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February 20, 2009

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 Cadmus Group Comments Titled "Comments on Responses to Request for Additional information (Class V treated Water Infiltration System Application): Final Report." Kennecott Eagle Minerals Company (KEMC), UIC Permit Application Number MI-103-5W20-0002**

Dear Ms. Harvey:

A letter dated October 30, 2008 was received from the United States Environmental Protection Agency (EPA) to clarify and/or supplement information provided in KEMC's UIC permit application and an earlier letter from KEMC dated August 21, 2008. In summary, EPA requested information related to three items:

1. Additional information to support the degree of discontinuity and permeability of the silty-sand layer within the TWIS.
2. Submittal of additional groundwater monitoring data within the TWIS area.
3. Additional analytical information for the TWIS area sediments.

KEMC submitted responses to all three items in letters dated November 14, 2008, November 21, 2008 and December 19, 2008. Within that letter EPA also attached a report authored by the Cadmus Group entitled *Comments on Responses to Request for Additional information (Class V treated Water Infiltration System Application): Final Report*, which provides additional detail on the three informational requests listed above.

Although EPA's letter did not request responses from KEMC on the full Cadmus Group comments, to assist the EPA with their review of KEMC's UIC permit application, please find answers in Attachment A to the Cadmus Group questions that were included with EPA's October 30, 2008 letter.

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

Sincerely,

Jonathan C. Cherry, P.E.
General Manager

cc: Gene Smary, Warner, Norcross & Judd, LLP
Dennis Donohue, Warner, Norcross & Judd, LLP
Dan Wiitala, North Jackson Company
Steve Donohue, Foth Infrastructure & Environment, LLC
Vicky Peacey, Kennecott Eagle Minerals Company
Alicia Duex, Kennecott Eagle Minerals Company

File: EC-Eagle-UIC-Corres to EPA

ATTACHMENT A

KEMC Response to Cadmus Report Entitled: *Comments on Responses to Request for Additional Information (Class V treated Water Infiltration System Application): Final Report*

BACKGROUND

In a letter dated July 18, 2008 EPA provided KEMC with their initial review of the UIC permit application and requested some additional information and clarification. KEMC provided responses to that request in a letter dated August 21, 2008. KECM received a second request for information/clarification from EPA in a letter dated October 30, 2008 asking KEMC to answer three questions. Included with that letter was a second round of comments from the Cadmus Group, which EPA did not specifically ask KEMC to address. In an effort to better assist EPA with their review, KEMC has provided the following responses to the second round of comments from the Cadmus Group on Kennecott's responses to EPA's request for additional information (UIC Permit Application No. MI-103-5W20-0002). Text from the second round of comments from the Cadmus Group is in italics. Answers from KEMC are in plain type.

For answers to the Cadmus Group's additional comments on EPA Comment No. 6, please see information provided in a letter to EPA dated December 19, 2008 providing additional analytical information for the TWIS area sediments. No additional responses to EPA comment No. 17 and 18 are required.

EPA Comment No. 2

Cadmus Follow-up to Kennecott 8-21-2008 Response to Comment No. 2: *The use of the transmissivity value of 6,100 gpd/ft is not relevant for this report. In the hydrogeologic study (Appendix A), Kennecott states that the transmissivity "is likely lower, however, to the north-northeast and south-southeast...." Kennecott notes in their response that the initial test was located south of the proposed discharge area and that additional testing has been done beneath the proposed discharge area. Data for this additional testing are provided in Appendix C (Aquifer Hydraulic Testing Data). A specific capacity test at well QAL031D resulted in transmissivity estimates of 1,230 gpd/ft (pumping) and 1,888 gpd/ft (recovery) (also discussed in section 4.3.3 of Appendix A). These estimates are substantially lower than 6,100 gpd/ft.*

KEMC 2-20-2009 Answer to Cadmus Comment No. 2: In-situ aquifer testing was used extensively at the Eagle Project in both site specific test locations for the proposed groundwater discharge area, and from more widely spaced regional tests. Tests used to determine transmissivity included both multiple well and single well test methodology and were described in detail in the Comprehensive Summary of Hydrogeologic Reports (North Jackson Company, 2006).

