Touquoy Gold Project Modifications – Environmental Assessment Registration Document Addendum No. 2

(Part 1 of 2)

December 21, 2022

CONTENTS

St Barbara LIMITED

Disposition of information requests from the May 12, 2022 letter from the Minister of Environment and Climate Change

No.	Additional Information Request	Response	Attachments
1	The third-party water modelling review I requested identified issues with water modelling and the recommendations from the review were not implemented by AMNS. Address the recommendations proposed by Wood Environmental & Infrastructure Solutions in the Water Modelling Third-party Review of the Touquoy Gold Project Site Modifications including but not limited to:	Work related to addressing the Third-Party Review was summarized in the March Addendum Report (Stantec, AMNS 2022) to the Environmental Assessment Report Document (EARD). The following documents attached to the March Addendum Report all addressed issues raised during the Third-Party Review: Responses to Ministerial IRs: Mine Pit Permeability (Section 2.1) and Third-Party Review (Section 3.1) Appendix B.1 – Touquoy In Pit Disposal Factual Data Report, Hydrogeological Site Investigation, Touquoy in-Pit Tailings Disposal Appendix B.2 – Touquoy In-Pit Disposal - Seepage Mitigation Measures Appendix B.3 – Report Update: Groundwater Flow and Solute Transport Modelling to Evaluate Disposal of Tailings in Touquoy Open Pit Appendix D – Touquoy Gold Project Assimilative Capacity Study of Moose River Touquoy Pit Discharge (Updated) Additional information is provided below in answer to specific Information Requests. AMNS, Stantec. 2022. Addendum to the Touquoy Gold Project Modifications – Environmental Assessment Registration. Available at: https://novascotia.ca/nse/ea/	
1.a	All comments and questions regarding identified in the Hydrogeological Site Investigation, modelling and present analysis of findings.	The following documents attached to the March Addendum Report (AMNS, Stantec 2022) all addressed issues raised during the Third-Party Review: Responses to Ministerial IRs: Mine Pit Permeability (Section 2.1) and Third-Party Review (Section 3.1) Appendix B.1 – Touquoy In Pit Disposal Factual Data Report, Hydrogeological Site Investigation, Touquoy in-Pit Tailings Disposal Appendix B.2 – Touquoy In-Pit Disposal - Seepage Mitigation Measures Appendix B.3 – Report Update: Groundwater Flow and Solute Transport Modelling to Evaluate Disposal of Tailings in Touquoy Open Pit Appendix D – Touquoy Gold Project Assimilative Capacity Study of Moose River Touquoy Pit Discharge (Updated) Attachment 1 presents a disposition of comments provided in, “Table 1 Detailed Review Comments and Recommendations Regarding Appendix D.1 and D.2”, of the Wood (2022) Water Modelling Third-party Review of the Touquoy Gold Project Site Modifications – Environmental Assessment Registration. Wood. 2022. Memorandum. Water Modelling Third-party Review of the Touquoy Gold Project Site Modifications – Environmental Assessment Registration. Available	Attachment 1: Disposition of Third Party Review Comments, Table 1 Detailed Review Comments and Recommendations Regarding Appendix D.1 and D.2

No.	Additional Information Request	Response	Attachments
		as Appendix C.1 to the Addendum to the Touquoy Gold Project Modifications – Environmental Assessment Registration at: https://novascotia.ca/nse/ea/ AMNS, Stantec. 2022. Addendum to the Touquoy Gold Project Modifications – Environmental Assessment Registration. Available at: https://novascotia.ca/nse/ea/	
1.b	Complete hydraulic connectivity testing in all fracture/fault zones, identified underground mine workings, Ground Penetrating Radar anomalous areas and the overburden and upper weathered bedrock layers surrounding the pit.	Hydraulic connectivity testing was completed and included in Appendix B to the March Addendum Report (AMNS, Stantec 2022; Appendix B). Additional commentary on the results of the investigations is provided in Attachment 2, which is structured to provide a holistic interpretation of the available hydrogeology data surrounding the open pit mine and discusses the requirement of completing additional hydraulic conductivity testing. The information and analyses provided in Attachment 2 demonstrates that sufficient hydrogeological characterization has been completed to understand the hydraulic conductivity and connectivity surrounding the Open Pit. Hydraulic testing shows that faults in the area do not indicate increased water flow. All main faults in the pit have been tested and results have shown that there is limited flow in these structures which have the highest probability of having the largest fractures and most interconnectedness. Results indicate significant flow will not occur along the major faults. Therefore, the likelihood of seeing increased flow through smaller structures is significantly less. Groundwater flow depends not only on the aperture size (*i.e.* pore size or fracture width) but also on the interconnectivity of these voids (*i.e.* permeability). Application of the Cubic Law, which governs fracture flow through rock aquifers, suggests that as fracture apertures decrease the flow rate will rapidly decrease (flow is related to the cube of the fracture aperture). Concentrated data collection was undertaken in the vicinity of the historical underground workings, including deep borehole logging, hydraulic testing using packers and a GPR survey. Based on the available information and analysis completed, the hydraulic conductivity for the bedrock mass in the pit area does not indicate additional seepage mitigation is required to avoid environmental interactions between the tailings deposited in the Pit and the environment. However, a low permeability clay liner was included as part of the design to mitigate uncertainty in this area. As described in Attachment 2, additional work was undertaken to provide additional information regarding water levels in the pit in relation to the top of the bedrock around the pit perimeter. Water levels will be allowed to increase to the maximum water level (spillway invert) at 108.0 m, when pit water can meet regulatory requirements (e.g., through natural attenuation or treatment). Prior to water quality in the pit meeting regulatory requirements to be discharged into the environment, the normal operating water level in the pit will be maintained at maximum elevation of 106.5 m. With the in-pit tailings deposition, AMNS maintains the operational flexibility to treat effluent through the existing Effluent Treatment Plant (ETP) to control water levels in the depleted open pit. If effluent treatment is required to manage pit water levels, the water-based discharges will be treated using the existing site infrastructure (*i.e.,* ETP, Polishing Pond, Constructed Wetland) to meet MDMER authorized limits	Attachment 2: Hydraulic Connectivity Testing Additional Interpretation

No.	Additional Information Request	Response	Attachments
		and IA limits prior to discharge as per normal operations. Elevation 106.5 m is 1.5 m below the spillway invert and below the top of the bedrock around the perimeter of the pit. The available data is considered adequate to understand the potential for connectivity between isolated fractures and the pit. Additional boreholes in the vicinity of the historical underground workings are not recommended for this reason, as well as the increased potential for creating flow pathways by drilling into the historical workings. AMNS, Stantec. 2022. Addendum to the Touquoy Gold Project Modifications – Environmental Assessment Registration. Available at: https://novascotia.ca/nse/ea/	
1.c	Provide a clear conceptual outline with all significant processes for the groundwater flow of a conservative solute from the pit to the Moose River. Evaluate the hydraulic and attenuation factors being assumed and describe how these are incorporated into the groundwater model. Describe what mechanisms in the model would result in limitations to non-reactive solute transport. If the new evaluation indicates a change in conceptual approach, update and re-run the groundwater solute transport model.	Refer to Attachment 3 for the full response: The conceptual basis for the Touquoy Pit groundwater flow and solute transport model are described in two previous reports included with the Touquoy Gold Project Modifications EARD (Appendix D.2) and the March Addendum Report (Appendix B.3). The groundwater flow and solute transport system between the Touquoy Pit and the Moose River is dominated by the processes of advection and dispersion. Advection refers to the transport of solutes due to the movement of groundwater within which those solutes are dissolved. Dispersion refers to the effects of pore-scale variability of flow paths through the aquifer matrix which causes a natural scattering or spreading of the solute along the flow path. It should be noted that a water level of 108 meters above mean sea level (masl) was used in the calibration and operation of the groundwater model. With the pit water level at 108 masl there is a small hydraulic gradient towards the Moose River in the southern portion of the Touquoy pit. With the water level at 106.5 masl, there will be a small gradient inward from the Moose River toward the pit. Chemical diffusion is accounted for in the Touquoy solute-transport model but is a relatively minor component of the overall flow and transport system. Chemical diffusion refers to the process of solute transport from areas of high concentration to areas of low concentration due to the concentration gradient independent of the hydraulic gradient. A real recharge due to precipitation is represented through a spatially distributed recharge value. Recharge from precipitation is assumed to contain no dissolved constituents, consistent with rainwater or snow. The process of recharge therefore gradually attenuates concentrations through dilution as a solute moves away from the Touquoy pit. Because solutes are only predicted to move a limited distance past the southwestern portion of the pit wall, the practical effect of dilution as an attenuation factor is limited in this case. Significant processes and mechanisms are captured in the numerical model and no further runs are necessary.	Attachment 3: Groundwater Modelling Additional Information

No.	Additional Information Request	Response	Attachments
		AMNS, Stantec. 2021. Touquoy Gold Project Modifications – Environmental Assessment Registration Document. Available at: https://novascotia.ca/nse/ea/ AMNS, Stantec. 2022. Addendum to the Touquoy Gold Project Modifications – Environmental Assessment Registration. Available at: https://novascotia.ca/nse/ea/	
1.d	Provide particle flowpath tracking for the area of the groundwater model between the pit and Moose River.	Refer to Attachment 3 for the full response: The updated groundwater flow and solute transport model included as Appendix B.3 to the March Addendum (AMNS, Stantec 2022) was used to develop particle tracks. The results presented in Attachment 3 are consistent with the site conceptual model. The particle tracks indicate that transport velocities are small and the resulting transport distances are low. This is due to a combination of relatively low hydraulic gradient between the pit and the Moose River and the estimated hydraulic conductivity of the uppermost portions of the aquifer in that region. The particle track results are consistent with the conceptual site model based on the available information, data, and model output. AMNS, Stantec. 2022. Addendum to the Touquoy Gold Project Modifications – Environmental Assessment Registration. Available at: https://novascotia.ca/nse/ea/	Attachment 3: Groundwater Modelling Additional Information
1.e	Present information to validate predicted tailings pore water quality and predicted open pit lake discharge water quality. Compare predicted values against water quality within the existing Tailings Management Facility.	Refer to Attachment 4 for the full response: Water quality predictions for the Pit Lake are presented for the first year of effluent discharge once the Pit Lake is full. Water quality predictions were modelled for base case and continuous operations scenarios. Predicted Pit Lake water quality was compared and validated against site water quality data within the existing Tailings Management Facility. Table 1 of Attachment 4 compares water quality predictions to historical water quality parameters. It is anticipated that there would be limited stratification between surface pit lake water and the pore groundwater in the subsurface tailings. For the purposes of modeling, the worst case was assumed (i.e., all water was assumed to be pore water associated with subsurface tailings); this represents a conservative estimate of pit lake water quality. As expected, the mean predicted water quality concentrations based on the base case tailings pore-water source terms (Lorax 2018) are higher than the historical mean of the exiting TMF water quality. The historical TMF quality shows the mill treatment circuit has been effective at maintaining consistent process water quality. AMNS, Stantec. 2022. Addendum to the Touquoy Gold Project Modifications – Environmental Assessment Registration. Available at: https://novascotia.ca/nse/ea/	Attachment 4: Pore Water Quality, Open Pit Discharge Water Quality
1.f	Define the stratigraphy geologic layers (including overburden and upper weathered bedrock layers) and corresponding hydraulic conductivity measurements within and surrounding the open pit mine show how	The stratigraphy of the geological layers is presented in Appendix B.1 of the March Addendum Report and an explanation of how this is reflected in the groundwater model is provided in Appendix B.3 (AMNS, Stantec 2022). Additional information and graphical representations of the existing data are provided in Attachment 5.	Attachment 5: Stratigraphic Sections

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	these are matched with the layers used in the groundwater model.	AMNS, Stantec. 2022. Addendum to the Touquoy Gold Project Modifications – Environmental Assessment Registration. Available at: https://novascotia.ca/nse/ea/	
1.g	Provide in graphical cross-section format, data showing stratigraphic layering through the southern pit wall including geology, fault zones, underground working zones, elevations of the final pit water level, groundwater level and Moose River seasonal water elevations.	The stratigraphy of the geologic layers is presented in Appendix B.1 of the March Addendum Report and an explanation of how this is reflected in the groundwater model is provided in Appendix B.3 (AMNS, Stantec 2022). Additional information and graphical representations of the existing data are provided in Attachment 5. AMNS, Stantec. 2022. Addendum to the Touquoy Gold Project Modifications – Environmental Assessment Registration. Available at: https://novascotia.ca/nse/ea/	Attachment 5: Stratigraphic Sections
2	Use all of the above information to update ground and surface water modelling and provide analysis.	The information presented in response to No. 1.a to 1.g above includes all required analysis as part of the associated Attachments 1-5. None of the information described above represents new data or changes to conditions that requires new modelling. Work related to addressing the Third-Party Review was summarized in the March Addendum Report (Stantec, AMNS 2022) to the Environmental Assessment Report Document (EARD). The following documents attached to the March Addendum Report all addressed issues raised during the Third-Party Review: Responses to Ministerial IRs: Mine Pit Permeability (Section 2.1) and Third-Party Review (Section 3.1) Appendix B.1 – Touquoy In Pit Disposal Factual Data Report, Hydrogeological Site Investigation, Touquoy in-Pit Tailings Disposal Appendix B.2 – Touquoy In-Pit Disposal - Seepage Mitigation Measures Appendix B.3 – Report Update: Groundwater Flow and Solute Transport Modelling to Evaluate Disposal of Tailings in Touquoy Open Pit Appendix D – Touquoy Gold Project Assimilative Capacity Study of Moose River Touquoy Pit Discharge (Updated) AMNS, Stantec. 2022. Addendum to the Touquoy Gold Project Modifications – Environmental Assessment Registration. Available at: https://novascotia.ca/nse/ea/	Attachment 1: Disposition of Third Party Review Comments, Table 1 Detailed Review Comments and Recommendations Regarding Appendix D.1 and D.2 Attachment 2: Hydraulic Connectivity Testing Additional Interpretation Attachment 3: Groundwater Modelling Additional Information Attachment 4: Pore Water Quality, Open Pit Discharge Water Quality Attachment 5: Stratigraphic Sections
3	Groundwater quality must be in compliance with the Industrial Approval for the site. Submit groundwater predictions for the site and compare to potable criteria and freshwater aquatic life criteria, as per the requirements in the Industrial Approval.	Refer to Attachment 6 for full response. Groundwater predictions were generated for location OPM-1B for two time periods; 5 years and 500 years from the time tailings are placed in the Touquoy pit. As a conservative case, the groundwater model predictions were developed for the in-pit tailings deposition assuming no additional seepage mitigation (i.e., in absence of the clay liner). The order of magnitude predicted additional concentrations above baseline concentrations ranged from 0.00834 ug/L (dissolved sulphate in the 500-year scenario) to 4.3E-16 ug/L (dissolved silver in the 5-year scenario). That is to say that the predicated incremental concentration increase resulting from the placement and storage of tailings in the Touquoy pit is extremely small and therefore minimally increases parameter concentrations from baseline. In many cases these increases	Attachment 6: Groundwater Predictions Compared to Industrial Approval Requirements

