is present, there exists significant hydraulic head differences between the A zone (water table aquifer) and the D zone (a confined aquifer). As a result, it is appropriate to create separate potentiometric maps for the A and D zones (Figures 2 and 3). Where the lacustrine deposit is absent, there is essentially no head difference. The A zone represents the water table aquifer underlying all of the Yellow Dog Plains, while the D zone represents a deeper, confined aquifer underlying most of the Yellow Dog Plains. However, the A and D zones are essentially the same system, controlled by the same hydrologic boundary conditions on the Plains. This is observed in the very similar potentiometric contour maps constructed using both A and D zone water levels, discussed further below.

Horizontal gradients in the A and D zones are generally between 0.01 and 0.03 ft/ft. The equipotential lines shown in the groundwater contour maps for both units illustrate that horizontal gradients increase toward the northeast, in response to the deeply incised tributary stream valleys that drain these aquifers toward the north/northeast into the Salmon Trout River system.

The measured downward vertical gradients between the A and D zones ranged from -0.004 ft/ft to -1.08 ft/ft (downward). The maximum value was measured at nest QAL008, which is located at the northern corner of the TWIS area, where a relatively thick lacustrine deposit exists. The lowest (absolute value) gradient measured between the A and D zones is at QAL051 location where no confining unit exists between the water table and base of the saturated outwash, indicating that flow is essentially horizontal in the absence of the lacustrine deposit.

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4. Visualization of Continuity of Hydrostratigraphic Units

In order to provide an improved visualization of the continuity of hydrostratigraphic units, a stratigraphic model of the Quaternary alluvial deposits of the TWIS area has been constructed using data from the 17 soil borings located within and immediately adjacent to the TWIS area.

Figure 4 provides a representation of the TWIS area stratigraphy. The orientation of the model (viewed from the southwest) is aligned with the regional groundwater flow direction shown in Figures 2 and 3. The representation illustrates that the lacustrine (clay-rich) deposit is present in the northwest portion of the area. The presence of the clay-rich material coincides with mounding of the regional water table in the northwest portion of the TWIS area. Where the clay-rich material is largely absent (towards the southeast), water table mounding does not occur. Although there are some thin (less than 4 feet thick), discontinuous stringers of transitional deposits above the saturated zone, they do not significantly impede natural infiltration, as evidenced by the absence of a perched aquifer associated with these deposits within the TWIS area.

Figure 5 shows the same stratigraphic model, with an orientation aligned roughly 180-degrees from the view in Figure 4 (looking towards the TWIS area from the northeast or against the regional flow direction). Again, the mounding of the A zone water table is apparent in the northwest portion, coinciding with the presence of the lacustrine deposit. No effect of the thin, discontinuous stringer transitional deposits in the unsaturated zone is observed.

In both model representations, the TWIS area is dominated by a relatively thick sequence (up to 100 feet) of unsaturated outwash sand. This material was adequately characterized by the infiltration tests performed for the HS Report. The other consistently continuous unit in the unconsolidated sequence is the basal till (poorly sorted clay/sand/gravel mix) unit directly overlying bedrock.

5. Conclusions

- The subsurface stratigraphy of the TWIS area is dominated by a thick deposit (up to 100 feet) of unsaturated outwash sand with very high infiltration rate characteristics.
- Water table elevations are very stable as measured by continuous monitors operational since 2004. Steep horizontal gradients towards the northeast exist at the TWIS. As a result, flow directions are very stable in all seasons (towards the northeast from the TWIS).
- Regional and local potentiometric maps of the A zone and D zone indicate a very steep gradient to the northeast (Figures 2 and 3) (consistent with flow in the Salmon Trout East Branch basin).
- Where the clay-rich lacustrine deposit is present in a small part of the northwestern portion of the TWIS area, there exists a water table aquifer (A zone) above the

deposit, and a confined aquifer (D zone) below. Where the lacustrine deposit is absent or discontinuous, which is over a large majority of the TWIS area, there is essentially a single unconfined aquifer.