Transmissivity (T) is the product of the average hydraulic conductivity (K) and the saturated thickness (B) of the aquifer ($T = KB$), and as such transmissivity will vary with both the aquifer media hydraulic conductivity and thickness. The unconsolidated glacial outwash aquifer in the area of the proposed groundwater discharge is quite thin (estimated saturated thickness of 16 feet at location QAL031D) and as a result the transmissivity of the aquifer is somewhat lower than in other areas tested.

The resulting hydraulic conductivity (K) of the formation tested with a short term, single well pumping test at location QAL031D is estimated to be about 25 feet per day (based on the transmissivities derived from those test solutions) and average horizontal hydraulic conductivity of the D zone aquifer is 40 ft/d at the location of a multiple-well, long term pumping test in the area of well QAL011 (where the value of transmissivity of 6,100 gpd/ft was calculated). While the K value for the outwash deposit aquifer is found to be lower at the QAL031D test location, given that the unconsolidated glacial formations K values range over 7 orders of magnitude at the Eagle site, the difference in K values estimated for the outwash sand aquifers within the discharge area and regionally is quite small (on the order of multiples of 2 or 3).

These test results are very similar to those presented in hydrogeologic studies of similar glacial hydrostratigraphic units in Marquette County, which employed the same methodologies over a broad area of the Sand Plain groundwater basin (Grannemann 1984).

Groundwater flow modeling for regional models (Fletcher Driscoll & Associates, 2006) used natural neighbor contouring algorithms to incorporate these fairly small spatial variations of K for the outwash aquifers to the model construction which was used to simulate steady-state groundwater basin flow conditions and surface water/groundwater interaction under discharge operations. The site specific numerical model constructed specifically for mounding estimates (Golder Associates, 2006) used hydraulic conductivity of 30 and 25 feet per day for glacial outwash aquifers, both of which were selected from site specific testing, and used to conservatively estimate the degree of mounding that may occur under discharge operations.

Based on the in-situ field testing results of aquifer physical properties, appropriate model input parameters were used to simulate flow and mounding conditions for discharge operations.

EPA Comment No. 3

Cadmus Follow-up to KEMC 8-21-2008 Response to Comment No. 3: *The infiltrometer results do not provide the necessary information at depth, in general, and in the vicinity of the clay layer, in particular. If the clays observed in the borings from the site are continuous, then they, not the sands, will dominate infiltration behavior at the site. The continuity of the clay layer should be explored. To do this, we suggest constructing a 3-D model using a program such as RockWorks or Target to better visualize the configuration of clay at this location. The cross-sections in the report are insufficient for determining the continuity of the clays.*

KEMC 2-20-2009 Answer to Cadmus Comment No. 3: 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. These were provided in the full response to EPA comments (North Jackson Company, 2008) in a letter dated November 21, 2008. Two illustrations of the stratigraphic model for improved visualization of the discharge area are contained in Figures 4 and 5 located at the end of this document.

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. 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.

EPA Comment No. 9

Cadmus Follow-up to KEMC 8-21-2008 Response to Comment No. 9: *We have rechecked the calculations, and the value of 153,000 ft^2 is not a rounding error. Nevertheless, the difference between 153,000 and 154,000 is a small percentage of the total square footage.*

The applicant has not answered the question as to whether all five cells can be used at once.

KEMC 2-20-2009 Answer to Cadmus Comment No. 9: Cadmus questions whether, if need arises, infiltration would be distributed to all five cells at once. Proposed plumbing of the site would allow infiltration to all five cells at once, but the intended operation is to have at least one cell off at any one time (to maintain good long term performance). There is adequate infiltration capacity in the four remaining cells to receive water at the treatment capacity of the plant (the proposed maximum discharge), and, due to the purity of the discharge, there is a low risk of significant reductions in infiltration capacity. Therefore, the likelihood of using all five cells at once is low.

EPA Comment No. 11

Cadmus Follow-up to KEMC 8-21-2008 Response to Comment No. 11: *The applicant did not answer EPA's question about the effects on the numerical model of having only four cells active at one time.*

KEMC 2-20-2009 Answer to Cadmus Comment No. 11: Neither the analytical nor the numerical model (a steady-state model) considered the rotational application of the proposed discharge into only four active cells. Inputs to both models are assumed to be constant with time, and the numerical model was only run in the steady-state mode. Descriptions for both models clearly stated that application rates were constant over a fixed infiltration area. Further modeling work would be needed if there was a requirement to characterize the expected dynamic response of the infiltration operation. Instead, the modeling work considered steady operation at the peak loading rate, as a conservative measure.

