newgold Rainy River Project

APPENDIX S-2

DETAILED RESPONSE TO REGULATORY COMMENTS ON DRAFT EA REPORT (VERSION 2)

Memo

To	**Kyle Stanfield**	File no	**TC111504.2013.9**
From	**Simon Gautrey**	cc	**Sheila Daniel** **David Simms**
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Date	**October 3, 2013**		

Subject: Combined Responses to Regulatory Comments on Groundwater-related Topics, Rainy River Project Draft Environmental Assessment Report

In September 2013, Rainy River Resources received comments and requests for information from government representatives, regarding documents submitted at part of the Draft Environmental Assessment (EA) Report including the groundwater modeling report (AMEC, May 2013). A number of comments pertaining to groundwater resource topics required a more detailed response and supporting graphics, which are addressed within this memo. The information is organized by comment agency.

Table 1 provides a listing of the response locations by comments received for ease of reference.

A) Natural Resources Canada (NRCan) Comments Received September 4, 2013

In the hydrogeology modelling report (Volume 3 Annex S p.25 and fig. 3.5), a few of the zones of influence (ZOIs) associated with the pumping of the open pit have been extended outside the model boundaries using interpolation. This procedure is somewhat unusual, as it is commonly accepted that any stress feature (e.g., pumping well) should not interfere with the boundaries of a numerical model to ensure proper simulations. NRCan understands that the choice of northern boundary was selected according to the potentiometric map under current conditions (i.e., without pumping), but from the presented simulations, this hydraulic boundary is likely to shift gradually as the pumping of the open pit progresses, a situation that cannot be represented by the current numerical model.

Information Request 1: NRCan requests that the proponent explain why they chose the interpolation approach instead of increasing the size of the numerical model to ensure that none of the ZOIs interfere with the model boundaries.

Response to Information Request 1: *AMEC agrees with the NRCan comment that model computed ZOIs "should not interfere with the boundaries of a numerical model to ensure*

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proper simulations", at least where the results of the predictions are modified by the boundary. Second, the northern model boundary was established based on the expected location of groundwater divide, associated with the topographic bedrock highs. Third, we would like to mention that noticeable interaction of the computed ZOIs with a model boundary occurred only in two simulated variants, i.e., 3a and 4a. This occurred partly as a result of late changes in the mining plan added a long ramp to the east causing an increase on the ZOI beyond what was seen in earlier draft versions of the model based on earlier mining plans. For these variants, computed drawdown beyond the model boundary, was extrapolated in a semi-log coordinate system. This extrapolation was anticipated to provide conservative results since it does not account for any potential recharge, or induced leakage, outside of the model boundary.

Information Request 2: NRCan requests that the proponent discuss the implications of the interpolation approach on the open pit dewatering pumping rates, the size of the ZOIs and the particle tracking for the corresponding simulations.

<u>Response to Information Request 2</u>: *As mentioned above, extrapolation of model predicted drawdown beyond the model domain boundary was expected to provide conservative estimates of ZOI since: (i) this method does not account for any potential recharge/leakage outside the model boundary; and (ii) drawdown, deflected by the impermeable boundary, tends to spread more along this boundary.*

The pumping rates (groundwater inflow) in the base case increase from 3,400 cubic metres per day (m^3/d) in the original model to 3,450 m^3/d in the original model m^3/d in the extended model. For case 3a, the groundwater inflow rates increase from 3,650 m^3/d in the original model to 3710 m^3/d in the extended model. For case 4a, the groundwater inflow rates increase from 3,820 m^3/d in the original model to 3,890 m^3/d in the extended model.

Particle tracking results are not expected to be affected by the proximity of the northern boundary to the mine site since (i) the potential source areas (tailings management area; TMA and east mine rock stockpile) are located at distance of about 2,000 to 3,000 metres (m) downgradient and cross-gradient from this boundary and; (ii) the particle tracking scenarios included the additional recharge from the TMA and east mine rock stockpile, which when accounted for, reduce the extent of ZOIs and eliminating their interaction with a model boundary (see AMEC response to the MOE comment No.1).

Information Request 3: NRCan requests that the proponent discuss the necessity of modifying the current numerical model and its planned updates (every three years following the exploitation of the open pit) to account for new boundaries.

<u>Response to Information Request 3:</u> *In order to fully address the NRCan comments related to the northern section of the model boundary, AMEC modified the original model by extending it to the north and east by up to 5,700 m in the area where the interaction between the computed ZOIs and the boundary was observed (Figure 1). Note that a*

significant portion of the model extension to the north is occupied by a large wetland complex. This wetland was simulated by using the MODFLOW river nodes with a specified elevation of 378 m. Conductance of these river nodes was computed based on the assumption that the wetland is underlain by clay, having hydraulic conductivity of 1E-8 metres per second (m/s). Figure 2 shows model computed ZOIs for the Base Case, 3a and 4a scenarios, previously reported by AMEC (May 2013). This figure shows that extending the model domain results in: (i) the reduction of all ZOIs extents to the west by about 600 to 700 m; (ii) minor change of the ZOI, corresponding to the Base Case scenario in other directions; and (iii) the reduction in the estimated extent of the ZOIs, corresponding to the simulated variants 3a and 4a, by up to about 2 kilometres (km) in the northeastern direction.

AMEC agrees with NRCan comment about recommended model updates every three years following the exploitation of the open pit.

B) Ministry of the Environment (MOE) Comments Received September 4, 2013

Comment 1, Appendix S - Page 15:

The hydrogeological model neglected major surface features that will affect groundwater onsite, including the TMA and the east mine rock stockpile. Their exclusion in modelling is not considered conservative and has the potential to impact the site water balance.

The report states that these features will increase the recharge to the groundwater onsite and not including them in the model is conservative and will tend to slightly over predict the size of the drawdown cone towards these features. A similar effect is expected due to the increased recharge, explained on Page 17 of Appendix S, caused by the lowering of the water table that will allow recharge where artesian conditions did not allow recharge previously.

It is the reviewer's opinion that these operational features may increase the seepage of water into the open pit relative to what has been modelled. The report should evaluate how these features would alter flow rates for the pit de-watering and how these increased rates would affect the ZOI and the total volume of water discharging from the dewatering wells.

Although it is agreed that these features will act to increase recharge, they also have the potential to increase local water levels and the magnitude of seepage to the pit. The impact of this additional seepage needs to be fully evaluated, particularly since the receiver of the pit dewatering efforts is volume sensitive. This revision to the modelling would enhance the accuracy in seepage rate prediction and the potential for dewatering effects on the Pinewood River.