No.	Additional Information Request	Response	Attachments
		are too low to be distinguishable from baseline by current laboratory detection methods. Based on the available information and analysis completed, the hydraulic conductivity for the bedrock mass in the pit area does not indicate additional seepage mitigation is required to avoid environmental interactions between the tailings deposited in the Pit and the environment. However, to address any uncertainty related to the presence and interconnectivity of the underground workings, a low permeability liner is proposed on the western side of the Pit. The baseline concentration, plus the predicted incremental concentration increase resulting from the placement and storage of tailings in the pit, are not materially increased from the average groundwater baseline concentrations. AMNS, Stantec. 2022. Addendum to the Touquoy Gold Project Modifications – Environmental Assessment Registration. Available at: https://novascotia.ca/nse/ea/	
4	AMNS did not describe how discharges would be protective of fish and fish habitat under the *Fisheries Act:*	Information describing how discharges would be protective of fish and fish habitat was provided in Section 7.7.2 and 8.7 of the EARD. Additional documentation provided in the March Addendum Report (AMNS, Stantec 2022) for Information requests No. 3, 4-c, and 8 support the protection of fish and fish habitat. Additional information is provided below in answer to specific Information Requests. AMNS, Stantec. 2022. Addendum to the Touquoy Gold Project Modifications – Environmental Assessment Registration. Available at: https://novascotia.ca/nse/ea/	
4.a	Complete the assimilative capacity study of Moose River to be compliant with the Industrial Approval which uses SW-11 as the background station for quality and propose discharge criteria that will be protective of fish and fish habitat, in all areas of the Moose River. Incorporate Fisheries and Oceans Canada recommendations to determine summer flow conditions.	Refer to Attachment 7 for full response. AMNS conducted an assimilative capacity (AC) study of Moose River, without the mitigating factors of the clay liner or treatment if required, for effluent discharge and seepage from the in-pit disposal of tailings. The water quality predictions were developed assuming no treatment of pit water, no pit wall clay liner mitigation and low flow conditions to determine conservative estimates of water quality. DFO's Framework for Assessing Ecological Flow Requirements were incorporated to determine summer flow conditions. As further described in Section 4.2, the 25% MAF was used to represent low flow conditions. By request from DFO, additional flow statistics were evaluated as part of the AC study to predict water quality for an extreme worst-case scenario for low flow conditions. The 7-day, 10-year low flow (i.e., the lowest running 7-day average flow predicted with an average recurrence interval of 10 years) ecological flow metrics are discussed in the addendum to Attachment 7. Because assimilative capacity in the river is lowest under those low flow conditions this scenario will produce the most conservative results, although these modelled conditions are not expected to occur. Based on the evaluation undertaken, even without the application of mitigation in form of a clay liner or treatment if required, Moose River has sufficient assimilative capacity to meet the WQCC, background concentration or site-specific water quality criteria at the end of the mixing zone.	Attachment 7: Assimilative Capacity Study of Moose River, and addendum

No.	Additional Information Request	Response	Attachments
		The mixing zone was established to follow the 14 guiding principles (CCME 2003b), which is further described in Appendix A of Attachment 7. Concentrations of the parameters of potential concern at the end of the mixing zone for the worst-case conditions are presented in Table 9.1 and Table 9.2. The predicted aluminum concentration at the end of the mixing zone will be slightly lower than background, but above the WQOs. The predicted arsenic concentration is above the WQOs but below the proposed site-specific water quality objective (Intrinsik 2022) and proximal to baseline conditions. The proposed site-specific water quality guideline for arsenic was described to NSECC as part of reporting on IA Condition 7.w (September 29, 2022). A formal request to adopt this site-specific guideline was made by Industrial Approval Amendment application in December 2022. The proposed site-specific arsenic criteria are based on the CCME guidelines and are intended to provide protection to fish and fish habitat across the site. The results of the assimilative capacity study show that water quality in Moose River is protective of fish and fish habitat. <u>Mitigation</u> AMNS operates in accordance with the IA for its operations. Condition 7.d.iii (a-c) requires AMNS to review surface water monitoring results against IA criteria. If an increasing trend is observed, an independent professional is retained to evaluate whether the increasing trend is due to site activities. Condition 7.d.vi requires AMNS to take, "…all mitigative and remedial measures to restore surface water quality" in the event of an exceedance of IA criteria. For groundwater, condition 8.b.vi outlines the compliance requirements for identified monitoring wells for groundwater quality. If a non-compliant result observed, the following actions are required: reporting; retaining a third-party expert to conduct additional investigation; and provide and implement a corrective action plan with NSECC approval. As mentioned above, water quality predictions for Moose River were developed in the absence of mitigation and water treatment. The predicted elevated arsenic concentrations will be mitigated by the treatment of pit water, if required. Treatment of effluent from the pit will be required to meet Metal and Diamond Mine Effluent Regulations (MDMER) limits as well as site specific requirements set under the Industrial Approval (IA). As the pit lake behaves like a large sedimentation pond during pit filling some metals concentrations from the pit lake will be improved to the background water quality in Moose River. Proposed water quality treatment during operation/closure is detailed in Attachment 9 as part of this submission. Although there is no indication that seepage from the pit toward Moose River will result in unacceptable environmental interactions, to address any uncertainty related to the presence and interconnectivity of the underground workings, mitigation in the form of a low permeability clay liner along the southwestern face of the pit from the crest of the pit to the rock bench at an approximate elevation of 60 masl is proposed. The low permeability clay liner would reduce groundwater seepage flow from the pit to Moose River resulting in a further reduction in changes to water quality parameters. Details of the clay liner are presented in Attachment 10.	

No.	Additional Information Request	Response	Attachments
4.b	Complete an assimilative capacity study of Watercourse #4 that will be protective of fish and fish habitat. Incorporate Fisheries and Oceans Canada recommendations to determine summer flow conditions.	Refer to Attachment 8 for the full response. AMNS conducted an assimilative capacity (AC) study of Watercourse 4 (WC4) for seepage from the Tailings Management Facility (TMF) and Waste Rock Storage Area (WRSA) of the Touquoy Gold Project. Concentrations of the parameters of potential concern at the end of the mixing zone in WC4, Otter Lake and Moose River are presented in Attachment 7. DFO's Framework for Assessing Ecological Flow Requirements were incorporated to determine summer flow conditions. As further described in Section 4.2, the 25% MAF was used to represent low flow conditions. By request from DFO, additional flow statistics were evaluated as part of the AC study to predict water quality for an extreme worst-case scenario for low flow conditions in WC4. The 7Q10 ecological flow metrics are discussed in the addendum to Attachment 8. In the extreme worst-case scenario, the 7Q10 ecological flow condition is dry (i.e., no flow). These low flow conditions occur following a period of low precipitation at the watershed. Under these conditions, there is no effluent discharge from the WRSA expected during this period. In addition, groundwater seepage to the watercourse was assumed to be negligible as seepage would be held in soil storage under these dry, unsaturated soil conditions. The water quality modelling results are summarized in Table 1 of the AC study addendum. Water quality meets IA WQ objectives after the mixing zone with exception of Aluminum and Arsenic. However, the predicted Aluminum and Arsenic concentrations at the end of the mixing zone will be lower than background. The mixing zone was established to follow the 14 guiding principles (CCME 2003b), which is further described in Appendix A of Attachment 8. The predicted aluminum concentration at the end of the mixing zone will be slightly lower than background, but above the WQOs. The predicted concentrations of arsenic and sulphate will meet WQOs at the end of the mixing zone. Based on the CCME factsheets for Arsenic and the BC ambient water quality guidelines for Sulphate, concentrations of these parameters in the Initial Dilution Zone are below the acute or short-term chronic toxicity to aquatic organisms. The results of the assimilative capacity study show that water quality in WC4 is protective of fish and fish habitat. <u>Mitigation</u> Predicted concentrations for WC4 do not exceed the WQCC and as such no specific mitigation is proposed at this time. AMNS operates in accordance with the IA for its operations. Condition 7.d.iii (a-c) requires AMNS to review surface water monitoring results against IA criteria. If an increasing trend is observed, an independent professional is retained to evaluate whether the increasing trend is due to site activities. Condition 7.d.vi requires AMNS to take, "…all mitigative and remedial measures to restore surface water quality" in the event of an exceedance of IA criteria. For groundwater, condition 8.b.vi outlines the compliance requirements for	<u>Attachment 8: Assimilative Capacity Study of Watercourse No. 4, and addendum</u>

No.	Additional Information Request	Response	Attachments
		identified monitoring wells for groundwater quality. If a non-compliant result observed, the following actions are required: reporting; retaining a third-party expert to conduct additional investigation; and provide and implement a corrective action plan with NSECC approval. Although water quality exceedances are neither predicted nor planned, the following considerations are provided for additional mitigation measures. Development of corrective action plans is site- and situation-specific. Mitigation proposed for one area or set of circumstances may not be broadly applicable and would be developed based on real-time observations; establishment of causality; and in consultation with the relevant regulatory authorities. <u>Mitigation – Operational Considerations</u> Planned activities will reduce the volume of seepage at the site in the near future, and will contribute to a reduction in changes to water quality parameters: • Since submission of the EARD in 2021, additional waste rock storage locations have been permitted in various areas of the mine site. This additional waste rock storage has alleviated the requirement for the entire 2.5 Mm^3 of capacity within the WRSA as requested in the EARD. As a result, the design to the WRSA expansion has been decreased. Development of this area for waste rock storage would also be subject to Authorization from DFO. • There will be a reduction in the size of the source material in the WRSA. In early 2023, the Open Pit will be depleted, and mining activities are due to conclude. In turn, the mill feed will consist entirely of stockpiled material, thus reducing the size of the WRSA stockpiles. • The proposed closure cover for the TMF will reduce infiltration of water and limit oxygen flux reaching the tailings, also leading to a reduction in changes to water quality parameters. The liner will consist of three layers: layers: a Capillary Break Layer (CBL) placed over the tailings; a Moisture Retaining Layer (MRL) acting as an oxygen barrier; and a Drainage and Protection Layer (DPL) to control water flow and other natural site conditions at the surface. <u>Mitigation – Additional Methods</u> The following additional mitigation methods may be employed, as required in case of unplanned exceedances of water quality criteria, in consultation with NSECC. Development of corrective actions plans is site, and situation-specific and mitigation proposed for one area or set of circumstances may not be broadly applicable. Therefore, any mitigation options or remediation requirement must be considered based on real-time observations and information.	

No.	Additional Information Request	Response	Attachments
		• Collection system changes: deepening of the perimeter ditches to intersect a higher volume of seepage; direct flow to treatment. • Recovery wells or groundwater collection trenches or recovery wells with pump-back capability.	
4.c	Options were provided for in-pit water treatment but a plan was not provided. Provide a detailed plan of how the open pit water will be treated to meet discharge requirements that will be protective of fish and fish habitat. Provide of schedule of when treatment will commence and end.	Refer to Attachment 9 for the full response. Attachment 9 details the proposed treatment schedule, treatment process and anticipated discharge requirements to protect fish and fish habitat in relation to in-pit deposition of tailings. Effluent discharge from the Touquoy open pit is projected, based on current plans, to occur 6 years after tailings/waste rock deposition is initiated. Initial water quality modelling for the Touquoy pit water quality has identified that arsenic and ammonia are parameters of concern and will likely require water treatment prior to discharge to the environment. Conceptual treatment options are outlined in Attachment 9. Modelling has shown that the future water quality parameters of concern in the pit water would be similar to the TMF effluent that is being treated by the Touquoy Effluent Treatment Plant (ETP). However, as natural degradation takes place during the 6 years of pit filling, the required treatment will be reduced, and some aspects may no longer be required. The pit filling time provides opportunity to monitor the pit water quality and conduct additional modelling and bench-scale level work. AMNS maintains the operational flexibility to treat effluent through the existing ETP to control water levels in the depleted open pit. If effluent treatment is required to manage pit water levels, the water-based discharges will be treated using the existing site infrastructure (*i.e.,* ETP, Polishing Pond, Constructed Wetland) to meet MDMER authorized limits and IA criteria prior to releasing effluent at the final discharge point (SW-14). AMNS, Stantec. 2022. Addendum to the Touquoy Gold Project Modifications – Environmental Assessment Registration. Available at: https://novascotia.ca/nse/ea/	Attachment 9: Touquoy Open Pit Water Treatment - Conceptual Approach
5	Mitigation measures were not adequately described in the Addendum	Mitigation was outlined in the Addendum, specifically Appendix B.2 of the March Addendum Report (AMNS, Stantec 2022) presented the conceptual design for the in-pit seepage mitigation. Additional information is provided below in answer to specific Information Requests. AMNS, Stantec. 2022. Addendum to the Touquoy Gold Project Modifications – Environmental Assessment Registration. Available at: https://novascotia.ca/nse/ea/	