In our previous response, we used reasoning that was based on simulations generated from the analytical model to better understand the potential effects on the numerical model from a four-cell loading. Since the analytical model generally predicts higher mounding heights than found in the numerical model, the mounding in the numerical model from steady loading to four cells (instead of 5) is expected to be less than what was found for the analytical model.

In reality, it takes some time (weeks to months) to build up the mound under the infiltration area, and the infiltration rate is not expected to be held constant at the treatment capacity. Because Kennecott fully expects periods of reduced infiltration loading, it is reasonable to consider that the combined effects of rotation and unsteady infiltration rates less than the treatment capacity will lead to less mounding than estimated from the conservative application of the numerical and analytical models.

EPA Comment No. 14

Cadmus Follow-up to KEMC 8-21-2008 Response to Comment No. 14 *The applicant has not discussed the differences in assumptions and parameters or the rationales for choosing the different values in the different studies.*

KEMC 2-20-2009 Answer to Cadmus Comment No. 14

The site specific mounding modeling exercise (Golder Associates, 2006a) used 400 gpm as an infiltration value used as part of the conservative treatment and infiltration design parameters (Foth and Van Dyke, 2006). The regional modeling (Fletcher Driscoll & Associates, 2006) used treatment system discharge values that were derived from mine inflow estimates of base case (75 gpm) and upper bound case (220 gpm) scenarios derived from bedrock hydrogeological characterization and modeling of inflow to underground mine workings (Golder Associates, 2006b)

EPA Comment No. 15

Cadmus Follow-up to KEMC 8-21-2008 Response to Comment No. 15 *The applicant has not discussed the reasons for the use of different boundary conditions and parameters.*

KEMC 2-20-2009 Answer to Cadmus Comment No. 15

The two models were constructed with different technical goals:

1. Golder Associates Model - This model was constructed in order to provide a focused, discharge site-specific simulation of the groundwater discharge, specifically to estimate the degree of mounding of the water table system in order to compare to analytical solution of mounding performed during the design of the treatment and infiltration system. This model was performed also to meet the specific requirements of the Part 22 rules of Michigan's Part 31 of Michigan's Natural Resources and Environmental Protection Act (NREPA), 1994 PA 451, as amended.

2. Fletcher Driscoll & Associates Model - This model was constructed as part of the overall baseline environmental baseline study of watersheds and groundwater basins of the Eagle Project, in order to describe the relationship and interaction between groundwater and surface water resources in several watersheds and subwatersheds. The baseline conditions and predictive assessment of mining conditions was performed under the Part 632 rules, Nonferrous Metallic Mineral Mining, of the NREPA, 1994 PA 451, as amended.

Each model operates on a different scale and domain due to the model assessment goals and regulatory requirements. Therefore, the models necessarily were constructed with different boundary conditions and model input parameters, while still being constrained by the extensive data base of site geological and hydrological conditions developed from multiple phases of site investigation and characterization data on both a regional and site specific scale.

EPA Comment No. 16

Cadmus Follow-up to KEMC 8-21-2008 Response to Comment No. 16 *The response addresses the first part of the question posed by EPA.*

Although the reviewers indicated that the model provides "reasonable evidence" that the glacial deposits do provide adequate hydrogeologic capacity to assimilate the additional infiltration without inundating the site, this does not preclude the need for performing an adequate sensitivity analysis. A more reasonable rationale for the limited sensitivity might be because the model was never properly calibrated.

KEMC 2-20-2009 Answer to Cadmus Comment No. 16

We concur that all models show reasonable evidence that the site has adequate hydrogeological capacity to assimilate the discharge without risk of surface inundation, and also without significant or measurable changes to watershed flow regimes.