The issue of omitting these features was raised in a memo sent to the MOE Senior Environmental Officer by Alisdair Brown, MOE Regional Hydrogeologist on January 2, 2013, regarding Groundwater Modelling Assumptions. At the time, the Consultant's justification for not including these features in the model was that their final geometries were not known at the time.

It is the opinion of the reviewer that estimated geometries and timelines for construction would still provide valuable and necessary information to the model.

These features should be added to the hydrogeological model to ensure accurate model results or the omission of these features needs to be more thoroughly justified from a hydrogeological perspective in the EA.

> *<u>Response (as pertaining to the increased seepage rates and ZOI):</u> The impact of the TMA, overburden and the east mine rock stockpiles on the model predicted seepage rates and ZOI was examined by adding these features into the model corresponding to the fully developed and dewatered mine (open pit, ramp and underground mine workings). The addition of these features resulted in the increase of the local water levels, predicted seepage rates and the decrease in the extents of ZOI (Figure 2). For example, under the Base Case scenario, the model predicted seepage rate into the fully dewatered mine increased by about 400 m^3/d (i.e., from 3,400 to about 3,800 m^3/d). The ZOI area reduced by about 8.8 km^2, i.e., from about 35.7 to 26.9 km^2. The 12% increase of the predicted seepage rate into the fully dewatered mine, due to the accounting for the additional recharge from TMA, overburden and the east mine rock stockpiles, is within the range of uncertainty in model predictions. The obtained results also confirmed that neglecting these surface features provides conservative estimates of ZOIs (AMEC May 2013).*

Comment 2, Page 4-11 and Appendix S - Page 15:

The hydrogeological model does not address the potential to induce consolidation due to dewatering; or settlement in the thick clay layers onsite due to the loading associated with surface features such as the TMA and the east mine rock stockpile. While this subject is mentioned in Section 4, a full description of the expected behaviour of the thick clay layers when subject to loading and the potential consequences does not appear to be present.

Settlement of the clay layers could result in significant changes to local drainage, which could affect the stability of these features or cause local flooding. Flooding could result in mercury release and methylation.

When exposed to significant loading or de-watering, clay units tend to compress and consolidate. The significant dewatering and surface loadings will likely cause consolidation in the underlying clay layers, affecting the local physiography. Significant subsidence of the ground surface could impact structural stability of surface features and/or induce localized flooding, either of which would have associated environmental impacts.

The potential for such consolidation should be considered, with likely environmental or structural impacts and mitigation and contingency options discussed in the EA.

<u>Response (as pertaining to consolidation):</u> The amount of drawdown induced consolidation settlement was estimated using the following formula:

Consolidation Settlement = C x H_0 x log ($\sigma_{initial}/\sigma_{final}$) where, C is either compression ratio or re-compression ratio (depending on the consolidated state of clay foundation), H_0 is the thickness of clay layer, and σ is the in situ effective stress.

Clay at the project site is stiff and over consolidated to approximately 12 to 15 m.

Settlement was not calculated for areas where there is only thin overburden, where the drawdown is minor, or there are large infrastructure planned (i.e., beneath the overburden stockpile); as either the settlement will be small, or the planned infrastructure already dominants the drainage changes and will prevent the creation of ponds. This leaves two general areas of thick overburden near the pit that are not covered by infrastructure (Figure 3): one on the south side of the Pinewood River, south of the open pit where the overburden is approximately 50 m thick (Area a), and one to the north of the open pit where the overburden is approximately 40 m thick (Area b).

For Area a, near the Pinewood River, the estimated drawdown was predicted for the base of the overburden from the groundwater model at the end of mining (AMEC May 2013), but there was assumed to be no drawdown at surface near the Pinewood River and an average drawdown of 5 m was applied to this area. Consolidation settlement due to groundwater depletion in this area is estimated to be between approximately 0.2 to 0.3 m. The existing topography in this area varies by approximately 4 m, and settlement at these amounts is unlikely to lead to development significant areas of ponding or the redirection of drainage.

For area b, north of the open pit, the drawdown was assumed to be 15 m. Consolidation settlement due to groundwater depletion in this area is estimated to be between approximately 0.5 to 0.6 m. The existing topography in this area varies by approximately 10 m, and settlement at the estimated amounts is unlikely to lead to development significant areas of ponding or the re-direction of drainage. Furthermore, re-grading of the area is proposed to create the west creek pond and for the re-alignment of west creek.

Comment 3, Page 5-75:

Based on the results of the hydrogeological model, it was stated by the Consultant that a volume of seepage from the TMA and the mine rock stockpiles will not be captured by the seepage collection ditches surrounding these features. It is expected that this seepage will discharge to the Pinewood River after a period of time. While the water quality of these seepages is estimated in Appendix T, the expected contaminant attenuation within the subsurface and the contaminant loading to the river are not present. This information is required to assess the impact that groundwater discharge will have on the Pinewood River.

The impacts of the seepage from mine rock stockpiles and the TMA need to be more thoroughly assessed with an estimate of the expected contaminant loadings. Since it is estimated (Appendix T) that the concentrations of almost all contaminants of concern within some seepage water will be in exceedance of PWQO criteria, it is requested that the impact of these high levels of contamination be estimated and discussed within the EA.

The expected attenuation of contaminants within the subsurface and the loading to the river due to groundwater discharge should be quantified with potential impacts discussed in the EA.

It would be beneficial to incorporate these contaminant loadings into the hydrogeological model since justification of the results may be required during the permitting stage to better understand the quality and quantity of seepage and potential impact to receptors.

Due to the extremely low assimilative capacity of the receiver, it may be necessary to show that discharging water is in compliance with PWQO.