No.	Additional Information Request	Response	Attachments
5.a	Provide signed stamped drawings of the proposed liner and/or all other proposed mitigation measures for the Touquoy pit and Watercourse #4. If concentrated grouting is proposed in localized fault zone(s) for the Touquoy pit, explain how the geological conditions will make this possible given its failure at the Tailings Management Facility in 2017 and, describe its durability and proposed schedule (*i.e.,* before or after deposition).	Attachment 10 provides the technical specifications and drawings for the pit slope seepage mitigation liner. As stated in the Updated Groundwater Flow and Solute Transport Modelling Report (Appendix B.3 to the March Addendum), based on the available information and analysis completed, the hydraulic conductivity for the bedrock mass in the pit area does not indicate additional seepage mitigation is required to avoid environmental interactions between the tailings deposited in the Pit and the environment. Notwithstanding this conclusion and the technical data provided to support it, to address any uncertainty related to the presence and interconnectivity of the underground workings, a low permeability liner has been proposed on the western side of the Pit. The design life or duration of effectiveness of a liner, is typically only considered in relation to "manufactured liners" (i.e., geosynthetics/polyethylene type products) that may degrade over time from exposure to biological, chemical, thermal or UV radiation, not soil (i.e., clay) liners as in our case. The liner proposed for the in-pit tailings disposal mitigation plan will be constructed from natural clayey soils that are not prone to the same concerns as a manufactured liner. As in the case of the main tailings dam, the design life of a clay core was not a design criterion since degradation of clay/soil minerals over the life of the structure is not a relevant factor. However, consideration must be given other to time-related changes in the properties of the soils of which the structure and its foundation are composed. For the in-pit liner design two principal factors have been considered including deformation through settlement and consolidation, and internal erosion through seepage. Similar to the main tailings pond dam, concerns related to deformation have been addressed by appropriate use of materials, and construction placement and compaction protocols, and issues related to seepage and internal erosion have been addressed by incorporating filter layers into the design. In general, clay cores for dams and liners are designed to have a long service life. For the Touquoy in-pit tailings disposal plan, with consideration of the clay properties, project specifications and construction QA/QC protocols, the duration of effectiveness of a liner is most likely in excess of 100 years. AMNS, Stantec. 2022. Addendum to the Touquoy Gold Project Modifications – Environmental Assessment Registration. Available at: https://novascotia.ca/nse/ea/	Attachment 10: Pit Slope Seepage Mitigation Technical Specifications and Drawings
5.b	Provide information on the need and potential methodologies for grouting underground mine workings and fracture zones between the open pit and the Moose River.	Refer to Attachment 11 for full response. Several documents have been provided regarding mitigation measures recommended to deal with concerns related to the underground mine workings, and the technical basis that there are no requirements for grouting fracture zones between the open pit and the Moose River. In addition to Attachment 11, refer to Attachment 2 and Attachment 10.	Attachment 11: Underground Workings and Fault Grouting

No.	Additional Information Request	Response	Attachments
		As stated in the Updated Groundwater Flow and Solute Transport Modelling Report (Appendix B.3 to the March Addendum), based on the available information and analysis completed, the hydraulic conductivity for the bedrock mass in the pit area does not indicate additional seepage mitigations are required to avoid environmental interactions between the tailings deposited in the Pit and the environment. Notwithstanding this conclusion and the technical data provided to support it, to address any uncertainty related to the presence and interconnectivity of the underground workings, a low permeability liner has been proposed on the western side of the Pit. AMNS, Stantec. 2022. Addendum to the Touquoy Gold Project Modifications – Environmental Assessment Registration. Available at: https://novascotia.ca/nse/ea/	
6	No alternatives to altering Wetland #15, a Wetland of Special Significance were provided. Provide analysis for avoidance of Wetland #15, a WSS under the ECC Wetland Policy.	This information was provided in Section 5.1 of the Addendum Report. As described in Section 5.1 of the March Addendum Report (AMNS, Stantec 2022), the total area of alteration of Wetland 15 was reduced through careful design and planning. Wetland 15 has been permitted for a total of 4.12 ha of alteration area under previous wetland alteration approvals, some of which overlaps with the areas proposed in the EARD. Only 0.62 ha of Wetland 15 was proposed for alteration, 15% of the previously approved alteration area. The proposed alteration area was confined to the northeast lobe and to a 0.1 ha area next to the existing WRSA area. The northeast lobe is dominated by the M1 – Mountain Holly – Alder Shrub Swamp vegetation community, which has low potential to support blue felt lichen. AMNS recognizes that wetlands are valued resources, protected by the Nova Scotia Environment Act. The proposed alternative design for the Expansion of the Waste Rock Storage Area (WRSA) will not require alteration of wetland habitat. As presented in the Environmental Assessment Report Document (EARD), AMNS requested an expansion to the WRSA to re-establish lost capacity, maintain stable height requirements, and accommodate future growth. The original WRSA expansion design had a footprint area of 7.1 ha and supported an additional 2.5 Mm^3 of waste rock storage capacity in the WRSA. Since submission of the EARD in 2021, additional waste rock storage locations have been permitted in various areas of the mine site. This additional waste rock storage has alleviated the requirement for the entire 2.5 Mm^3 of capacity as requested in the EARD. As a result, AMNS is proposing an alternative design to the WRSA expansion. The development area of the proposed design is outlined in the attached figure (Attachment 12). The alternative WRSA expansion footprint has been reduced to approximately 3.1 ha and eliminates the direct interaction and impact to Wetland 15. The resulting waste rock storage capacity gained from the alternative WRSA expansion is approximately 1.0 Mm^3. The placement of the WRSA expansion uses infrastructure currently in place for the existing WRSA to optimize mining activities, reduces the potential for direct and indirect effects of the expansion and focuses new development to previously	Attachment 12: Alternative Waste Rock Storage Area Design

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No.	Additional Information Request	Response	Attachments
		impacted areas (*i.e.,* historically cutover). Potential indirect wetland impacts through changes to hydrology associated with the development areas (e.g., drainage patterns, surface water management) are presented in the EARD. The wetland receives water through a drainage inlet to the north of the wetland and passive overland/throughflow drainage from adjacent uplands. The primary flow path within Wetland 15 is north-south, via Watercourse No. 4. No direct impacts are proposed to the wetland or in the contributing catchment area north of Wetland 15. As a result, it is not expected that the WRSA expansion footprint proposed will cause new hydrological (*i.e.,* flow) impacts to Wetland 15. Existing infrastructure is located in the upland areas east (WRSA) and west (Plant Site) of Wetland 15. No hydrological impacts have been observed to date in Wetland 15 through the wetland monitoring program (Table 14 of the EARD). AMNS, Stantec. 2022. Addendum to the Touquoy Gold Project Modifications – Environmental Assessment Registration. Available at: https://novascotia.ca/nse/ea/	
7	Options were provided by AMNS to manage the historic mine tailings but a plan was not provided. Provide a detailed plan to manage the historic mine tailings on site.	Refer to Attachment 13 for additional details. An updated Tailings Management Plan and covering letter was provided in the March Addendum Report (AMNS, Stantec 2022) as Appendix H in answer to the original question on this matter. The design and location of the Open Pit spillway is a matter of closure planning, and many options are under consideration including avoidance of historic tailings altogether. Attachment 13 provides an additional update with more information around the options under consideration. The management of any historic tailings is planned to be completed in accordance with the existing Historic Tailings Management Plan (HTMP) and the current Nova Scotia Environment Contaminated Sites Regulations (NSE CSR) framework. The appropriate NSECC protocols, forms, and reports will be issued to NSECC as required within this provincial framework. AMNS, Stantec. 2022. Addendum to the Touquoy Gold Project Modifications – Environmental Assessment Registration. Available at: https://novascotia.ca/nse/ea/	Attachment 13: Historic Tailings
8	AMNS did not provide adequate fish sampling data. Conduct additional fish sampling in Moose River. Survey methods and level of effort are to be designed in consultation with Fisheries and Oceans Canada.	The information contained within the EARD (AMNS, Stantec 2021) and March Addendum Report (AMNS, Stantec 2022) is sufficient to assess effects on fish in Moose River, as fish species present and their habitat preferences are well known. Fish sampling was conducted in Moose River, Square Lake, and Watercourse #3 in 2021 to support the EA. The results were documented in Appendix I of the March Addendum Report (AMNS, Stantec 2022). In addition, two habitat surveys were conducted in Moose River in 2020 to document the types of fish habitats present. The results of these programs were summarized in the EARD with full reports attached as SD-15 and SD-16. The effects assessment, including proposed mitigation and prediction of residual effects, assumed the presence of fish and fish habitat, therefore	Attachment 14: Moose River Fish Surveys

No.	Additional Information Request	Response	Attachments
		additional fish sampling would have no bearing on the assessment of environmental effects. In response to this Information Request, new work was undertaken and is fully reported in Attachment 14. The study design was submitted to DFO (September 1, 2022) documenting the proposed survey methods and level of effort. DFO provided feedback on the study design on September 9, 2022, and email responses and a memo from AMNS were submitted back to DFO on September 12, 2022. Additional electrofishing fish surveys, including collection of eDNA samples, were conducted at six sites in Moose River in September 2022. During the 2022 electrofishing and minnow trap surveys, ten species of fish were confirmed to be present in Moose River. Similar species were captured in June and September, as were those caught by electrofishing and using minnow traps. Two Species of Conservation Concern were captured: American eel and Atlantic salmon. American eel is listed as threatened under COSEWIC. Sea-run Atlantic salmon are part of the Nova Scotia Southern Upland population, listed as Endangered under COSEWIC. Neither American eel nor Atlantic salmon have prohibitions under the *Species at Risk Act.* Because the effects assessment, including proposed mitigation and prediction of residual effects assumed the presence of fish and fish habitat, there is no change to assessment of residual effects presented in the EARD. AMNS, Stantec. 2021. Touquoy Gold Project Modifications – Environmental Assessment Registration Document. Available at: https://novascotia.ca/nse/ea/ AMNS, Stantec. 2022. Addendum to the Touquoy Gold Project Modifications – Environmental Assessment Registration. Available at: https://novascotia.ca/nse/ea/	

Attachment 1

Disposition of Third Party Review Comments, Table 1

The following table provides a disposition of the comments included in, “Table 1 Detailed Review Comments and Recommendations Regarding Appendix D.1 and D.2” from the Wood (2022) Water Modelling Third-party Review of the Touquoy Gold Project Site Modifications -Environmental Assessment Registration. Existing documentation that is referenced throughout this table includes:

- AMNS, Stantec. 2021. Touquoy Gold Project Modifications – Environmental Assessment Registration Document (EARD). Available at: https://novascotia.ca/nse/ea/
- AMNS, Stantec. 2022. Addendum to the Touquoy Gold Project Modifications – Environmental Assessment Registration. Available at: https://novascotia.ca/nse/ea/, referred to as the March Additional Information Addendum.
- Wood. 2022. Memorandum. Water Modelling Third-party Review of the Touquoy Gold Project Site Modifications – Environmental Assessment Registration. Available as Appendix C.1 to the Addendum to the Touquoy Gold Project Modifications – Environmental Assessment Registration at: https://novascotia.ca/nse/ea/

Disposition of Third Party Review Comments, Table 1 Detailed Review Comments and Recommendations Regarding Appendix D.1 and D.2

ID	Summary of Comments and Recommendations with Respect to the Groundwater Model	Atlantic Mining Response
TABLE A: D1.app_gw_model_pit.pdf		
1	General Comments Sections 1 and 3: The sections describing the project site and conceptual hydrogeological model are described only in limited detail. For example, typically maps are provided showing inferred groundwater equipotential lines and flow directions based on baseline data, potential groundwater recharge and discharge locations, the distribution of data used in generating overburden thickness maps etc. There is also limited discussion of groundwater and surface water interactions.	Noted. The reviewer has not posed a specific question. Many of the aspects of this statement are addressed in subsequent questions and associated responses included below. The conceptual hydrogeological model was developed over time (2015 – present) and the reporting developed along with it. The data presented in the 2017 Surface Water and Groundwater Annual Report (Stantec, 2018) represents the complete set of baseline data that were used to develop the groundwater flow model. This included maps of groundwater equipotential lines and flow directions based on baseline data. Stantec Consulting Ltd. 2019. 2018 Annual Report - Surface Water and Groundwater Monitoring. Prepared for Atlantic Mining Nova Scotia Corp. Dated April 30, 2019.
2	Section 2.2, - Climate pg 2.3 (12): Table 2.1 – Lake Evaporation is presented as mm/day – should be mm/yr	This error was identified and corrected in the *Touquoy Open Pit Tailings Disposal Groundwater Model Update*, dated March 2022 (the Updated Modeling Report) and included as Appendix B.3 of the March Additional Information Addendum.

ID	Summary of Comments and Recommendations with Respect to the Groundwater Model	Atlantic Mining Response
3	Section 3.3.1, - Overburden Hydrostratigraphic Units pg 3.1 (19): Slug test values should be tabulated and provided.	Slug test data was completed in the overburden wells in June 2018 by GHD. The results from the shallow (A) wells are included as **Attachment A.**
4	Section 4.2, - Distribution of Hydrogeological Parameters pg 4.4 (25): There are no figures provided to show how the material properties (K, recharge, etc.) are distributed within the numerical model. Figures should be provided showing the distributions of hydraulic properties as they have been implemented within the numerical model.	The updated modeling report, provide as Appendix B.3 of the March Additional Information Addendum contains the following figures: - Figure 2.2 through Figure 2.11 (pages 7 through 16) show the distribution of the hydraulic conductivity in each of the 10 layers of the calibrated model. No changes were made to the input values for recharge and evapotranspiration. Per Section 4.3.2 of Appendix D.1 of the EARD, a uniform recharge and a unform evapotranspiration rate of 323 mm/year (yr) and 53 mm/yr, respectively, were applied across the uppermost active layer of the model domain.
5	Section 4.2, - Distribution of Hydrogeological Parameters pg 4.4 (25): It would be beneficial to include Figures showing the locations and inferred values from hydraulic testing. A histogram of hydraulic test results would also be useful in demonstrating that using the geometric mean value for input hydraulic conductivity is appropriate.	Figure 6-3 in the Factual Data Report (Appendix B.1 of the March Additional Information Addendum) provides the requested histogram showing the distribution of hydraulic conductivity with depth. This figure has been included as **Attachment B.** The additional packer testing completed in late 2021 was within ranges of historical hydraulic conductivity testing. Table 2.4 in the Updated Groundwater Modeling Report, provided as Appendix B.3 of the March Additional Information Addendum, provides the hydraulic conductivity values assigned to each model layer following calibration and sensitivity analysis.
6	Section 4.3.1, - Model Boundary pg 4.4 (25): There should be figures included showing the distribution of data points used in making the bedrock surface. Additionally, contour maps of bedrock elevation and overburden thickness should be provided. These may be of particular importance when considering groundwater movement at the scale of the WRSA i.e., demonstrating confidence in the distribution of hydraulic properties of the shallow soils that underlay the WRSA.	The data points used to generate the bedrock surface were based on the available borehole information collected through various site investigation programs. Figures illustrating the distribution of points, the bedrock surface and the overburden thickness are provided as **Attachment C**.