- The clay-rich lacustrine deposit pinches out and is largely absent in most of the TWIS area.

- The thin, discontinuous stringers of transitional deposits (silt/sand/clay mixtures) located above the saturated zone do not significantly impede natural infiltration, as evidenced by the absence of any perched saturated zones associated with these deposits within the TWIS area.

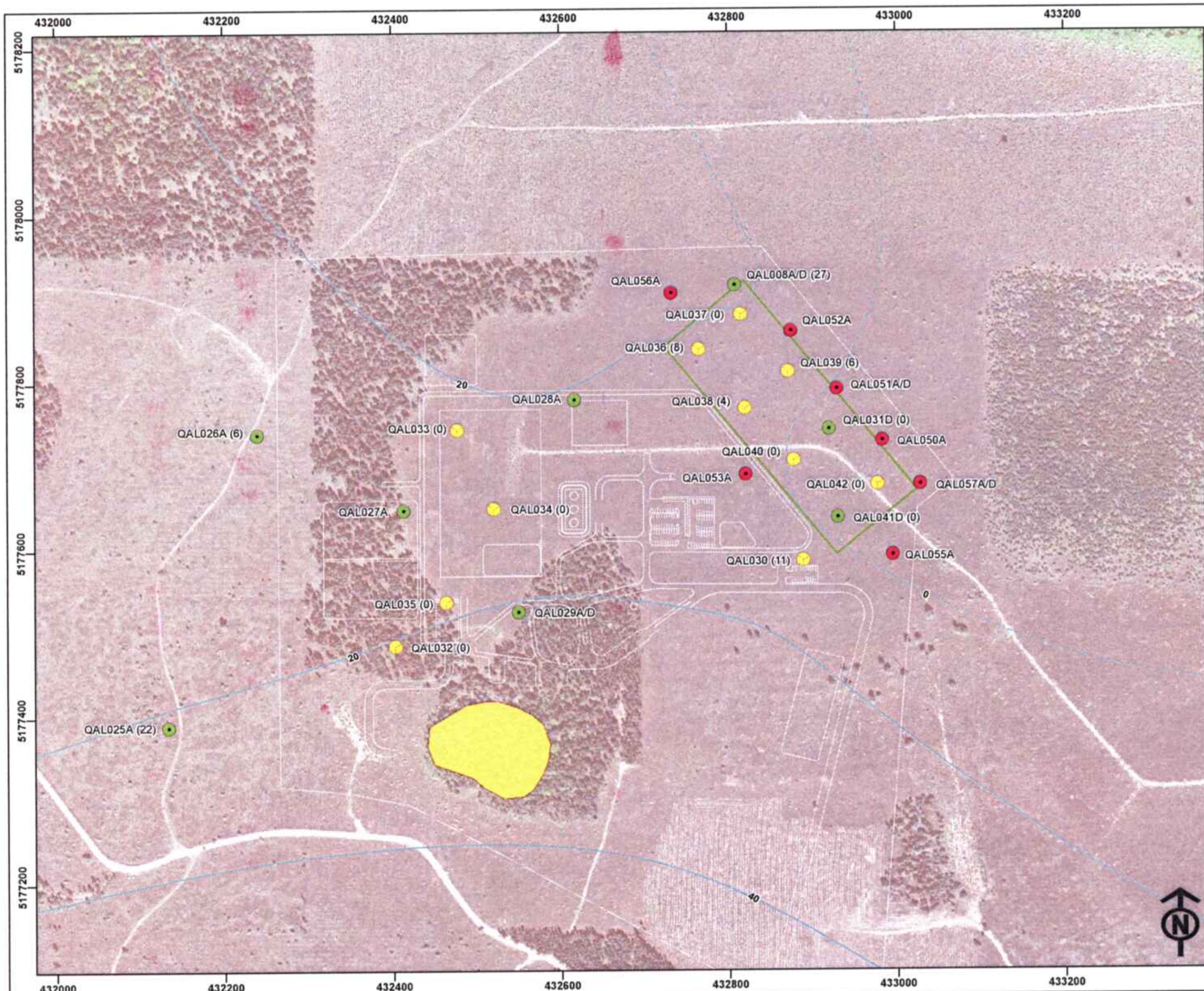
- The transitional zone deposits are significantly more conductive than the true clay-rich lacustrine deposits with a hydraulic conductivity of 10^{-03} to 1 ft/d, compared to lacustrine deposit hydraulic conductivity of 10^{-05} to 10^{-02} ft/d.