> *<u>Response (as pertaining to the fate of seepage from TMA and mine rock stockpiles):</u>* *Most of the pore water in the TMA and mine rock stockpiles is expected to be captured by the perimeter drains and ditches; however, a small portion (on the order of 400 m^3/day from the TMA and 25 m^3/day from the rock stockpile) is expected to bypass the drains and ditches and eventually report to the Pinewood River after several decades (AMEC May 2013), which will likely extend to centuries when retardation is considered. Attenuation of the concentrations within the subsurface is expected to be substantial, but difficult to quantify, partly because the initial concentrations in the TMA are not known at this time.*
>
> *Assimilation within the Pinewood River is expected. The groundwater model was prepared using steady state conditions to represent typical conditions, and does not represent extreme dry condition. Under these typical conditions, there is approximately 6,400 m^3/day of discharge to the Pinewood River and its tributaries. The water originating from the mine rock stockpile is essentially zero and too small to have an observable effect on the river. The volume of water originating from the TMA is approximately six percent of the flow in the watershed, providing a dilution factor of approximately 15 for the river for steady state conditions. Flows in the Pinewood River can be zero during dry years when groundwater discharge is reduced to zero. However, under these conditions, there would also a corresponding decrease the discharge of groundwater originating from the TMA, such that during periods of very low flow in the river, the groundwater discharge to the river would not be dominated only by the portion that originates at the TMA or mine rock stockpiles.*
>
> *In terms of source water quality, waters within the pond on top of the TMA will be diluted with precipitation over time and are expected to meet the Provincial Water Quality Objectives (PWQO) for the protection of aquatic life within a few years and will not be a long term source of impacted groundwater. However, the water chemistry of the pore water within the TMA is expected to exceed the PWQO for several metals. Laboratory*

trickle leach column tests are currently under way to predict the final pore water chemistry for the TMA, and will be completed at the end of October, 2013. At that time it will be possible to make a prediction of the final water quality in the Pinewood River.

Comment 4, Appendix S—Figure 3-2:

The hydrogeological model domain needs to be extended to reduce potential boundary effects. Significant changes in head are observed at the bottom boundary of the model domain (Appendix S, Figure 3-2) and it is believed that these changes could introduce inconsistencies in the simulated results. An extension of the model domain, or justification as to why it is not necessary, is needed.

The simulated changes in head could be sensitive to the relationship between horizontal and vertical permeability utilized in the model, with sensitivity likely increasing with depth. This ratio was not found in the draft EA Report. This ratio and the sensitivity of the model to this ratio are important in understanding the interactions and interpreting results and need to be included in the final EA Report.

The elevated errors in predicted head values observed with depth could be attributed to the issues noted above.

It is the reviewer's opinion that the hydrogeological model domain should be of sufficient size as to observe no changes in head at the bottom boundary. Significant changes at this boundary could unrealistically alter the simulated results, introducing errors. The potential effects of these significant changes in head should be discussed and, if increasing the size of the model domain is not required, further justification must be provided.

Field measured bulk permeability's are typically representative of horizontal permeability's, while vertical permeability's are generally defined as a ratio between horizontal and vertical permeability's. This ratio influences the simulated drawdown cone and changes in head with depth. An understanding of this relationship, how this relationship was determined in the EA, and the sensitivity of the model to this relationship are needed to interpret the simulated results. This information is requested for the final EA.

Potential evidence of discrepancies in the model with depth is present in the relationship between the computed and observed groundwater levels summarized in Figure 2-3 of Appendix S (both A and B), where the deepest layer analyzed, layer 6, shows the most inconsistent results.

For the final EA, the size of the model domain should be increased to a size which yields no changes in head at the bottom boundary or the size of the model domain must be more thoroughly justified with respect to model accuracy.

<u>Response to Comment 4 (as pertaining to calibration results):</u> Analysis of the calibration results shows that the discrepancies between computed and observed water levels for

the bedrock wells are somewhat higher than the discrepancies in overburden wells. For example: residual mean values (average discrepancies between computed and observed heads) are 0.46 and 0.74 m for the overburden and bedrock wells, respectively; while the absolute residual mean values are 1.36 and 1.75 m, respectively. There is no systematic inconsistency between computed and observed water levels in the bedrock wells, with the correlation coefficient being about 0.92 for the bedrock wells versus 0.96 for the overburden wells.

In order to assess the impact of the bottom boundary on the calibration results the bottom of the model, corresponding to the pre-mining non-pumping conditions, was moved down 1,000 m, from -500 to -1,500 m with the introduction of three additional model layers in deep rock. The impact of such lowering of the model bottom on the calibration results in layer 6 (weathered rock) appeared to be minimal: the residual mean changed from 0.74 m (model depth at -500 m) to 0.75 m (model depth at -1,500 m). Other calibration statistical parameters did not show any change within two decimal points. In our opinion, the following factors are primarily attributed to somewhat higher discrepancies between computed and observed heads in bedrock wells: (i) several bedrock wells are private water supply well that have not been surveyed for elevation; (ii) some of the bedrock wells are actually long open holes without screens (for these wells the assumption was made that their water levels correspond to the water levels in shallow weathered rock. This assumption may not be valid in cases when the well(s) intercept unknown relatively deep transmissive fracture zones); and (iii) actual flow in bedrock is primarily controlled by a fracture network (the equivalent porous medium (EPM) assumption utilized in MODFLOW is expected to be sufficiently accurate for the large-scale predictions, but it can introduce noticeable errors at the local scale, i.e., in the vicinity of the individual bedrock wells).

<u>Response to Comment 4 as pertaining to anisotropy:</u> In AMEC's opinion, there is no justification for examining potential anisotropy of the Pleistocene Aquitard, comprised of Brenna, Whitemouth Lake Till and Wylie units; since flow through these units is primarily vertical and, therefore, only vertical K-value is relevant in this case. Similarly, only the horizontal hydraulic conductivity of the lower granular deposits (PLGD) is relevant since: (i) flow in this unit is primarily horizontal; and (ii) this unit is overlain and underlain by much less permeable hydrostratigraphic units (Wylie clay and shallow bedrock). Second, potential anisotropy of bedrock can be attributed to fracture orientation. Anisotropy of the shallow bedrock zone was not considered since its fractures are related to weathering and as such are not expected to have any preferential orientation. Below the weathered zone orientation of fractures in granitic rock is expected to be either vertical or subvertical. Based on the above, only the impact of bedrock anisotropy below the shallow weathered zone was examined as per the MOE comment. Analysis was carried out by increasing vertical hydraulic conductivity of the intermediate and deep bedrock zones by a factor of 10, resulting in the anisotropy coefficient, or the Kh/Kv ratio, of 1:10. As a result, model predicted seepage rate increased by 290 m^3/d or about 8.5%, compared with the seepage rate of 3,400 m^3/d for the Base Case scenario. Figure 2 shows model predicted ZOI corresponding to the simulated Kh/Kv=10 case. Note both

model predicted change in seepage rate and the extent of ZOI are within the range of the previously reported uncertainty in the model results (AMEC May 2013).