ID	Summary of Comments and Recommendations with Respect to the Groundwater Model	Atlantic Mining Response
7	Section 4.3.2, - Recharge and Evapotranspiration pg 4.4 (25): Was available surface flow gauging (i.e., estimated baseflow values) used to help in establishing recharge rates? The bulk of the model domain (Figure 2.3) indicates that bedrock is the predominant surficial material, would it be expected to have the same recharge and evapotranspiration rates as the till soils located in the southern portion of the model domain. No description is provided about how the initial transpiration parameters were selected or how these were adjusted during the model calibration process.	Surface water flow data were not used independently of the groundwater flow model to establish recharge rates. As stated in Section 4.3.2 of Appendix D.1 of the EARD, recharge rates were assigned based on the hydrostratigraphic units exposed at the top of the model domain and considering the surficial geology mapping for the area. Recharge rates were adjusted for the three units during calibration; however, at the end of calibration the recharge was found to be relatively uniform across the site, so a uniform recharge rate was used in lieu of varying recharge based on hydrostratigraphic unit. Recharge rates were specified for average annual and average summer conditions. No changes were made to recharge rates in the Updated Modelling Report (Appendix B.3 of March Additional Information Addendum). Evapotranspiration (ET) was also assigned to the model domain, using a uniform rate representing average annual and average summer conditions. An extinction depth of 0.5 m was specified for the ET rate. No changes were made to the ET rates in the Updated Modelling Report. As discussed in Section 4.3.2. of Appendix D.1 of the EARD, the recharge rates were originally input considering the various hydrostratigraphic units at surface (till, silty drumlin and bedrock). Following model calibration, the recharge was determined to be fairly uniform across the site and therefore a uniform recharge rate was applied.
8	Section 4.3.3, - Lakes pg 4.4-4.5 (25-27): Individual lakes that had bathymetric data available should be listed. For other lakes assumptions used regarding lake depth should be stated. Since the conductance term is related to the conductivity/thickness of the lakebed sediments the final selected values should be discussed - are they plausible given what is known, or can be reasonably assumed, about the properties and thickness of the lakebed sediments. For the GHB cells used to represent lakes, was a single set of conductance terms used for both summer and average annual condition model calibrations?	Bathymetric data for lakes, where available, were used in developing the groundwater flow model. In cases where the bathymetric data were not available (i.e., in areas of the model that were remote from the Touquoy mine), the lakes were assigned a General Head Boundary (GHB) in the overburden unit. Bathymetric data was available for Square Lake and Scraggy Lake. Conductance was varied as a calibration parameter in the mode used for the EARD (Appendix D.1). GHB conductance was not varied as part of the calibration process during the most recent model runs (Presented in Appendix B.3 of the March Additional Information Addendum).

ID	Summary of Comments and Recommendations with Respect to the Groundwater Model	Atlantic Mining Response
9	Section 4.3.4, - Watercourses pg 4.6 (27): Similar comment as with the GHB's used to represent lakes, i.e., since the conductance term is related to the conductivity/thickness of the riverbed sediments the final values should be discussed - are they plausible given what is known, or can be reasonably assumed, about the properties of the riverbed sediments. For the river cells used to represent watercourses, was a single set of conductance terms used for both summer and average annual condition model calibrations?	The GHB and drain conductance were used as calibration parameters. There was a very limited data set available for the thickness and hydraulic conductivity of the lake sediments, therefore, the same conductance was applied to both the average annual and summer flow scenarios.
10	Section 4.3.5, - Touquoy Open Pit pg 4.6 (27): As the final conductance term applied to the drain cells representing the potential seepage faces of the open pit are based on the thickness and hydraulic properties of the blast affected bedrock they should be discussed with respect to those terms. Initial input and final calibrated conductance terms should be provided. Was a single set of conductance terms used to estimate the pit inflow rates for both summer and average annual condition model calibrations?	The GHB and drain conductance were used as calibration parameters. The conductance of the pit walls was estimated by using the hydraulic conductivity of the host material and were adjusted during calibration. A single set of conductance terms was used to estimate the summer and average annual conditions, as this parameter would be unaffected by the time of year.
11	Section 4.4.1, - Calibration Methodology pg 4.7 (28): Conductance of drain cells representing dewatered open pit faces were also varied as part of the model calibration, this should be included in the list of calibration parameters.	Noted. Table 2.6 of the Updated Modeling Report provided as Appendix B.3 of the March Additional Information Addendum included conductance data missing from the original Appendix D.1 to the EARD. These values were not varied during recalibration of the updated model.

ID	Summary of Comments and Recommendations with Respect to the Groundwater Model	Atlantic Mining Response
12	Section 4.4.2, - Calibration to Water Levels pg 4.7 (28): When assessing impacts to groundwater levels/flows resulting from mine operations groundwater flow models are often initially calibrated to the premining conditions. Once calibrated the model can then be verified against the operational data. Is there a reason that was not done here?	The original model (Appendix D.1 of the EARD) was calibrated to pre-mining conditions. The calibration for the current model (Appendix B.3 of the March Additional Information Addendum) was updated to represent the current baseline conditions at the request of Nova Scotia Environment and Climate Change / Natural Resources Canada (NSECC / NRCan), because of changes in summer baseflow conditions. The dataset available for this comparison was collected during 2019, a summer with much lower observed baseflow. Therefore, this condition was the one simulated. The groundwater model was calibrated to the dataset at the time with good agreement. The updated model (Appendix B.3 of the March Additional Information Addendum) was calibrated by varying the hydraulic parameters, with no changes made to the boundary condition conductance.
13	Section 4.4.2, - Calibration to Water Levels pg 4.8 (29): Figure 4.5 – wells 6749 and 6719 are shown on figure but not included in the data tables, if they have not been used in model calibration they should be removed from the figure.	This is an opinion on data presentation and is not pertinent to the performance of the model. For clarification, neither of the water wells were used in the model calibration.
14	Section 4.4.2, - Calibration to Water Levels pg 4.14-4.15 (35-36): Although the overall model calibration statistics appear reasonable, a residual distribution map should be included to see, even if only qualitatively, if there are any areas where there could be bias in the model predictions. From Figure 4.6 it looks as if model calibration may not be as good in those areas with observed groundwater elevations above about 125m. From Figure 3.7-3.8 of Stantec (2021) it looks as if areas of >125m gw elevation are located around the WRSA and Plant site which are areas of primary importance in Appendix D2 – Waste Rock Storage Area Groundwater Modelling Update.	A residual distribution map has been included as **Attachment D.** As shown on the figure, residuals do not show a bias high or low around any particular area within the model domain. A balance of positive and negative residuals are observed around all project components

ID	Summary of Comments and Recommendations with Respect to the Groundwater Model	Atlantic Mining Response
15	Section 4.4.3, - Calibration to Groundwater Flow Rates pg 4.15 (36): Determination of baseflow would benefit from more discussion of surface water flows in Section 2 and a plot of the regression fitting. Not enough information is presented to make a determination on the suitability of the baseflow estimation.	Noted. his is an opinion on data presentation with no question. The Moose River streamflow data collected between 2017 and 2020 and the corresponding baseflow estimates are available in the corresponding Annual Reports - Surface Water and Groundwater Monitoring for 2017, 2018, 2019 and 2020. Stantec Consulting Ltd. 2018-2021. (2017-2020) Annual Report - Surface Water and Groundwater Monitoring. Prepared for Atlantic Mining Nova Scotia Corp.
16	Section 4.4.3, - Calibration to Groundwater Flow Rates pg 4.15 (36): Have the pit inflow numbers been processed to account for process water pumped into the open pit for operational purposes? Has precipitation been removed from the pit inflow rates?	As stated in Section 4.4.3, the pit inflow rates were corrected for precipitation. Operational process flows are managed at the TMF, not the open pit. Therefore, no corrections to pit inflow rates were required.
17	Section 4.4.4, - Calibrated Model Parameters pg 4.16 (37): Differences in hydraulic conductivities between weathered and competent members of the same bedrock type vary from 2x to more than 50x. Does the available data support this spatial variability? Section 3.3.2 states that there appears to be no significant differences in hydraulic properties between the greywacke and argillite bedrock types at the Touquoy site, however the weathered units of these rock types vary by almost 20x between the Tangier and Moose River greywacke and Moose River argillite. **What is the rationale behind the difference?** Also, the ratio between the weathered/competent bedrock hydraulic conductivity of these two units varies between 49x for the Tangier and Moose River greywacke vs 2x for the Moose River argillite. **Is this supported by the available data or is it a result of the PEST calibration procedure?** A similar comment can be made regarding the vertical anisotropy values for bedrock units presented in Table 4.6.	The drilling program completed in late 2021 in support of In-pit tailings disposal advanced an additional 21 boreholes around the extent of the open pit. The wells were logged and packer tests were completed at specified intervals to test the rock as well as the conductivity with the faults. This updated information was incorporated into the original model providing a more accurate depiction of the conductivity conditions in the subsurface. The work was reported in the March 14, 2022, Factual Data Report (Appendix B.1) and the Updated Modeling Report (Appendix B.3) in the March 2022 March Additional Information Addendum. This data along with previously collected hydraulic conductivity data has also been complied into a response to IR 1.b in this package (Refer to IR 1.b and Attachment 2: Hydraulic Connectivity Testing Additional Interpretation). Two figures related to this comment have been provided as Attachments to this IR response. **Attachment B**, previously discussed in line #5 above, shows the hydraulic conductivity results from all testing completed around the pit. In general, the conductivity of the competent bedrock ranges between 10^{-9} m/s and 10^{-7} m/s based on packer test results. The calibrated conductivity values used in the original model ranged between 10^{-8} m/s and 10^{-9} m/s which is in good agreement with the conductivity data. Hydraulic conductivity values at depths less than 20 m is typically on the order of 10^{-5}

ID	Summary of Comments and Recommendations with Respect to the Groundwater Model	Atlantic Mining Response
		m/s to 10^{-8} m/s with a wider range in conductivity due to the inherent variability likely resulting from the interaction of weathering processes with the uppermost surface of the bedrock. Based on field data there is typically a one (1) to two plus (2+) order of magnitude difference between the conductivity in the upper weathered bedrock and the lower competent bedrock. This is likely the result of the combination of variability in the bedrock mineralogical content and degree of structural deformation and the natural weathering processes. The data does support spatial variability and the conductivity values that have been assigned to the model layers and their associated bedrock types aligns well with the ranges seen in the data from Site. Hydraulic conductivity was updated in the Updated modeling report, provided as Appendix B.3 to the March Additional Information Addendum, based on the additional information obtained from the 2021 drilling and packer testing program.
18	Section 4.4.4, - Calibration to Groundwater Flow Rates pg 4.16 (37): Since conductance terms representing streambed sediments, lakebed sediments and blast affected bedrock were used in model calibration the initial input and final calibrated values should be discussed here. **Do the calibrated values represent realistic properties for these units?**	Conductance is a parameter that represents the effects of both hydraulic conductivity and thickness. The inverse relationship between hydraulic conductivity and thickness in the conductance formula makes it difficult to back-calculate the values for the individual components. A sensitivity analysis conducted during the EARD model calibration process revealed that the calibrated flow values were relatively insensitive to variability in streambed and pit-wall conductance. This means the model is equally well calibrated over a wide range of conductance values and by extension a wide range in the combination of hydraulic conductivity and thickness components. Conductance values were not varied as part of the calibration process for the Updated Model, presented in Appendix B.3 of the March Additional Information Addendum.
19	Section 4.4.5, - Calibration Uncertainty pg 4.16 (37): The calibration measure to which the model is sensitive is not defined here. Is this related to the RMS error?, M.A.E?, Pit inflow estimate...etc?.	As described in Section 4.4.5, the sensitivity presented in Figure 4.5 was determined using PEST. It is not a single calibration measure, and it is not intended to reflect the degree to which the model is calibrated, but rather the relative sensitivity of varying different parameters to the calibration. Detailed information on the PEST-calculated sensitivity can be found in Doherty (2018). Doherty, J. 2018. PEST: Model-Independent Parameter Estimation, User Manual (7th Edition). Watermark Numerical Consulting.

ID	Summary of Comments and Recommendations with Respect to the Groundwater Model	Atlantic Mining Response
20	Section 4.4.6, - Sensitivity of Streambed and Pit Wall Conductance pg 4.18 (39): Since the conductance terms influence water level predictions as well as inflow predictions is there a reason they were not included in the PEST calibration routine?	Section 4.4 describes the model calibration and the calibration methodology. The process of model calibration involves the adjustment of model parameter values to match field-measured values within a pre-established range of error. A hybrid calibration approach was used that combined automated parameter estimation, facilitated using the Parameter Estimation (PEST) code (Doherty 2018), together with professional judgement and interpretation of the calibration results. Riverbed and lakebed conductance was one of the five parameters adjusted during calibration of the model: horizontal hydraulic conductivity, vertical hydraulic conductivity, recharge evapotranspiration, and riverbed and lakebed conductance. Doherty, J. 2018. PEST: Model-Independent Parameter Estimation, User Manual (7th Edition). Watermark Numerical Consulting.
21	Section 4.4.6, - Sensitivity of Streambed and Pit Wall Conductance pg 4.18 (39): Were the conductance terms of the GHB/river cells and pit seepage faces varied together? If so, what is the basis for varying these together as they are physically separate and unrelated.	The sensitivity of the pit inflow rates and stream baseflow rates to the conductance terms were varied independently. The sensitivity of varying the conductance of cells in Moose River are shown in the Moose River base flow rates in Figure 4.8 of Appendix D.1 of the EARD.
22	Section 5.1.2, - Results pg 5.1 (41): Figure 5.1 should also show the inferred groundwater contours from the premine baseline data and comment on the model match. As it is, no comments can be made regarding the model match to the premining heads/hydraulic gradients.	Commentary on the model match is provided in the text of both the EARD submission (Appendix D1) report and the Updated Modelling Report submitted as Appendix B.3 of the March Additional Information Addendum. Both documents state that there is good representation of the expected pre-development (of the open pit for tailings storage) groundwater flow conditions with groundwater in the area of the open pit flowing from a high east of the current pit towards Moose River.
	How do the simulated premining baseflows compare to the observed premine baseline baseflow data? Model computed drawdown for the current 2019 conditions should be compared to the actual drawdown that has been inferred from the baseline (premine) site data.	The model was intended to predict the impact of in pit tailing storage following mine decommissioning. Baseline for the model was taken to be the time when the pit was at its fullest extent of excavation as this represents the pre-filling starting point. At the time of modeling this was the August 2019 final pit shell. A comparison of modeled versus measured baseflows exists in both the original (presented in Appendix D.1 of the EARD) and the Updated Modeling Report results (presented in Appendix B.3 of the March Additional Information Addendum).