- Localized flow pattern changes caused by TWIS operation will be overwhelmed by the strong regional gradient to the northeast, as demonstrated both by local and regional scale flow modeling.

Attachments

5 Figures

CONFINING UNIT (B&C ZONE) ISOPACH HS VIEW



OUTCROP

PROPOSED SITE PLAN

PROPOSED DISCHARGE AREA

CONFINING UNIT (B&C ZONE) CONTOUR (CONTOUR INTERVAL 20', DASHED WHERE INFERRED)

MONITORING WELL

SOIL BORING

NEW WELL INSTALLED for GWD PERMIT MARCH 2008

Reference

Data provided by Kennecott Minerals, North Jackson Company, Foth & Van Dyke and Assoc. Inc.
Projection & Datum: UTM NAD 83 Zone 16N

0 400 800 Feet

Scale: 1:4,800

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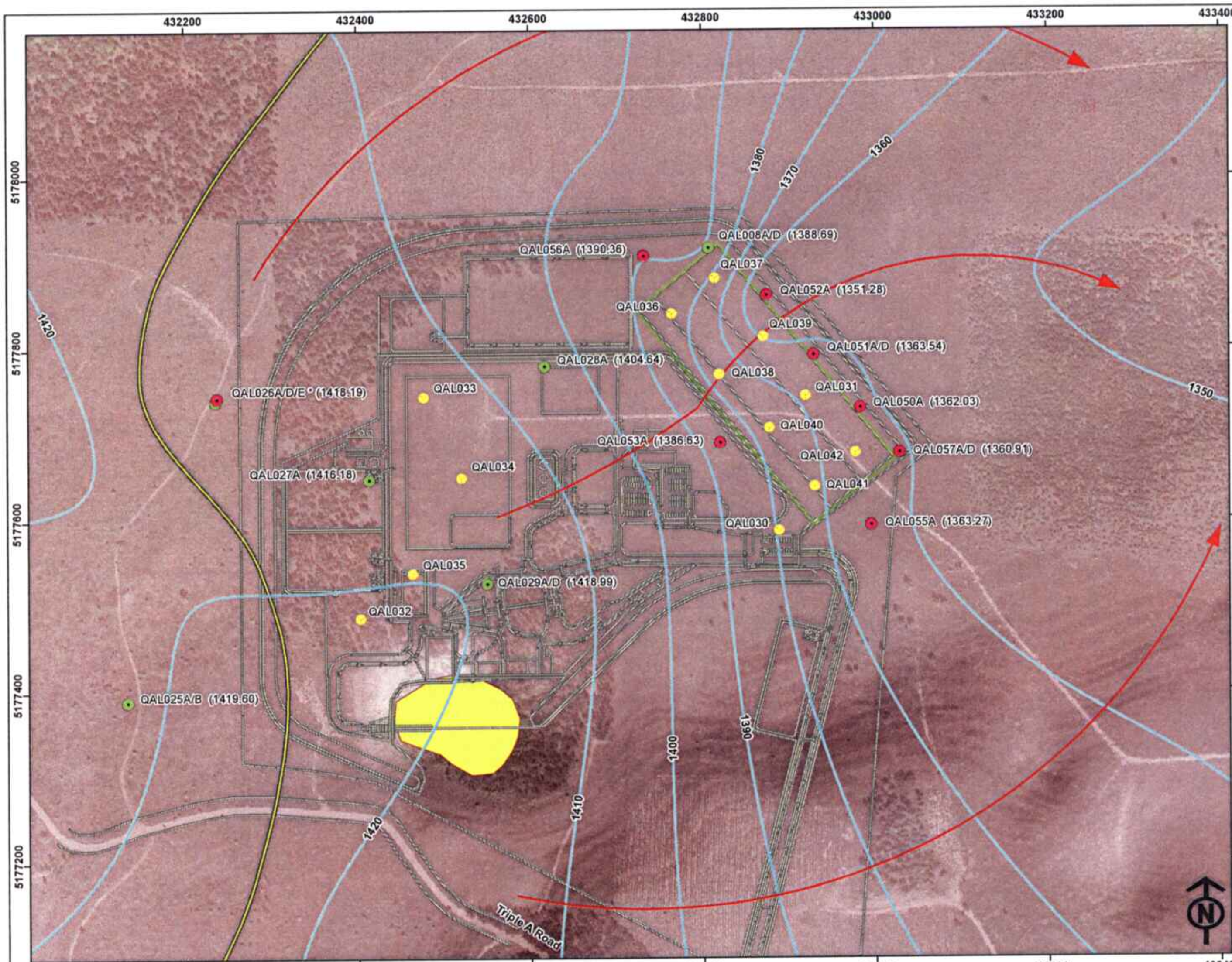
Figure: 1