Response to Comment 4 (pertaining to the results shown in Figure 3-2 and model predicted inflows): In order to examine the impact of the model bottom boundary on the predicted results the bottom of the model was lowered from -1,500 to -3,000 metres above sea level (masl) and two additional model layers were added below the elevation of -1,500 masl. As a result, less noticeable changes in heads at the bottom boundary were computed: maximum computed drawdown in the lowest / deepest model layer was reduced from about 200 to 70 m (Figures 4a and 4b, respectively). Despite significant reduction in drawdown at the lowered model bottom, the model predicted groundwater seepage rate into the fully developed mine increased by about 70 m^3/d, which constitutes only 2%, compared with the reported inflow rate of 3,400 m^3/d. Lowering of the model bottom from -1,500 to -3,000 masl had also very little effect on the computed heads in shallow layers, including layers 5 (PLGD) and 6 (Shallow Bedrock). As a result, model predicted ZOI, defined by a 1 m drawdown contours in these layers, remained almost the same as the previously reported one (AMEC May 2013). Minor variations in model predicted seepage rate and ZOI, associated with the lowering of the model bottom are attributed to the low K-value (1E-9 m/s) assigned to the deep bedrock layers. Note that the changes introduced by the deepening of model bottom would have been even smaller if the hydraulic conductivity of the deepened portion (below -1,500 masl) was assumed to be less the bedrock K-value above, i.e., less than 1E-9 m/s.

Comment 5, Page 6-100:

The preferred alternative for closure of the open pit involves flooding of the pit. Since pre-development local water levels are above the ground surface, it is expected that the pit will eventually fill completely and a floodway will be constructed to permit discharge directly to the Pinewood River. While the expected water quality of the flooded pit is estimated in Appendix T, the expected contaminant loading to the river does not appear to be estimated. Since some contaminant concentrations within the pit lake are expected to be in exceedance of PWQO criteria, an estimation of the loading is needed to help assess the impact to the receiver.

Existing ground water levels at the mine site are above the ground surface. Therefore, once flooded, the pit lake will be discharged via a floodway to the Pinewood River. The elevated levels of some contaminants expected in this discharging water will impact the river due to the low flow within the river. An estimation of the contaminant loading to the river from the pit lake and a discussion of potential long term impacts to the water body are required.

The magnitude and impacts of the contaminant loading expected from the pit lake discharge to the Pinewood River should be discussed in the EA.

Due to the extremely low assimilative capacity of the receiver, it may be necessary to show that discharging water is in compliance with PWQO.

<u>Response to comment 5 (as pertaining to the estimate of contaminant flux from the flooded open pit into the Pinewood River):</u> As described in responses to similar comments, it is expected that PWQO criteria can be met without treatment, but treatment is possible as a contingency, should it be necessary. Furthermore, the volume of groundwater inflow into the open pit lake and hence outflow from the lake under low flow conditions will be proportionate to the elevation of water in the lake, which can be controlled by the outlet elevation. Using the existing groundwater flow model (AMEC May 2013), the groundwater inflow into the open pit lake was estimated to be just under 900 m^3/day when the outlet of the lake is set at the elevation of the Pinewood River downstream of the pit lake, which is the lowest elevation the outlet can be set to. Increasing the elevation of the outlet will result in lower groundwater discharge values. The elevation of the outlet could either be adjusted permanently or temporarily. The surficial area of the open pit is 1,681,000 m^2, meaning that should there be no outlet from the lake, the groundwater inflow would result in a 16 mm increase in lake level each month when the elevation of the pit lake reaches the elevation of the Pinewood River. Therefore, the simple addition of a temporary 10 cm log to the outlet would create six months of groundwater storage in the lake. This could be released during rainy periods when there is flow and assimilative capacity in the river.

Comment 6, Page 6-100:

The post-closure rising of the local water table could result in the partial saturation of mine rock stockpiles. Partial saturation of the stockpiles could results in acid rock drainage (ARD) generation if potentially acid generating (PAG) rocks are subjected to fluctuations in water levels. This concept was not discussed in the draft EA Report and should be considered in the final EA Report.

The elevated water level associated with the flooding of the pit will likely act to raise the water table in large surface features such as the mine rock stockpiles. If the water table were to fluctuate within a stockpile containing PAG rocks, the conditions for potential ARD or metal leaching could develop. A discussion of the potential for such an impact and the related consequences is needed.

The environmental impacts of increasing local groundwater levels within large surface features should be discussed in the EA with consideration to the conditions for ARD. It may be beneficial to include these large surface features in the hydrogeological model to assess the profile of the water table within them.

<u>Response to comment 6 (as pertaining to the effect of rebounding groundwater levels on PAG rocks):</u> Very little to no infiltration is expected through the clay cap over the PAG rock. Groundwater discharge to the depression centred along the path of the former intermittent creek bed under the rock pile will be minimized by the low hydraulic conductivity of the underlying clay and bedrock, such that water inflows to the encapsulated PAG portion of the rock pile will be minimal. The mine rock piles beneath the cap will consist mostly of very coarse, gravel to boulder sizes pieces of rock,

between which water will be able to quickly drain towards the low part of the rock pile near the treatment pond. The down slope side of PAG mine rock pile will be constructed with drains to allow any water that reaches the toe of the rock pile to exit into the treatment pond drainage system, preventing a build up of water levels in the rock pile.

References

AMEC May 2013. Rainy River Gold Project Hydrogeology Modelling Report.

Closing

Should you have any questions regarding this memo or require more information, please feel free to contact the undersigned at (905) 312-0700.