ID	Summary of Comments and Recommendations with Respect to the Groundwater Model	Atlantic Mining Response
23	Section 5.2.1, - Model Setup pg 5.3 (43): A figure showing model cross section through the simulated pit illustrating the model changes would be useful here.	Noted. This is a matter of preference as stated; no response required.
24	Section 5.2.2, - Results pg 5.3 (43): Table 5.1 should state that the presented groundwater flows are model simulation results.	This has been addressed through Table 3.1 in the Updated Modeling Report (Appendix B.3 of the March Additional Information Addendum) which compares the predicted baseline average annual flows between the Existing (2019) Conditions to the Original Model and the Updated Model.
25	Section 5.2.2, - Results pg 5.4 (44): Figure 5.2 - the 10m drawdown contour appears to fall within a portion of the dewatered pit that has been excavated deeper than 10m. The inferred drawdown from site monitoring data should be shown on this figure. It would also be beneficial to show a model cross section through the open pit illustrating the drawdown.	Noted. This is a matter of preference as stated; no response required.
26	Section 5.3.1, - Model Setup pg 5.5 (45): The description of the modifications made to the model to simulate the partially flooded conditions is not clear, from the description is not clear if drain cells below the stage elevation, i.e., in the flooded portion of the pit, are removed. Have the drain cells in the flooded portions of the open pit where tailings have been placed been removed from the model for each of the stages?	During development of the model used in the EARD, two modifications were conducted to assess the partially flooded conditions. First, the stage of drain cells were adjusted so that drain cells existed only at or above the flooded stage. The boundary condition (drain) was removed for the flooded cells. Second, the hydraulic conductivity of the cells infilled with tailings was adjusted to represent the tailings.
	What type of boundary has been applied to the surface of the tailings placed in the open pit to simulate the pit lake?	Upon the full flooding a General Head Boundary (GHB) condition (and constant concentration) was used to model the surface of the tailings and the surface of the pit lake. The conductances of the GHBs were assigned based on the hydraulic conductivity of the tailings.
27	Section 5.3.2, - Results pg 5.8 (48): Figure 5.5 - The footprint of the end pit lake should be shown on the figure.	Noted. This is a matter of preference as stated; no response required.

ID	Summary of Comments and Recommendations with Respect to the Groundwater Model	Atlantic Mining Response
28	Section 5.4, - Model Setup pg 5.9 (49): References should be provided for literature values used in model set up.	The ranges of porosity values used in the model setup were estimated based on Freeze and Cherry (1979). Freeze, R.A. & J.A.Cherry, 1979. Groundwater. Prentice Hall Inc. Englewood Cliffs, VA.
29	Section 5.4, - Model Setup pg 5.9 (49): A description of the transport model assumption and limitations should be included, i.e., pointing out that the transport model is not calibrated, only advection/dispersion (no sorption/reactions etc) is simulated.	Noted. This is a matter of preference as stated no response required. The model setup section describes the details of how the model is set up, including the use of a conservative species which would not undergo sorption/reactions along the flow path.
30	Section 5.4, - Model Setup pg 5.9 (49): Transport specific model boundaries, i.e. constant concentration cells applied within tailings, recharge concentration applied to top of tailings, are not described. More description of the implementation of the transport model should be included here. Transport model time step-size should also be discussed.	Additional information regarding the transport model boundaries is included in the updated modeling report (Appendix B.3 to the March Additional Information Addendum). The updated transport model uses the same source boundary cells and concentrations as the original EARD model. The simulation considers the transport of a conservative solute from the water in the open pit with a constant source concentration of 1 mg/L through the groundwater to the receiving environment over time. Figure 3.5 of the Updated Modeling Report shows the cells defined as constant-concentration boundaries for the top layer of the tailings in the open pit. Cells representing tailings in the deeper layers of the open pit were also defined as constant-concentration boundaries with the same source strength.
31	Section 5.4.2, - Model Results pg 5.10 (50): Are relative concentration plots shown on Figures 5.6 to 5.8 shown as maximum concentration with depth?	Most of the flow and transport is in the relatively higher conductivity overburden. Consequently, the contours represent maximum concentration with depth, although not by design.
32	Section 5.5, - Prediction Confidence pg 5.21 (61): Are relative concentration plots shown on Figures 5.6 to 5.8 shown as maximum concentration with depth?	Refer to Item No. 31.

ID	Summary of Comments and Recommendations with Respect to the Groundwater Model	Atlantic Mining Response
TABLE B: D1.app_gw_model_wrsa.pdf		
1	Methodology pg 2 The model on which the WRSA model update is based on was developed as a regional scale numerical model designed to predict the impacts to groundwater from the dewatering of the Touquoy open pit mine. It was calibrated to water levels across the entire site, without particular attention to any one area, such as the WRSA. Some discussion of this should be made here along with discussion in potential bias in model results when looking at the scale of the WRSA and if changes in the model calibration for simulating seepage from the WRSA is warranted.	Information regarding the model set up specific to the WRSA and associated seepage ditches is included in the report. No further work required.
2	Methodology pg 2 As the stage of the drains is set at 1m below the local ground surface elevation rather than based on an actual engineered ditch invert elevation some mention of the potential errors and how they may affect the accuracy of the model predictions should be made as it illustrates the level of detail incorporated into the modelling and the level of confidence in the model results that can be expected.	The constructed ditch elevation and the assumed ditch elevation in the model based on topography were very similar because the actual ditch profile was based on topography to facilitate gravity drainage. This level of detail was deemed sufficient for the modeling described in Appendix D.2 because of the uncertainty in the WRSA recharge rate, and the conservatism built into the assumptions of steady-state groundwater flow and use of particle tracking to assess potential mass loading rates to surface water receptors.
3	Methodology pg 2 Estimated lake evaporation value of 515 mm/yr has been used in calculating the net precipitation on the WRSA. Given that the waste rock is coarse material and not vegetated it may be expected that evaporative loses will be lower than the 515 mm/yr. This would result in a higher recharge to the WRSA. Additionally, no justification is provided for the assumed runoff coefficient of 30%. As specified recharge input to the footprint of the WRSA represents the seepage from the WRSA there should be more description of the assumptions used in generating the recharge value.	As detailed on page 2 of Appendix D.2 of the EARD, the net annual precipitation was estimated to be 843 millimetres per year (mm/yr), resulting in estimated recharge through the WRSA as 591 mm/yr (for Scenarios 1 and 2). As indicated above, the recharge rate was developed from net annual precipitation and evaporation and runoff rates. Potential uncertainty in the determination of the recharge rate was addressed in the sensitivity analyses presented in the results section of the WRSA modelling report.

ID	Summary of Comments and Recommendations with Respect to the Groundwater Model	Atlantic Mining Response
4	Methodology pg 2 Should mention/reference what software code was used to calculate particle tracks.	MODPATH, the particle tracking companion software to MODFLOW was used to calculate the particle tracks (Pollock, 2012). Pollock, D.W., 2012. User Guide for MODPATH Version 6 – A Particle-Tracking Model for MODFLOW. U.S. Geological Survey Techniques and Methods 6-A41. Reston Virginia.
5	Methodology pg 3 A plot of model computed and inferred hydraulic head values over the WRSA/TMF footprints and nearby surface water receptors should be included along discussion of the model match to the observed heads.	A figure showing the calibration residuals has been included as **Attachment D.** There is reasonable agreement between the computer and measured hydraulic head values around the WRSA and TMF.
6	Results, pg 7 Changes to the groundwater flow system due to the presence of the TMF will likely alter the groundwater flow system within the footprint of the TMF. While this will not change the amount of seepage discharging from the TMA it does have the potential to alter the flow paths and therefore final discharge locations of particle tracks and thus change the proportion of discharge reaching surface water body receptors (i.e., the distribution of discharges shown in Table 1 and 2 will change, but not the overall totals). The TMF should be included in model simulations.	Agreed, seepage from the TMF would likely affect the groundwater flow system and the resulting flow paths from the WRSA. The groundwater flow model was updated to include seepage from the TMF with the approved 2.5m raise. Resulting particle tracks under average annual conditions are presented in Figure 1 included in **Attachment E**. When compared, Figure 3 of Appendix D.2 of the EARD (also included in Attachment E) and the new figure have very similar particle tracks; these are provided in Attachment E. Groundwater particle flow outward from their point of origin within the WRSA to terminate at the adjacent watercourses (WC#4, WC#14, WC#5) and Scraggy Lake. No material changes in flow paths resulted from the inclusion of the TMF groundwater flow in the model.
7	Results, pg 7 Sensitivity analysis was carried out on the recharge rates only.	The sensitivity analysis focused on the variability of the recharge rates to present an understanding of the effects on the downstream environment. The recharge rate represented the least certain variable in the modeling conducted and has the greatest potential impacts of mass loading to the receiving environment.

ATTACHMENT A

Hydraulic Conductivity Data from Wells around the Open Pit provided as a response to Line 3 of Table 1. Hydraulic conductivity testing and analysis was completed by GHD (2016)

	Well	Date	Conductivity (m/s)	Lithology
Open Pit Mine Wells	OPM-5A	June 14, 2016	9.45×10^{-6}	Silty sand over fractured bedrock
	OPM-6A	June 14, 2016	3.78×10^{-6}	Silty sand over fractured bedrock
	OPM-7A	June 14, 2016	2.19×10^{-6}	Silty sand over fractured bedrock
Plant Site Wells	PLM-3A	June 9, 2016	3.47×10^{-7}	Silty sand
	PLM-4A	June 1, 2016	2.92×10^{-6}	Silty sand
	PLM-5A	May 16, 2016	3.14×10^{-6}	Silty sand over fractured bedrock
Waste Rock Storage Area Wells	WRW-1A	May 16, 2016	7.42×10^{-7}	Silty sand
	WRW-2A	May 10, 2016	3.61×10^{-7}	Silty sand
	WRW-3A	May 10, 2016	1.02×10^{-5}	Silty sand
	WRW-4A	May 12 2016	5.17×10^{-6}	Silty sand
	WRW-5A	May 16, 2016	3.68×10^{-6}	Silty sand over fractured bedrock
Tailings Management Facility Wells	TMW-1A	May 12, 2016	3.2×10^{-6}	Silty sand over fractured bedrock
	TMW-2A	May 12, 2016	7.48×10^{-7}	Fractured bedrock
	TMW-3A	May 11, 2016	284×10^{-6}	Silty sand over fractured bedrock
	TMW-4A	May 11, 2016	5.47×10^{-6}	Fractured bedrock
	TMW-5A	May 11 2016	2.76×10^{-6}	Silty sand over fractured bedrock
	TMW-6A	May 11 2016	8.36×10^{-7}	Silty sand over fractured bedrock
	TMW-7A	June 14 2016	2.35×10^{-6}	Cobbles & boulders over fractured bedrock
	TMW-8A	June 15 2016	4.11×1^{-6}	Fractured bedrock
	TMW-9A	June 14 2016	4.17×10^{-6}	Fractured bedrock
	TMW-10A	June 15, 2016	2.19×10^{-7}	Fractured bedrock
	TMW-11A	June 15, 2016	7.25×10^{-6}	Boulders & cobbles over fractured bedrock
	TMW-12A	June 13, 2016	2.72×10^{-6}	Silty sand
	TMW-13A	June 13, 2016	2.72×10^{-6}	Silty sand
	TMW-14A	June 12, 2016	1.61×10^{-6}	Silty sand
	TMW-15A	June 13, 2016	1×10^{-6}	Silty sand
	TMW-16A	June 13, 2016	3.1×10^{-6}	Silty sand

ATTACHMENT B

Histogram showing the variation of hydraulic conductivity with depth around the Open Pit, Touquoy Mine Site provided as part of the response to Lines 4 and 17 of Table 1