A ZONE GROUNDWATER ELEVATION CONTOURS, MAY 2008

- OUTCROP
- GROUNDWATER FLOWLINE
- PROPOSED MINE FACILITIES
- GROUNDWATER CONTOUR ELEVATION (10' CONTOUR INTERVAL, DASHED WHERE INFERRED)
- GROUNDWATER BASIN DIVIDE
- TREATED WATER INFILTRATION SYSTEM (TWIS)
- EXISTING QUATERNARY AQUIFER MONITORING WELL
- NEW WELL INSTALLED for GWD PERMIT MARCH 2008
- SOIL BORING

(1415.59) GROUNDWATER ELEVATION (ft MSL on 5/29/2008)

* QAL026A was an existing well. QAL026D was installed for the GWD Permit. QAL026E was installed in March 2008 for the Mining Permit.

Reference
Data provided by Michigan Center for Geographic Information, North Jackson Company
Projection & Datum: UTM NAD 83 Zone 16N

0 400 800 Feet

Scale: 1:4,800

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Eagle Project
Groundwater Discharge Permit
Monitoring Well Installation Report
June 2008

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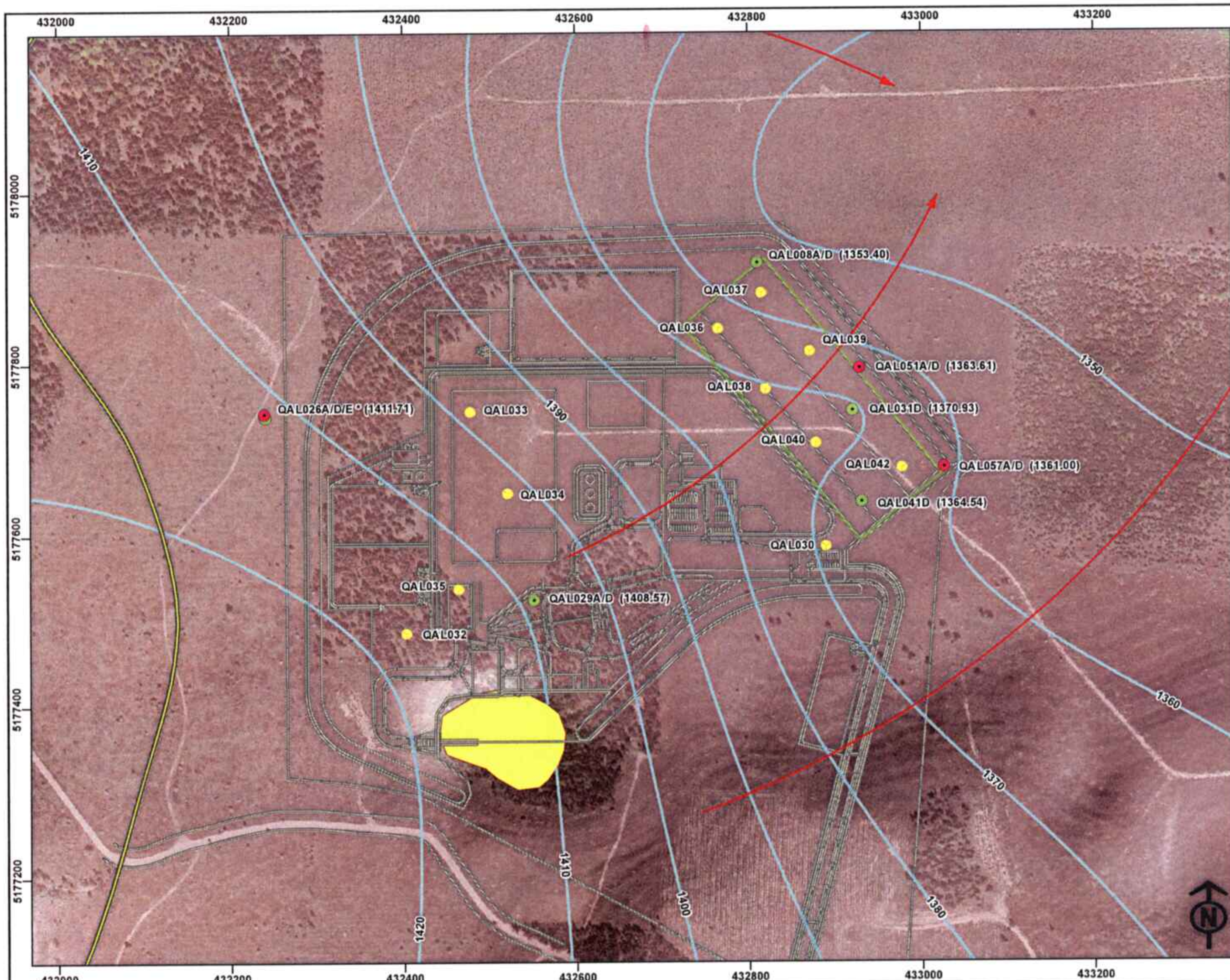
Figure: 2



B/D ZONE GROUNDWATER ELEVATION CONTOURS, MAY 2008

- OUTCROP
- GROUNDWATER FLOWLINE
- TREATED WATER INFILTRATION SYSTEM (TWIS)
- PROPOSED MINE FACILITIES
- GROUNDWATER CONTOUR ELEVATION (10' CONTOUR INTERVAL)
- GROUNDWATER BASIN DIVIDE
- EXISTING QUATERNARY AQUIFER MONITORING WELL
- NEW WELL INSTALLED for GWD PERMIT, MARCH 2008
- SOIL BORING

(1364.54) GROUNDWATER ELEVATION (ft MSL on 5/29/2008)

* QAL026A was an existing well. QAL026D was installed for the GWD Permit. QAL026E was installed in March 2008 for the Mining Permit.