Sincerely,
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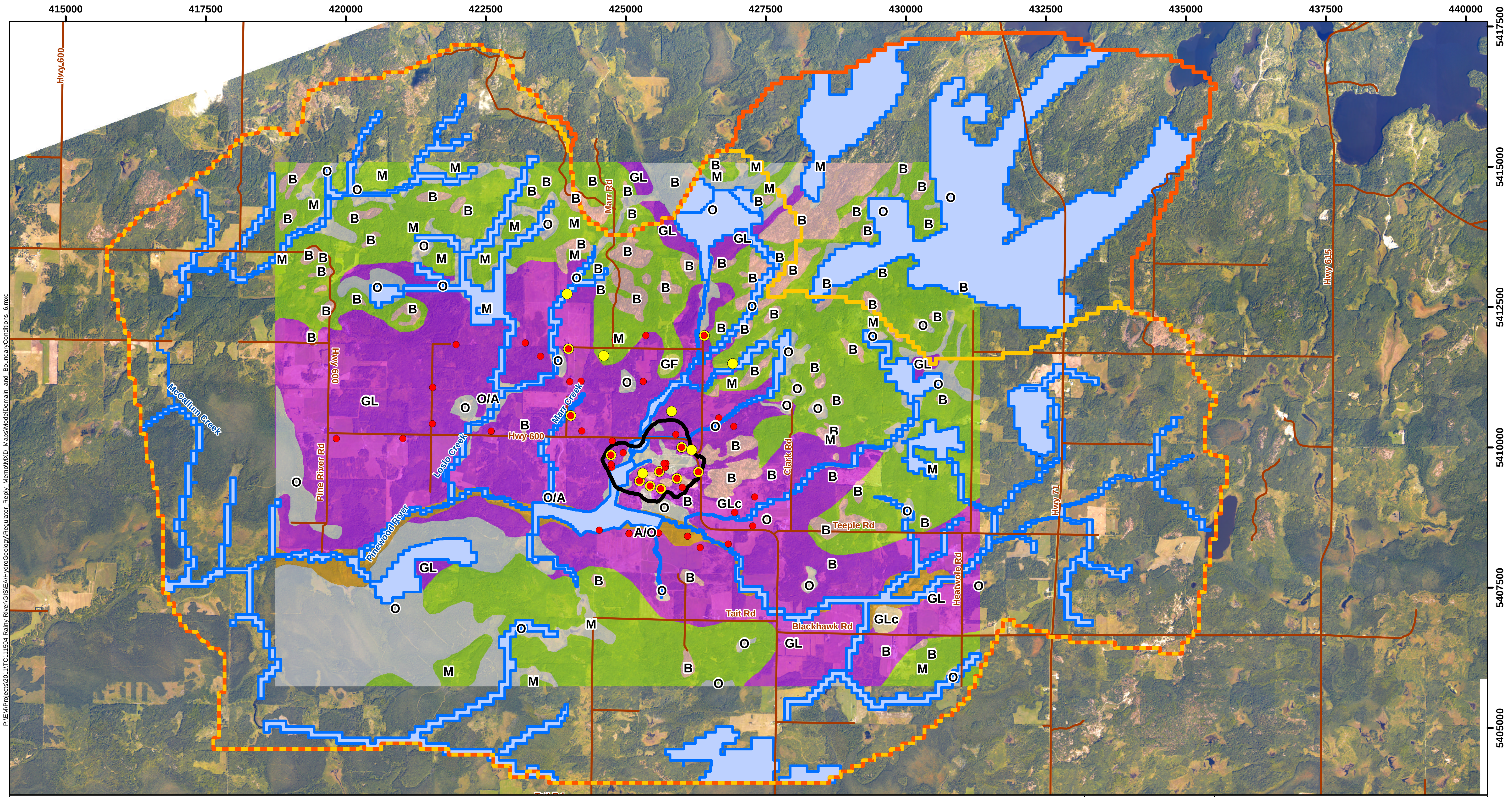
Attachments: 4 figures

Table 1: Summary of Government Comments regarding Groundwater Resources and Response Locations

Reviewing Agency and Date Comments Received	Comment Number and Section of Draft EA Referenced in Comment	Location of Response
Ontario Ministry of Northern Development and Mines, September 3, 2013	14, 7.7.1 – Groundwater – Environmental Effects	Table of responses provided previously to government. Will also be included in Appendix D of Final EA Report
Health Canada, September 4, 2013	9, Section 5.7.5; 7.7.1; 5.1 of Summary Doc. – Groundwater 10, Section 6.11.1 - Groundwater (Including Water Quality and Quantity) 11, Section 5.2.7 – Groundwater 12, Section 7.4.1 – Groundwater 13, Section 7.7 – Groundwater	Table of responses provided previously to government. Will also be included in Appendix D of Final EA Report
NRCan, September 4, 2013	1, Volume 1, Sections 4.0, 6.3 to 6.5, 7.0; Volume 2, Sections 5.1, 5.2.1 to 5.2.5, 5.4, 5.5; Volume 3, Appendix H, Section 2.0	Table of responses provided previously to government. Will also be included in Appendix D of Final EA Report
	2, Volume 3, Annex H and S Volume 2, Sections 4.0, 5.0, 6.0, 6.3 – 6.5, 7.0, 8.0 10-13	Within this memorandum
MOE, September 4, 2013	1, Appendix S – Page 15	Within this memorandum
	2, Page 4-11 and Appendix S—Page 15	Within this memorandum
	3, Page 5-75	Within this memorandum
	4, Appendix S – Figure 3-2	Within this memorandum
	5, Page 6-100	Within this memorandum
	6, Page 6-100	Within this memorandum
	7, Page 7-43 and Appendix S—Figure 5-1 8, Page 11-1 9, Appendix H	Table of responses provided previously to government. Will also be included in Appendix D of Final EA Report



LEGEND

Approximate Open Pit Outline

Roads

Model Domain Boundary

Extended Model Domain Boundary

Original Model Domain Boundary

Unchanged Model Domain Boundary

Observation Wells (2012)

Observation Wells (2010)

Cells used to Simulate Surface Water Features

Quaternary Geology

O	Organic: peat and organic clay; includes bogs, fens, marsh, ponds and standing water along poorly defined creeks.
A	Alluvium: fine sand, silt, and clay; deposits of Pinewood River and tributaries
B	Bedrock: exposures or with very thin cover
GL	Glaciolacustrine: clay, silt, and minor sand; glacial lake bottom
GLc	Glaciolacustrine Coarse Grained: sand and gravel; beach, bar and, near-shore deposits
GF	Glaciofluvial: sand, gravel, and boulders, minor till; deposited from glacial meltwater in ice-contact environment.
M	Moraine: glacial till with some interbedded glaciolacustrine clay and silt; inferred to mostly Whitemouth Lake Till, clay rich with carbonate rocks and matrix.