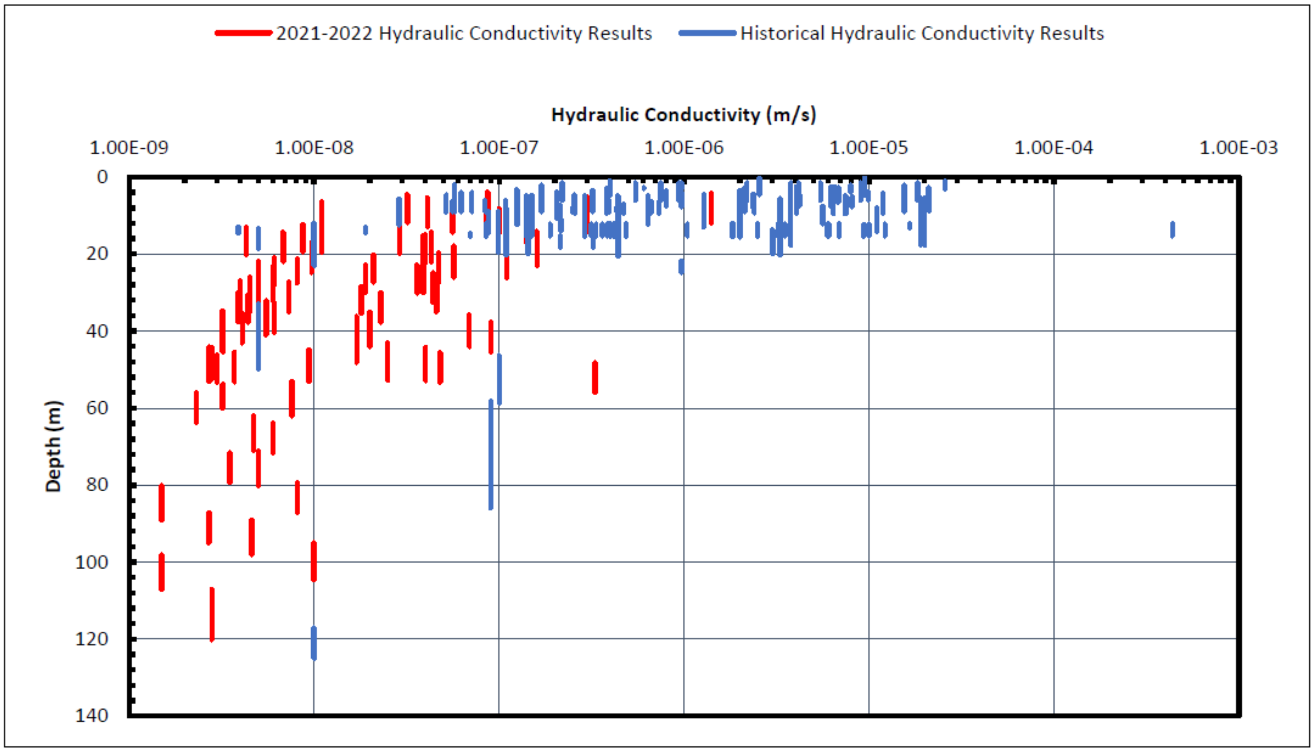
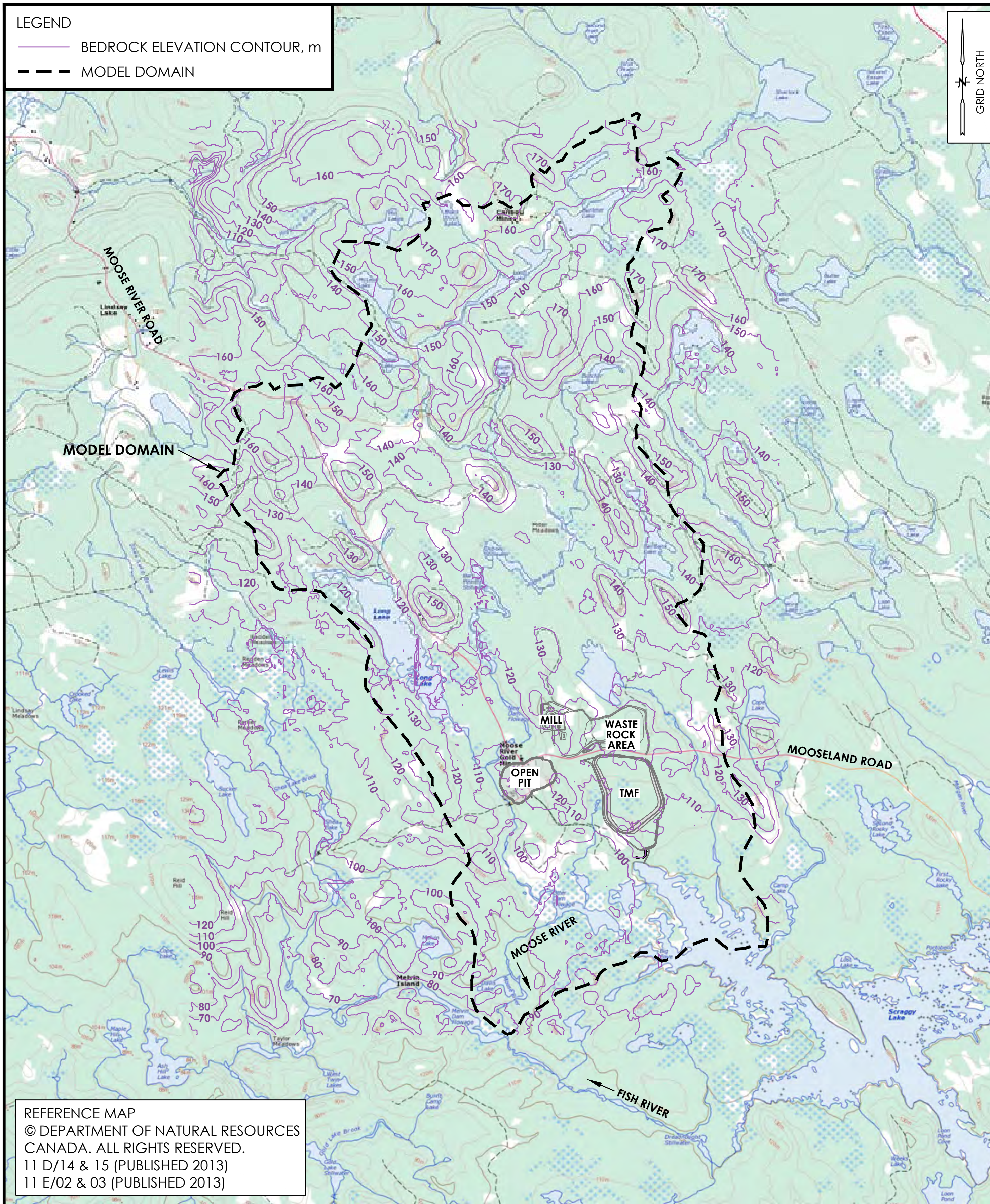


Figure 6-3 Compilation Bedrock Hydraulic Conductivity (Historical and 2021 Investigation)

ATTACHMENT C

Bedrock Elevation and Overburden Thickness Contours in response to Line 6 of Table A.



REFERENCE MAP

11 D/14 & 15 (PUBLISHED 2013)
11 E/02 & 03 (PUBLISHED 2013)

THIS DRAWING ILLUSTRATES SUPPORTING INFORMATION SPECIFIC TO AN ATLANTIC GOLD CORPORATION MEMO AND MUST NOT BE USED FOR OTHER PURPOSES.

BEDROCK ELEVATION CONTOURS GROUNDWATER MODELING REPORT TOUQUOY GOLD PROJECT HALIFAX COUNTY, NOVA SCOTIA	Job No.:	121619250	Fig. No.:	1
	Scale:	1 : 75 000		
	Date:	2022 11 03	Stantec	
	Dwn. By:	JL		
Client: ATLANTIC MINING NS INC.	App'd By:	MH		

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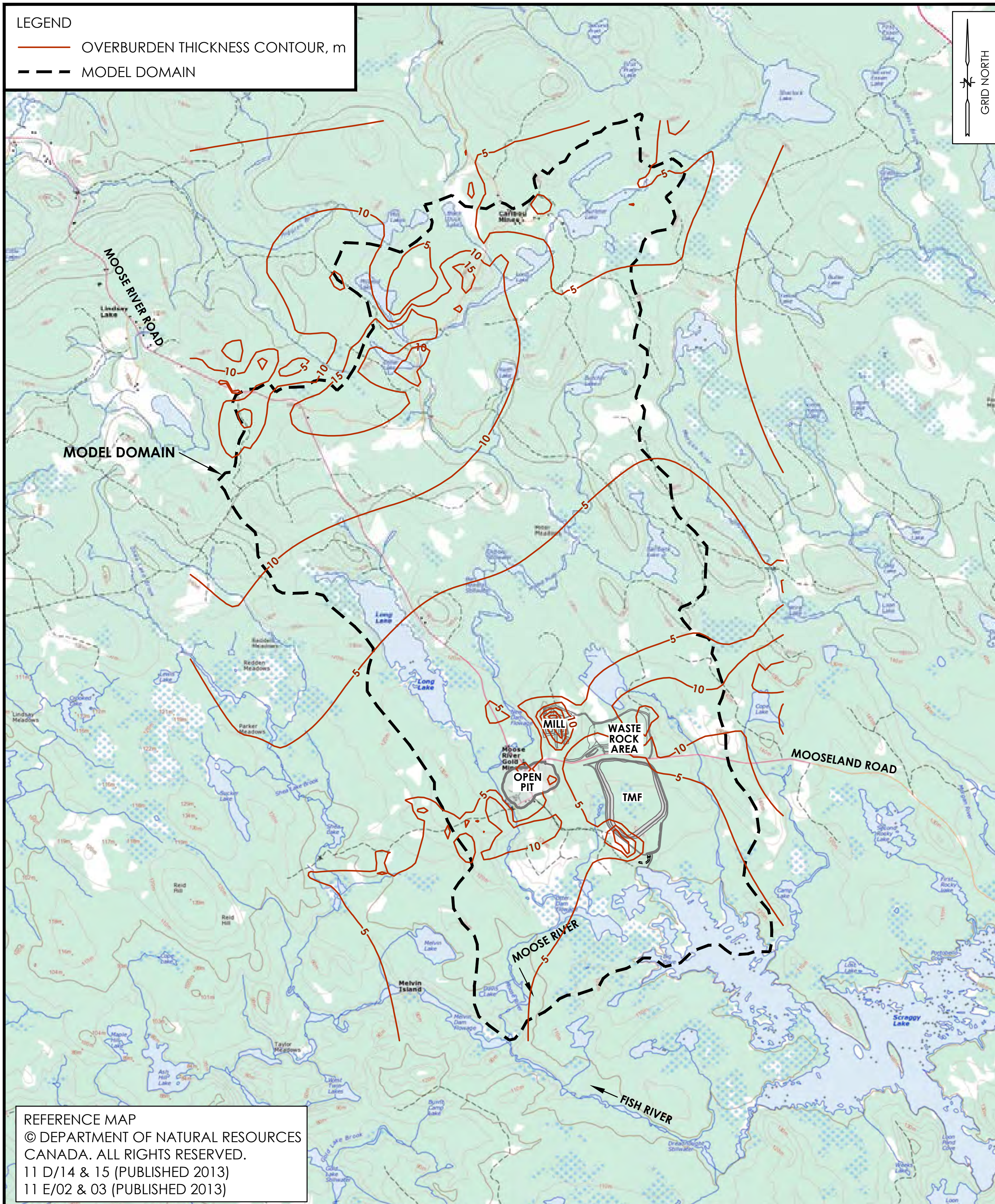

THIS DRAWING ILLUSTRATES SUPPORTING INFORMATION SPECIFIC TO AN ATLANTIC GOLD CORPORATION MEMO AND MUST NOT BE USED FOR OTHER PURPOSES.

OVERBURDEN THICKNESS CONTOURS
GROUNDWATER MODELING REPORT
TOUQUOY GOLD PROJECT
HALIFAX COUNTY, NOVA SCOTIA

Client:	ATLANTIC MINING NS INC.
Job No.:	121619250
Scale:	1 : 75 000
Date:	2022 11 03
Dwn. By:	JL
App'd By:	MH
Fig. No.:	2

Stantec

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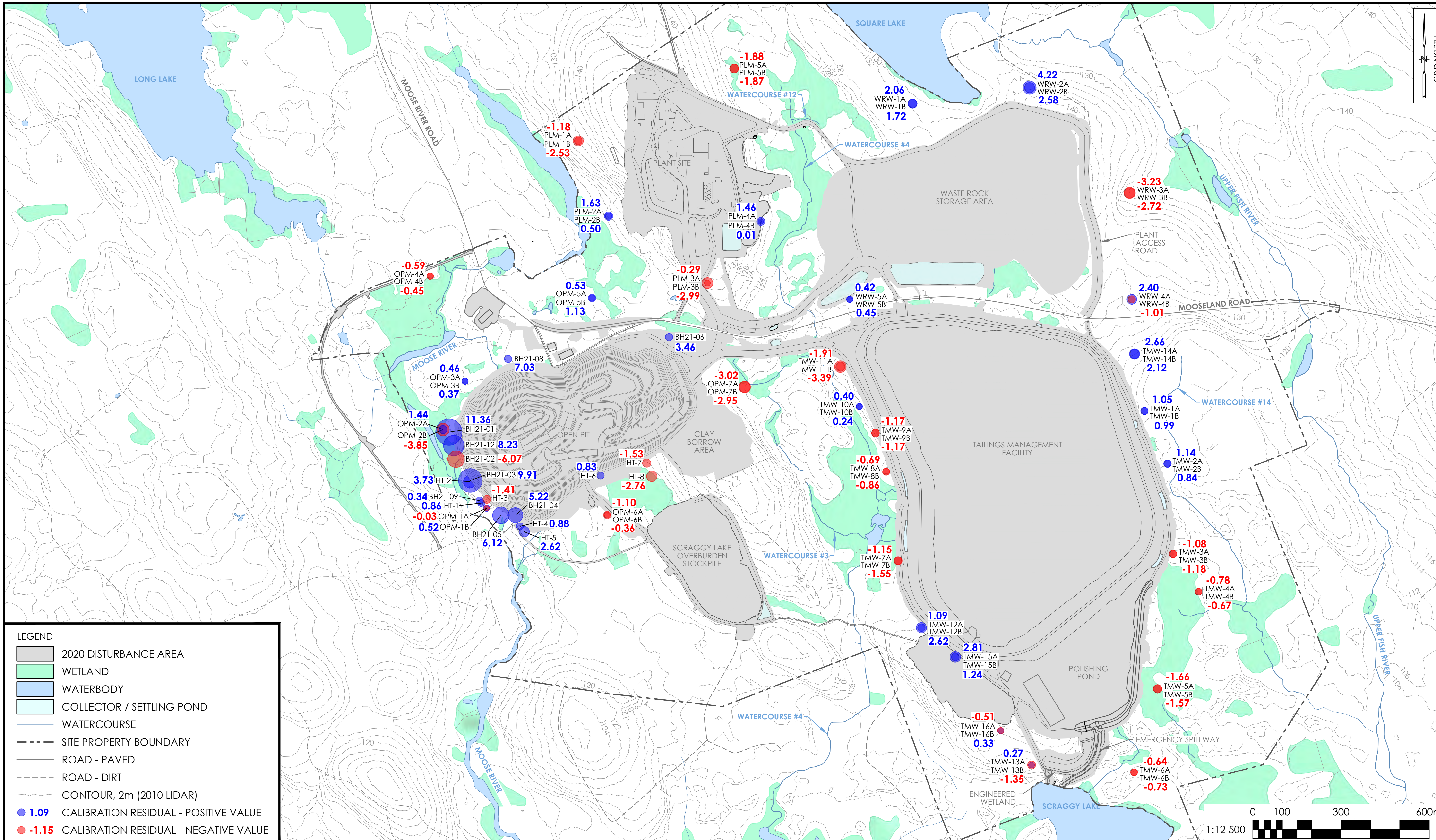
ATTACHMENT D

Residuals Distribution Map in response to Line 14 of Table A and Line 5 of Table 2



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THIS DRAWING ILLUSTRATES SUPPORTING INFORMATION SPECIFIC TO A STANTEC CONSULTING LTD. REPORT AND MUST NOT BE USED FOR OTHER PURPOSES.

Reference:
1. PROVINCIAL BASE DATA REPRODUCED AND DISTRIBUTED WITH THE PERMISSION OF SERVICE NOVA SCOTIA & MUNICIPAL RELATIONS (SNSMR, 2006) AS PER THE TERMS OF USE OUTLINED IN THE UNRESTRICTED DATA USE LICENSE AGREEMENT FOR GEOGRAPHIC DATA.
2. SITE DATA PROVIDED BY ATLANTIC MINING NS INC. AND McCALLUM ENVIRONMENTAL.