Reference
Data provided by Michigan Center for Geographic Information, North Jackson Company
Projection & Datum: UTM NAD 83 Zone 16N

0 400 800 Feet

Scale: 1:4,800

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Groundwater Discharge Permit
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Figure: 3

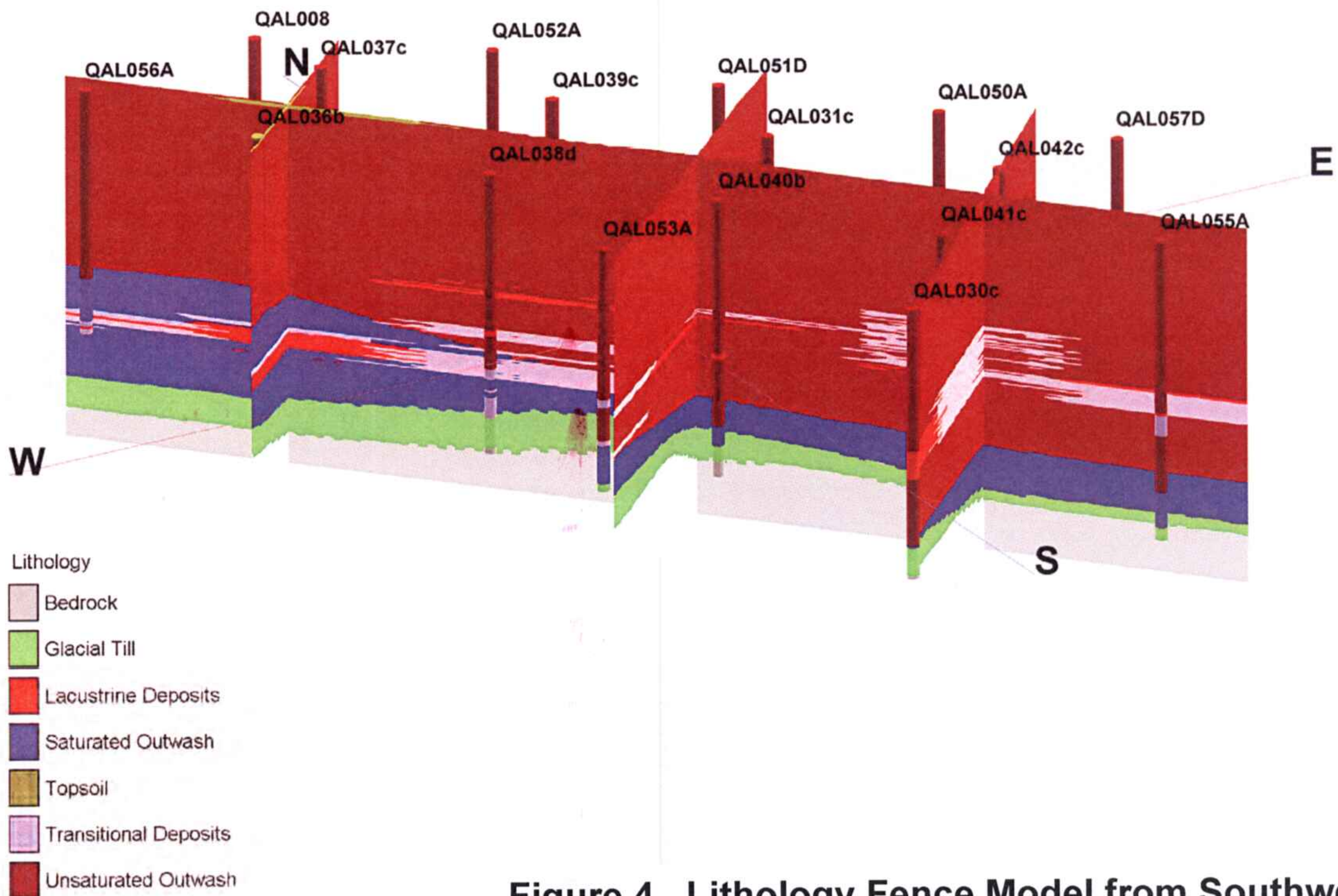

Figure 4. Lithology Fence Model from Southwest

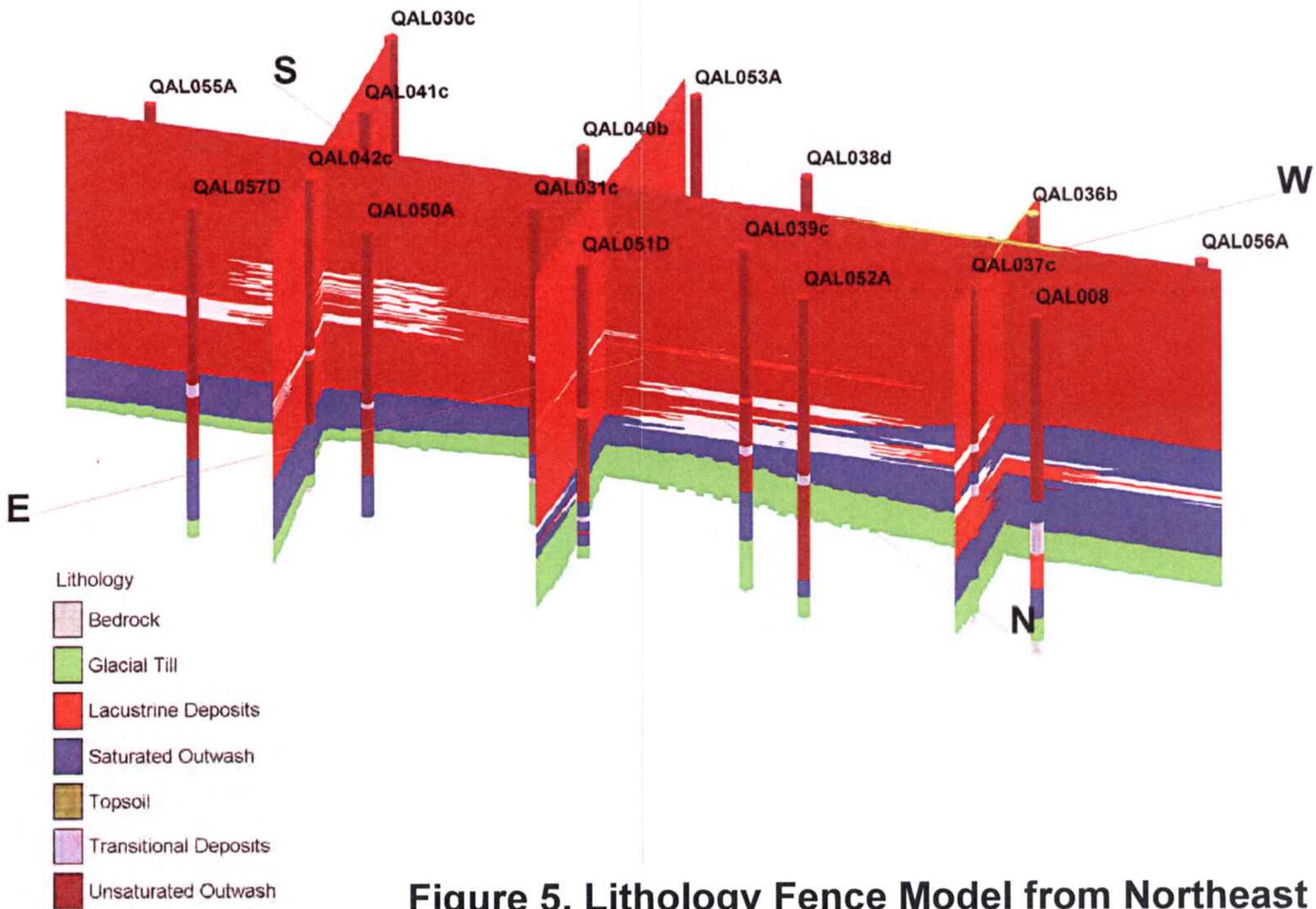

Figure 5. Lithology Fence Model from Northeast