0 1.5 3 6 9 12 15 Kilometres

NOTES:
- Road data extracted from Land Information Ontario, Ontario Road Network, MNR Queen's Printer for Ontario, 2011-2012
- Surficial geology based on air photo analysis and review of published geology maps. Surficial materials may vary from those indicated

Datum: NAD83
Projection: UTM Zone 15N

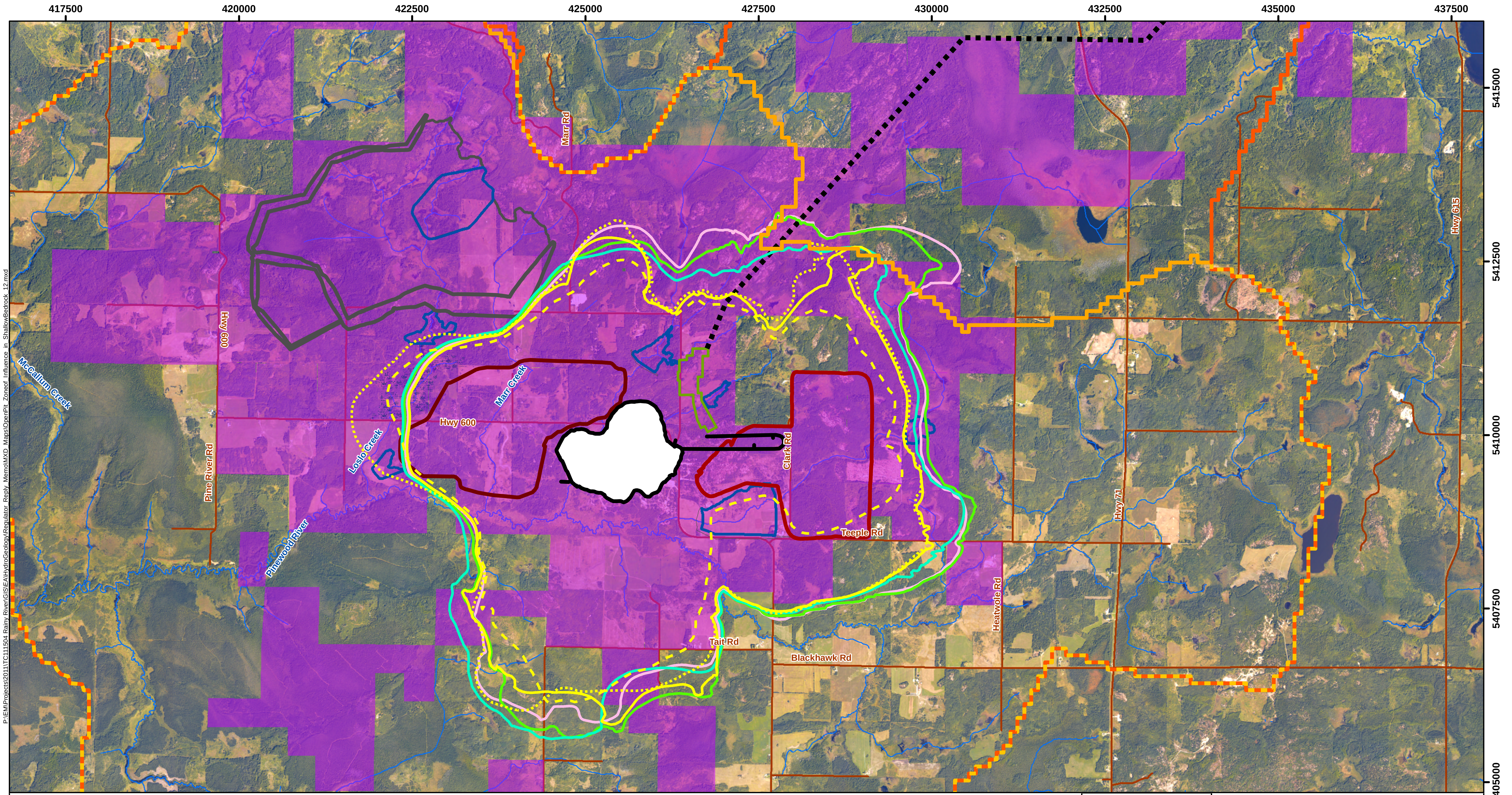
N W E S

RAINY RIVER amec

RAINY RIVER PROJECT

Extended Groundwater Flow Model Domain and Boundary Conditions

PROJECT N°: TC111504	**FIGURE: 1**
SCALE: 1:64,500	DATE: September 2013



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LEGEND

- Approximate Open Pit Outline and Underground Ramp
- RRR Active Dispositions/Claims
- Roads
- Watercourses corresponding to current conditions

Model Domain Boundary

- Extended Model Domain Boundary
- Original Model Domain Boundary
- Unchanged Model Domain Boundary

One metre Drawdown (ZOI) Contours by Case

- Base Case ZOI for Original Model Domain
- Base Case ZOI for Extended Model Domain
- Base Case ZOI for Original Model Domain - (TMA and Mine Rock Stockpile Influence)
- Case 3a ZOI for Extended Model Domain
- Case 4a ZOI for Extended Model Domain
- Anisotropy (Kv x 10) Case ZOI for Extended Model Domain

Proposed Site Features

- Tailings Management Area
- Overburden / West Mine Rock Stockpile
- Ore / East Mine Rock Stockpile
- Plant Site / Ancillary Facilities
- Ponds
- Transmission Line

NOTES:
- Road data extracted from Land Information Ontario, Ontario Road Network, MNR Queen's Printer for Ontario, 2011-2012
- Surficial geology based on air photo analysis and review of published geology maps. Surficial materials may vary from those indicated