CALIBRATION RESIDUALS MAP

TOUQUOY GOLD PROJECT
HALIFAX COUNTY, NOVA SCOTIA

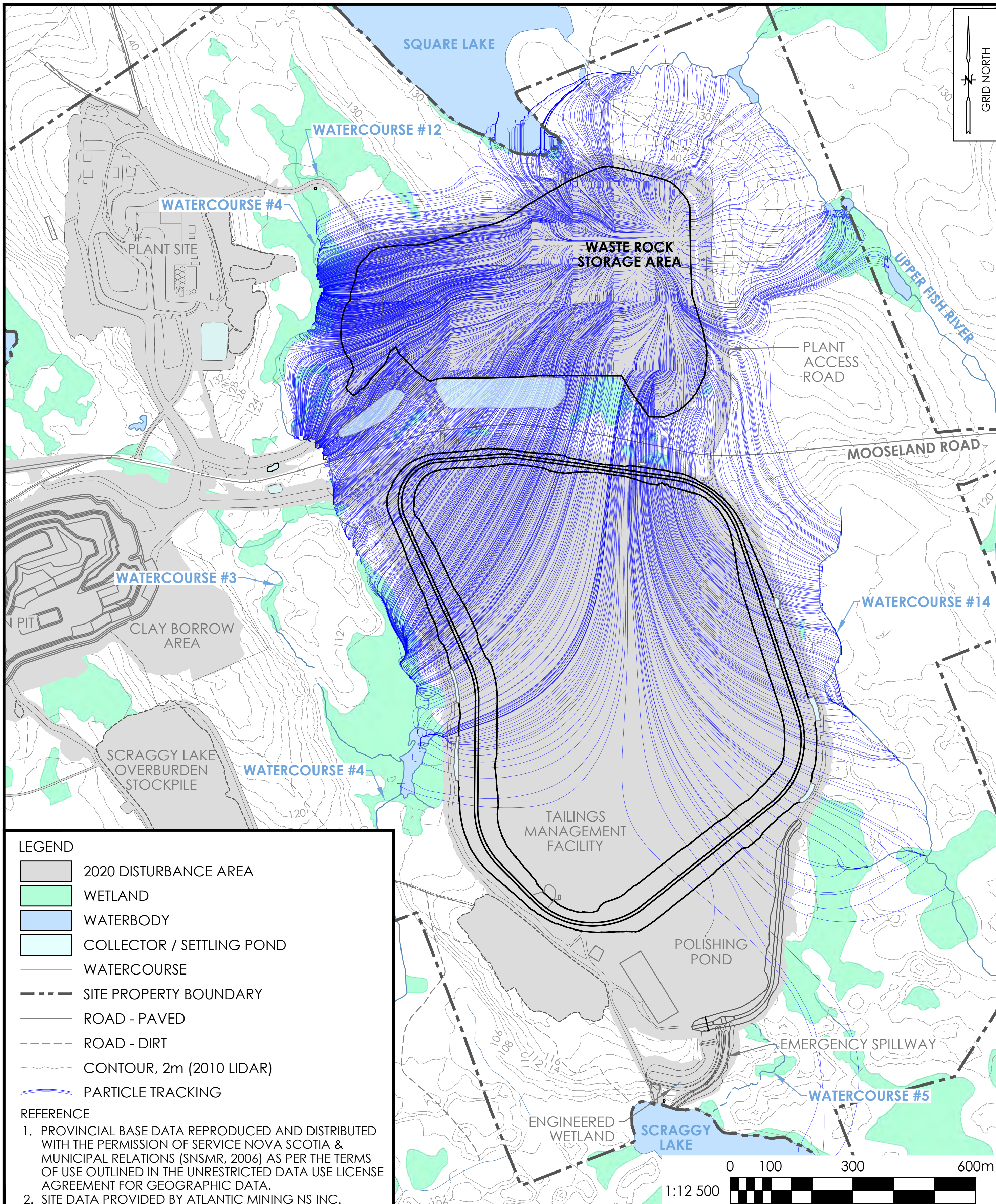
Client: ATLANTIC MINING NS INC.

Job No.:	121619250
Scale:	1 : 7500
Date:	14-OCT-2022
Dwn. By:	JL
App'd By:	RR
Fig. No.:	1

Stantec

ATTACHMENT E

Updated particle tracks for the Waste Rock Storage Area (WRSA) under average annual conditions.



REFERENCE
1. PROVINCIAL BASE DATA REPRODUCED AND DISTRIBUTED WITH THE PERMISSION OF SERVICE NOVA SCOTIA & MUNICIPAL RELATIONS (SNSMR, 2006) AS PER THE TERMS OF USE OUTLINED IN THE UNRESTRICTED DATA USE LICENSE AGREEMENT FOR GEOGRAPHIC DATA.
2. SITE DATA PROVIDED BY ATLANTIC MINING NS INC.

THIS DRAWING ILLUSTRATES SUPPORTING INFORMATION SPECIFIC TO AN ATLANTIC GOLD CORPORATION MEMO AND MUST NOT BE USED FOR OTHER PURPOSES.

WASTE ROCK STORAGE AREA PARTICLE TRACKING

TOUQUOY GOLD PROJECT
HALIFAX COUNTY, NOVA SCOTIA

Client:	ATLANTIC MINING NS INC.
Job No.:	121619250
Scale:	1 : 12,500
Date:	2022 10 21
Dwn. By:	JL
App'd By:	MH
Fig. No.:	1

Stantec

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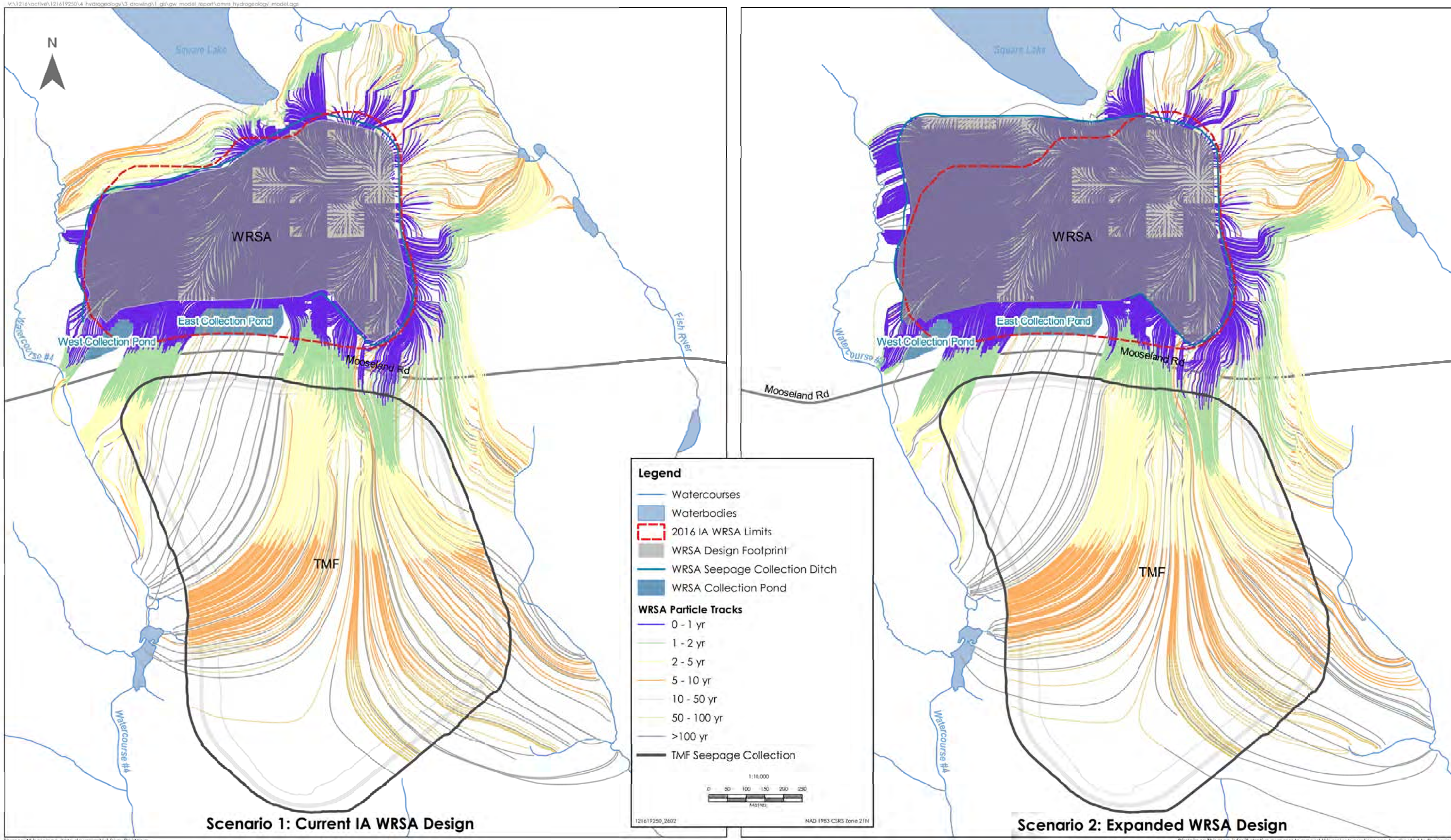


Sources: All basemap data downloaded from GeoNova.

Disclaimer: This map is for illustrative purposes to support this project; questions can be directed to the issuing agency.

Stantec

Comparison of Predicted Steady-State Particle Tracks Originating at WRSA

Figure 3

Attachment 2

Hydraulic Connectivity Testing Additional Interpretation

To:	Atlantic Mining Nova Scotia	From:	Titia Praamsma, Ph.D., P. Geo. Megan Hughesman, M.Sc., P.Geo.
Cc:	Mark Flinn, P.Eng. Paul Deering, P.Eng.		
File:	121619250.2600.2000	Date:	December 9, 2022

Reference: AMNS EA IR Request 1.b: Hydraulic Connectivity Testing

INTRODUCTION

Stantec Consulting Ltd. (Stantec) has been retained by Atlantic Mining Nova Scotia (AMNS) to prepare responses to the information requests (IR) received from Nova Scotia Environment and Climate Change (NSECC) in a letter dated May 12, 2022. This memo responds to the NSECC IR request #1.b:

> Complete hydraulic connectivity testing in all fracture/fault zones, identified underground mine workings, Ground Penetrating Radar anomalous areas and the overburden and upper weathered bedrock layers surrounding the pit.

This memo is structured to provide a holistic interpretation of the available hydrogeology data surrounding the open pit mine and discuss the requirement to completing additional hydraulic conductivity testing.

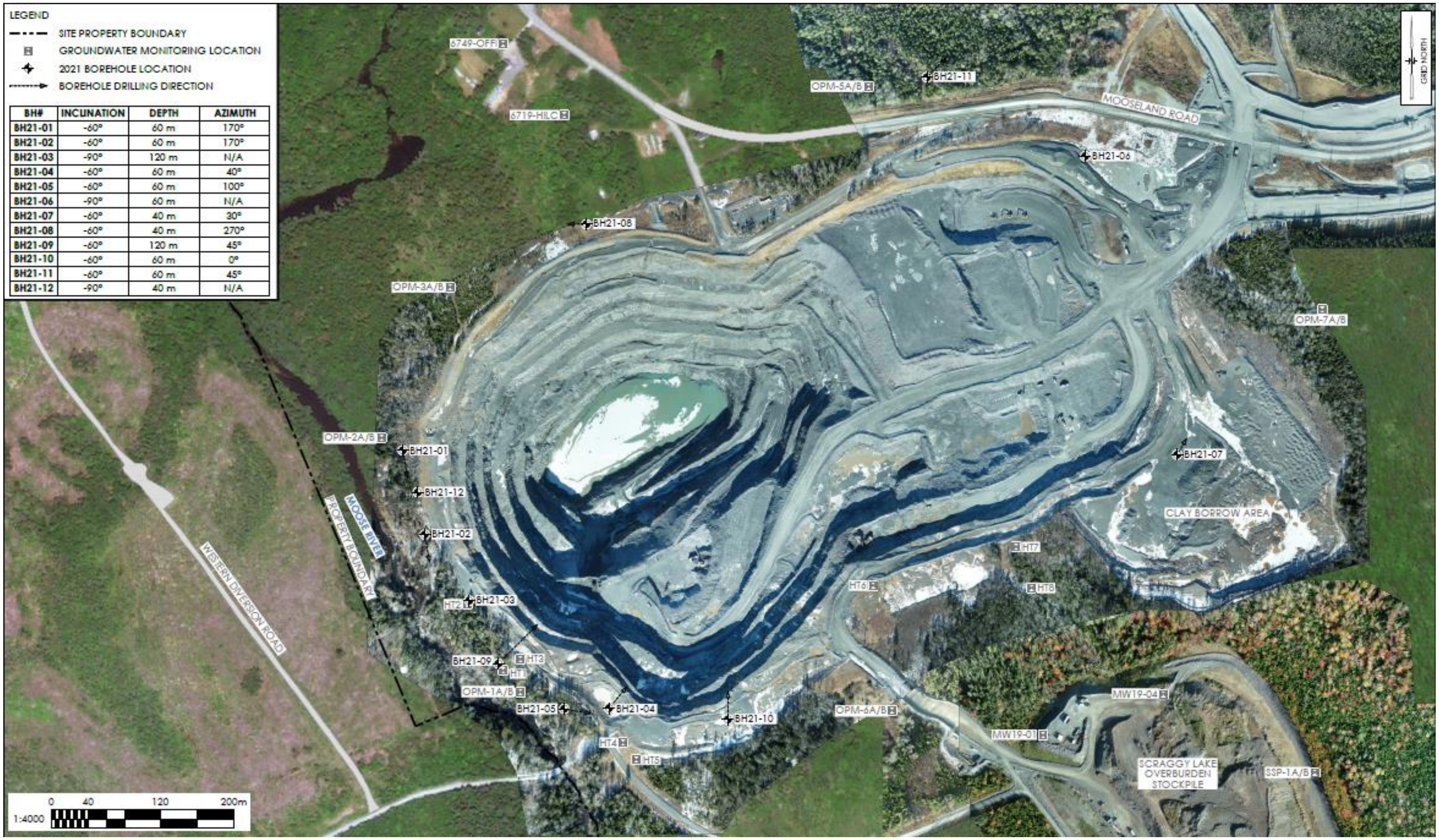
The first section consists of background information that includes hydraulic conductivity and water level data collected from the overburden, upper weathered bedrock and lower bedrock layers through a series of monitoring wells and deep boreholes. Background information also includes the current understanding of the underground workings and plans for mitigating potential effects of the planned in-pit tailings disposal. The final sections of the memo provide further evaluation of the available dataset to support the information request.