The sensitivity analyses performed by Golder Associates on its model also indicates that the conservative hydraulic conductivities used in its model for the aquifers (30 ft/d and 25 ft/day) likely result in an over prediction of mounding, and if higher values (50 or 40 ft/d) were used (as are supported by multiple well pump testing south of the discharge area) then mounding will be less. Also, the model indicates that porosity will have some effect on estimated travel times, but all reasonable porosity values used indicated that the discharged water will reach stream receptors while the infiltration and treatment system is operational (within 2 to 6 years of discharge). These sensitivity analyses are consistent with the regional model particle tracking that indicated particles will reach stream receptors within 10 years, and some in less than 5 years.

Figure 4 and Figure 5

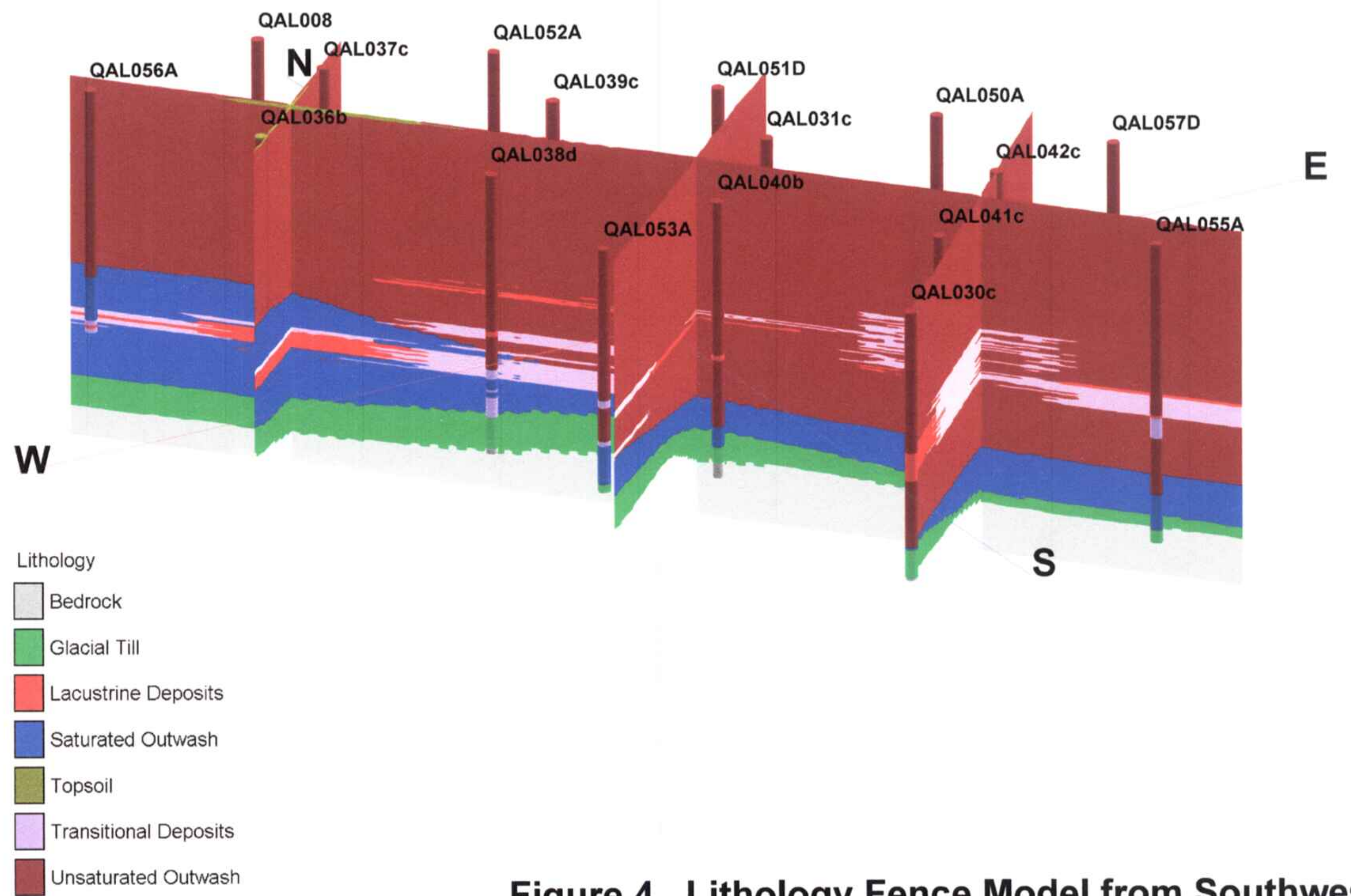

Figure 4. Lithology Fence Model from Southwest

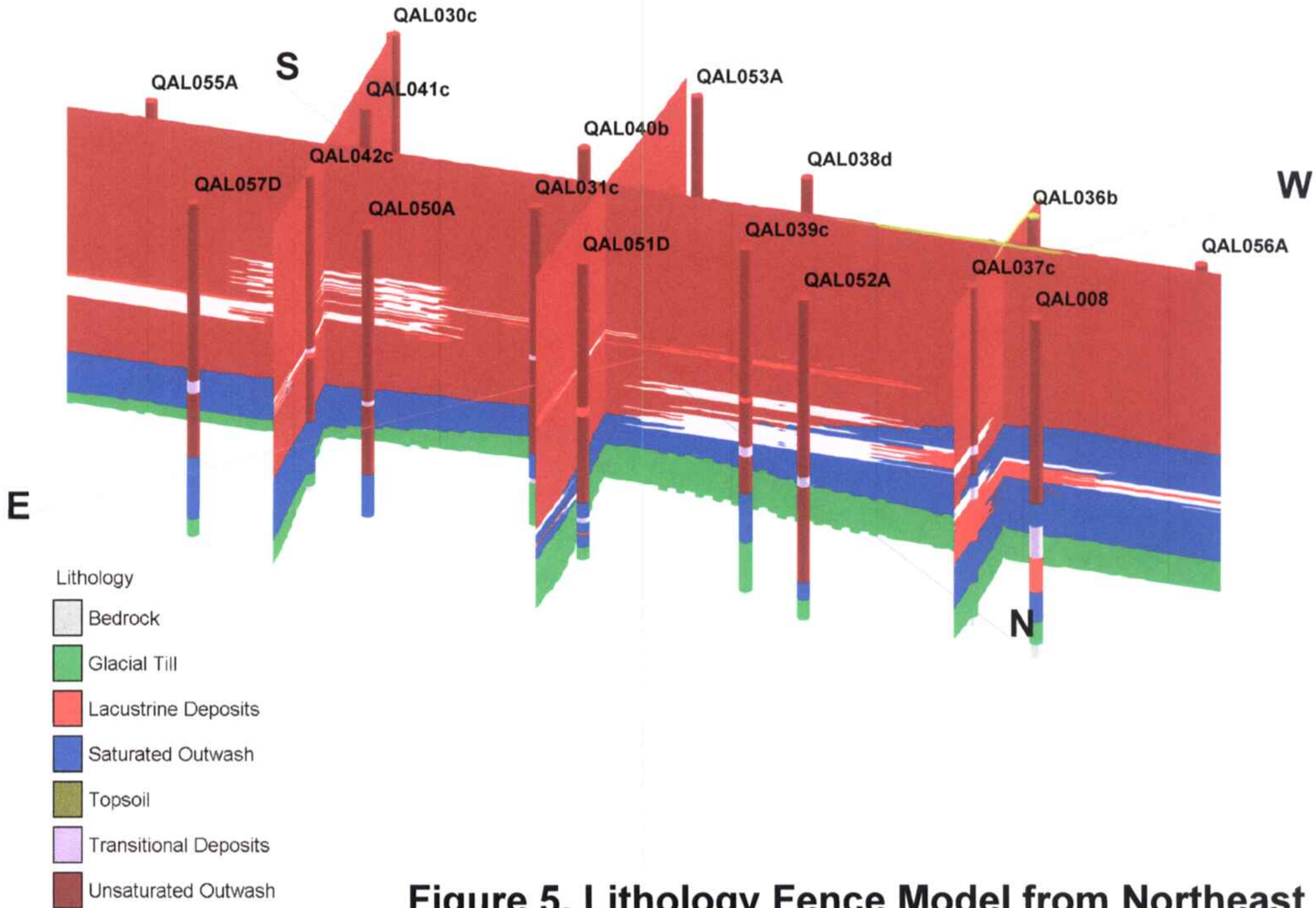

Figure 5. Lithology Fence Model from Northeast