Datum: NAD83
Projection: UTM Zone 15N

N E S W

0 1 2 4 6 8 10 Kilometres

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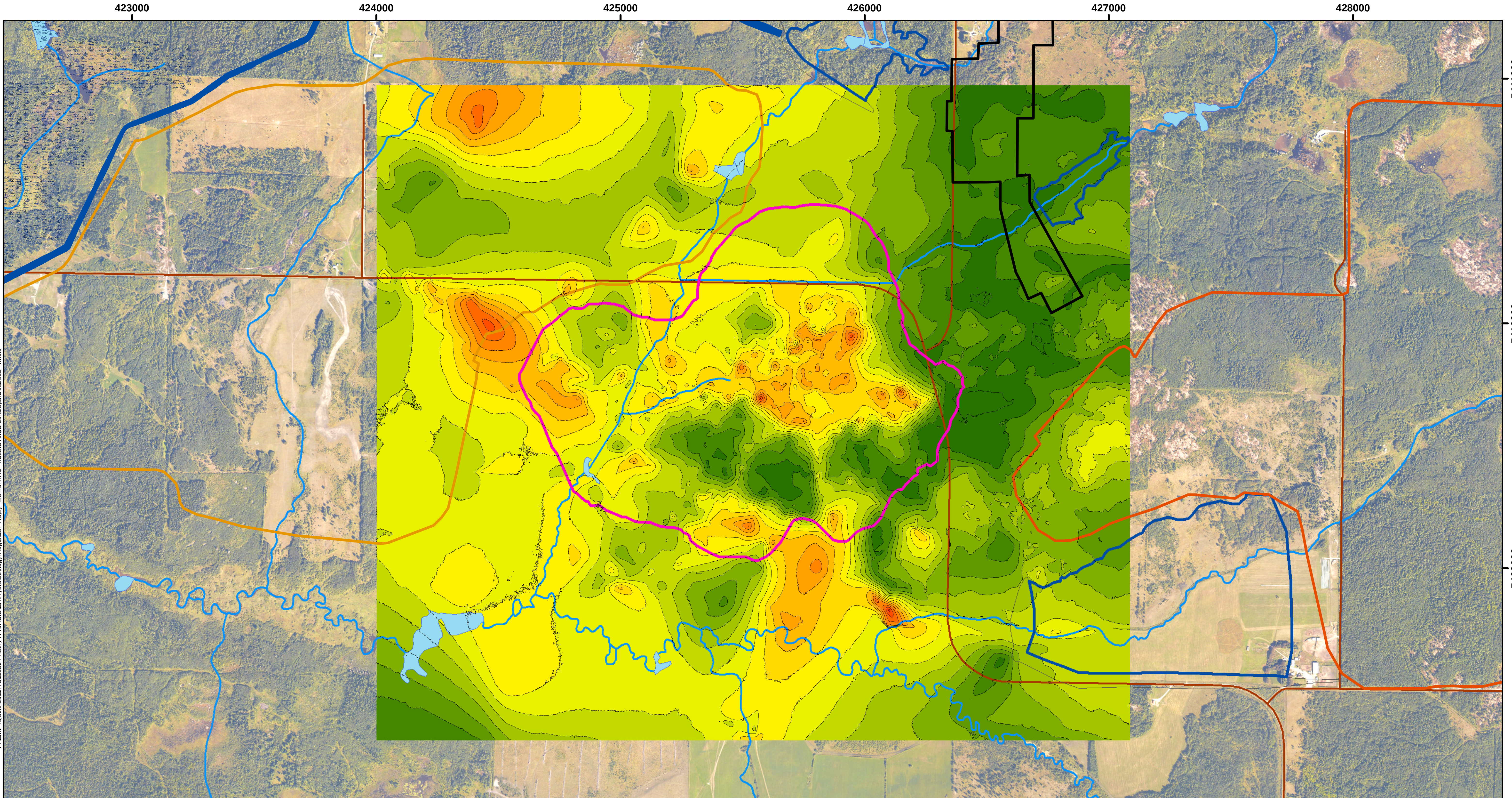
RAINY RIVER PROJECT

Predicted ZOIs for the Original and Additional Model Runs

PROJECT N^{o}: TC111504	FIGURE: 2
SCALE: 1:52,000	DATE: September 2013



P:\EM\Projects\2011\TC111504 Rainy River\GIS\EA\HydroGeology\Regulator_Reply_Memo\MXD_Maps\OverburdenDepthDec2012_4.mxd

LEGEND

Overburden Thickness Filled Contours (m)

- 0 - 5
- 5 - 10
- 10 - 15
- 15 - 20
- 20 - 25
- 25 - 30
- 30 - 35
- 35 - 40
- 40 - 45
- 45 - 50
- 50 - 55
- 55 - 60
- 60 - 65
- 65 - 70
- 70 - 75

Proposed Site Features

- Open Pit
- Tailings Management Area
- Overburden / West Mine Rock Stockpile
- Ore / East Mine Rock Stockpile
- Plant Site / Ancillary Facilities
- Ponds
- Transmission Line
- Watercourse Diversion Route

0 0.5 1 2 3 Kilometres

NOTES:
- Topographic data extracted from Land Information Ontario (MNR)
- Bedrock depths were compiled from the following investigation programs:
(a) RRR resource exploration program
(b) 2010 geotechnical site investigation (KCB)
(c) 2011 geotechnical and geomechanical site investigation (AMEC)
(d) 2012 geotechnical and geomechanical site investigation (AMEC)

Datum: NAD83
Projection: UTM Zone 15N

N W E S

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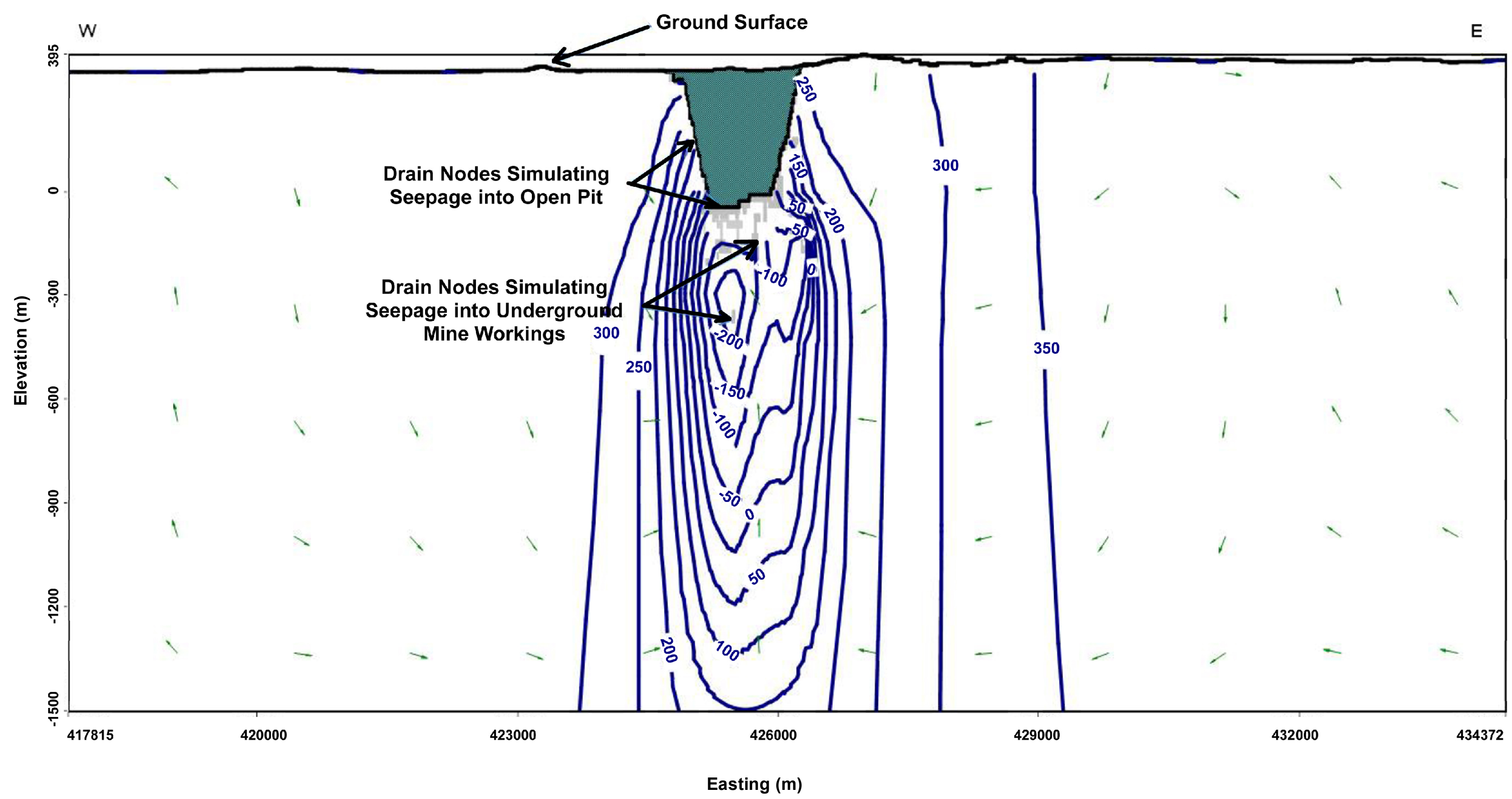
RAINY RIVER PROJECT

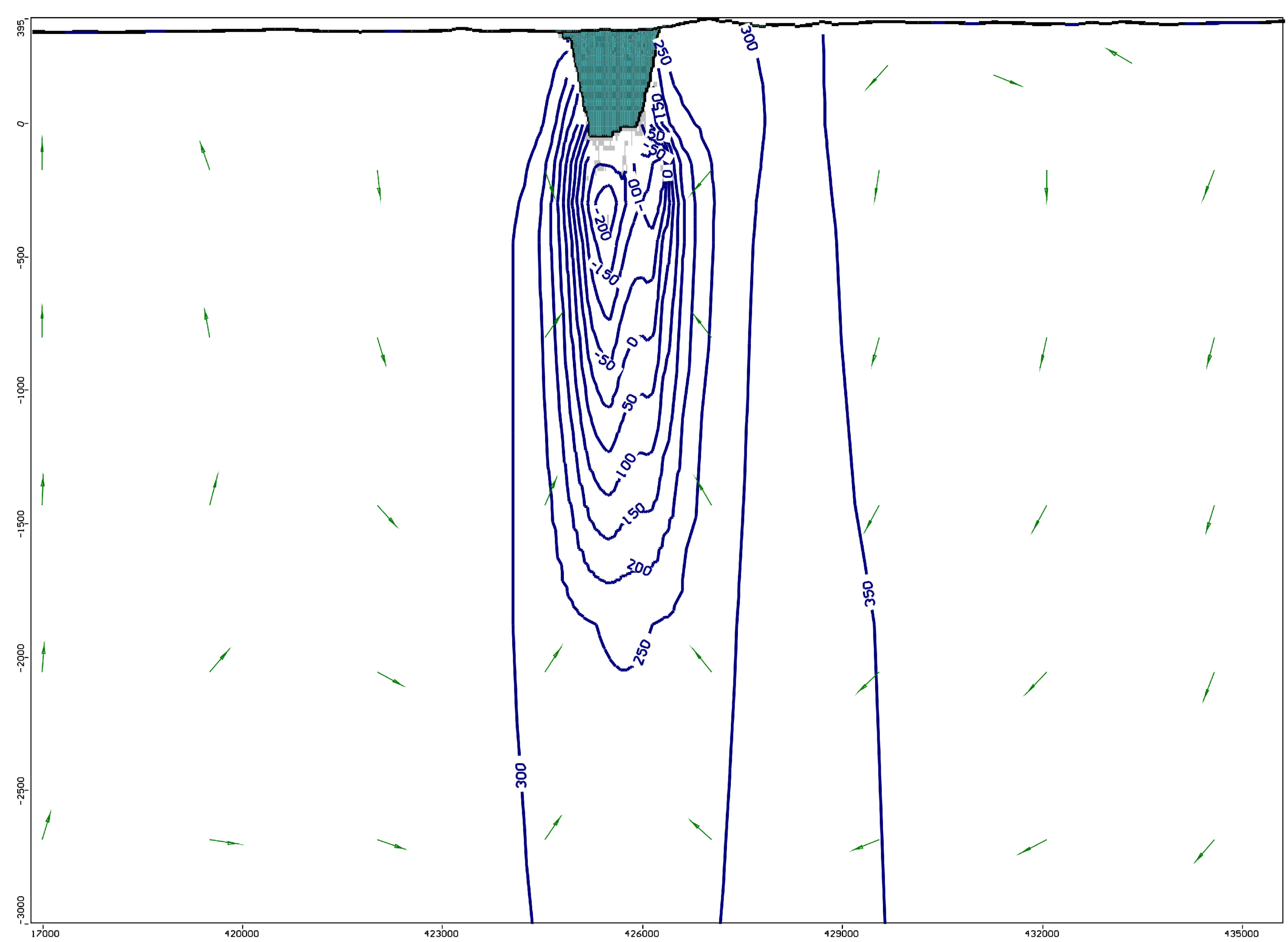
Overburden Thickness in the Open Pit Area

PROJECT N°: TC111504	FIGURE: 3
SCALE: 1:15,000	Date: September 2013

a) 1,500 metre below sea level model bottom



b) 3,000 metre below sea level model bottom



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LEGEND

Computed Head Contours, Base Case

Flow Direction

NOTES:

Datum: NAD83
Projection: UTM Zone 15N

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RAINY RIVER PROJECT

Potentiometric lines for (a) 1500 and (b) 3000 metres below sea level models

PROJECT N^{o}: TC111504	**FIGURE: 4**
SCALE: 1:500,000	DATE: September 2013