BACKGROUND

The Touquoy mine site is an active open pit gold mine located 60 km northeast of Halifax, Nova Scotia. Underground mining was originally conducted at the site in the late 19^{th} and early 20^{th} centuries. The current open pit mining commenced in 2017. The configuration of the open pit in 2022 (current pit shell) is shown in Figure 1.

Stantec has conducted hydrogeological studies on the site since 2017, including most recently in 2021/2022, a report presenting the results of the hydrogeological site investigations completed in support of the in-pit tailings disposal was prepared by Stantec in a report entitled "*Factual Data Report. Hydrogeological Site Investigation, Touquoy In-Pit Tailings Disposal*" dated March 14, 2022 (see Appendix B.1 in the Additional Information Addendum Report). A drawing from this report showing the boreholes and monitoring wells from the above investigations in the open pit are shown Figure 1. Prior to Stantec, GHD conducted baseline investigations on the site. Additional commentary on the results of the investigations are discussed in the following sections.

Reference: AMNS EA IR Request 1.b: Hydraulic Connectivity Testing



BH#	INCLINATION	DEPTH	AZIMUTH
BH21-01	-60°	60 m	170°
BH21-02	-60°	60 m	170°
BH21-03	-90°	120 m	N/A
BH21-04	-60°	60 m	40°
BH21-05	-60°	60 m	100°
BH21-06	-90°	60 m	N/A
BH21-07	-60°	40 m	30°
BH21-08	-60°	40 m	270°
BH21-09	-60°	120 m	45°
BH21-10	-60°	60 m	0°
BH21-11	-60°	60 m	45°
BH21-12	-90°	40 m	N/A

Figure 1 **Current (2022) Open Pit configuration including associated borehole and monitoring well locations**

Monitoring Wells

Seven pairs (shallow/deep) of monitoring wells were installed by GHD around the planned open pit in 2016. The shallow wells were completed to depths of approximately 6 m below ground surface (mbgs) (labelled "A" wells) and the deeper wells were completed to depths of approximately 15 mbgs (labelled "B" wells). These 14 monitoring wells (named OPM wells) form part of the regulatory monitoring well network for the Touquoy mine site. Most of these monitoring wells were screened in the bedrock, with some of the shallow wells straddling the overburden and bedrock hydrostratigraphy. Falling head single well hydraulic tests (i.e. slug tests) were conducted on each of the wells. Reported hydraulic conductivity values ranged from 9.9 x 10^{-6} m/s to 2.0 x 10^{-5} m/s. Completion information and hydraulic conductivity data for the OPM wells are provided in Table 1 in the attachment at the end of the memo.

Monthly water level monitoring has been conducted at the OPM wells since 2016. Water level changes that can be attributed to the open pit mining dewatering operation have been observed in a single well pair (OPM2A/B). An approximately 10 m decrease in water level has been observed in OPM-2B, which is the deeper of the two wells. The reported hydraulic conductivity value at this location is 6.9 x 10^{-6} m/s, which is on the lower end of the reported hydraulic conductivity range for the OPM wells. OPM-2A, on the other hand, has a reported hydraulic conductivity of 1.8 x 10^{-5} m/s, but has not exhibited a consistent downwards trend that would suggest a connection to pit dewatering. Given the OPM-2 wells' location near the northwest corner of the pit and between the Moose River and the pit (Figure 1), if potential connections between the Moose River and the pit exist they could be expected to be reflected in the water level data collected from this well pair, as well as the OPM-1 well pair, located near the southwest corner of the pit and also between the Moose River and the pit. Water level elevation data from 2016 to 2022 for the OPM wells are shown in Figure 2.

In addition to the OPM wells, eight shallow monitoring wells were drilled in 2018 to monitor water quality effects from historical tailings that were located near these wells (HT wells: HT-1 to HT-8). Falling head single well hydraulic tests (i.e. slug tests) were conducted on five of the eight wells in 2022 to further refine the hydraulic characteristics surrounding the pit. Three of the HT wells were not tested because two were dry at the time of hydraulic testing (HT-2 and HT-3) and one of the wells (HT-1) did not have conclusive results due to an insufficient water displacement during the test. Reported hydraulic conductivity values ranged from 9.3 x 10^{-7} m/s to 2.8 x 10^{-8} m/s. Well completion information and hydraulic conductivity data for the HT wells are also provided in Table 1 in the attachment at the end of the memo. Water levels have been collected monthly in the HT wells since they were first drilled in 2018. Most of the HT wells are not indictive of connectivity with the pit, except for HT-3, which is in the vicinity of the historical underground workings which was too dry to conduct hydraulic testing on in 2021 and exhibited low water levels since 2019. Water level elevation data from 2018 to 2022 for the HT wells are shown in Figure 3.

Reference: AMNS EA IR Request 1.b: Hydraulic Connectivity Testing

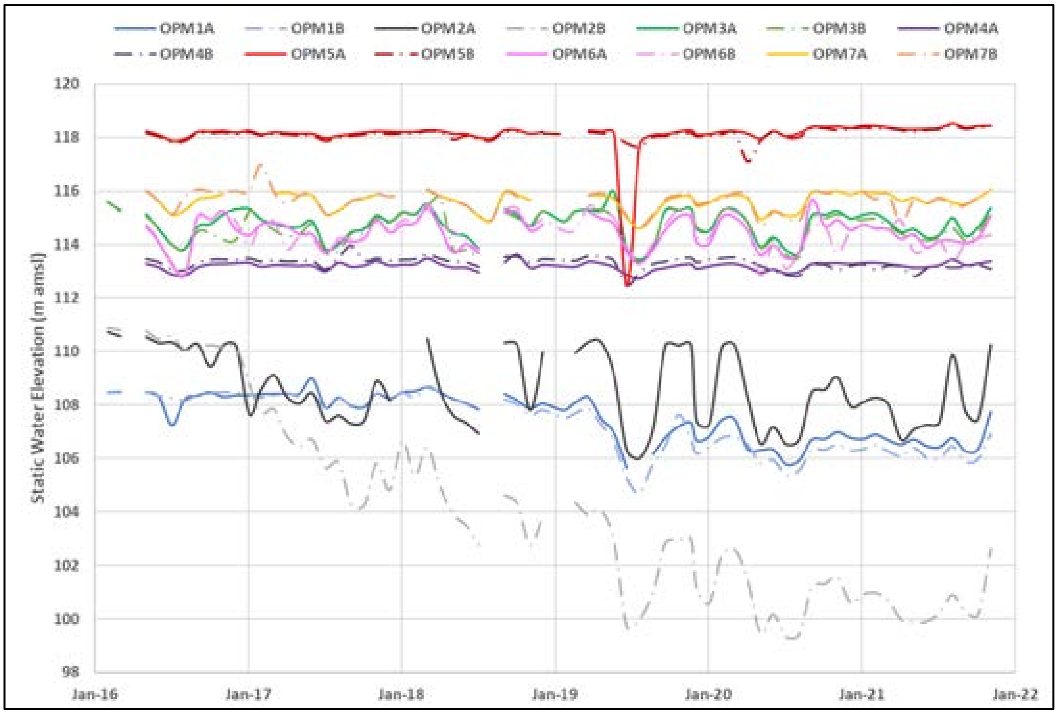


Figure 2 Water Level Elevations in the Open Pit Mine (OPM) Monitoring Wells from 2016-2022

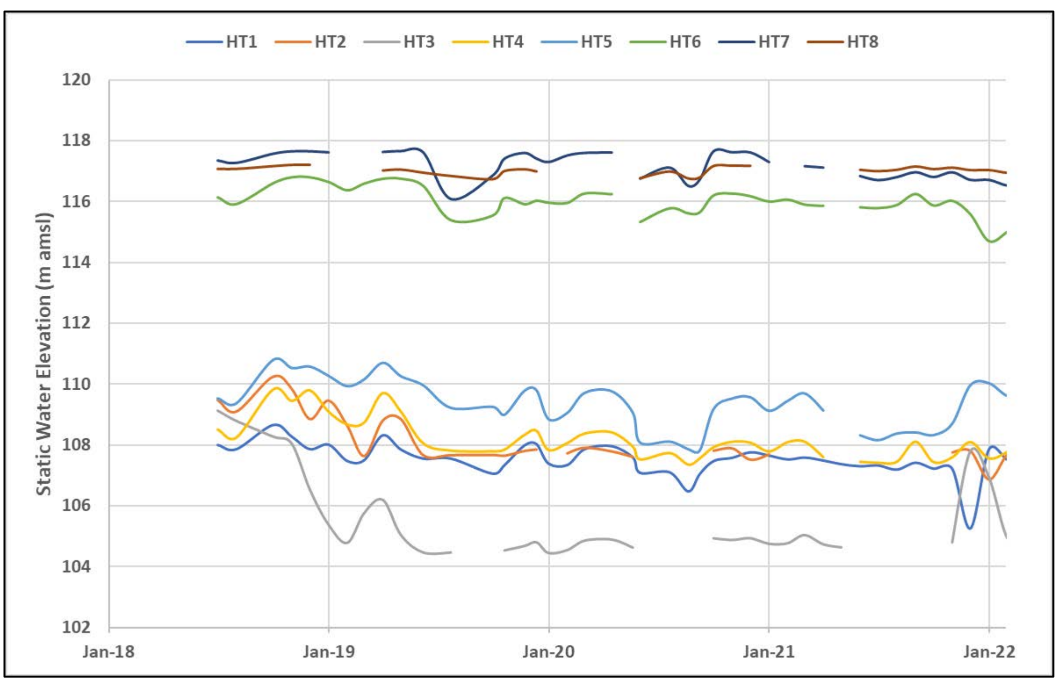


Figure 3 Water Level Elevations in the Historical Tailings (HT) Monitoring Wells from 2018-2022

Borehole Testing Program (2021)

In 2021, Stantec conducted a borehole drilling program in the vicinity of the open pit that included 12 boreholes between 40 and 120 m long. Three of the boreholes were drilled on a vertical axis (i.e. 90 degrees) while the other nine were directionally drilled at – 60˚ from the horizontal in various compass orientations, depending on the targeted geological feature (e.g. faulting) or a known area with underground workings (i.e. BH21-09). Each borehole location, orientation, direction and depth were chosen to intersect mapped faults within the open pit, with a focus on the main structural discontinuities that were observed to be blocky, impact pit slope stability or exhibit wet conditions. Core was recovered from each borehole using a triple tube core tube assembly and was logged by Stantec personnel for general lithology, solid core recovery, the rock quality designation (RQD), and fracture locations.

Hydraulic testing using a single packer assembly was conducted to isolate 10-20 m zones within each borehole. Hydraulic conductivity values were calculated for each zone using flow and pressure data collected during the test. The resulting hydraulic conductivity is shown with depth on Figure 4. Figure 4 also shows hydraulic testing results from the OPM and HT wells. Calculated hydraulic conductivities for the 2021 boreholes ranged from 1.5 x 10^{-9} m/s to 1.4 x 10^{-6} m/s, with the lowest hydraulic conductivity values observed at depths of greater than 50 mbgs. All the hydraulic conductivity data along with the RQD percentage is provided in the attachment at the end of the memo. No relationship between faulting, RQD, and hydraulic conductivity results were observed in the data set, suggesting that neither the geological structures nor rock quality control discrete fracture flow into and around the open pit mine, including from surface water flow from the Moose River.

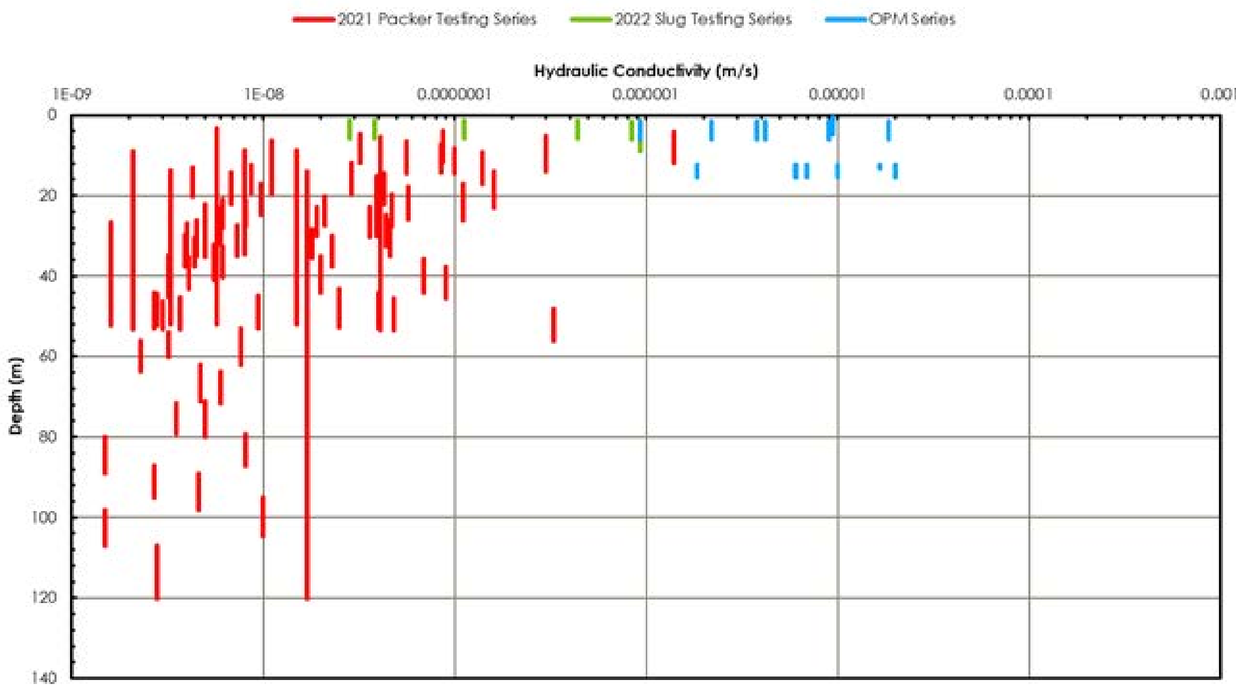


Figure 4 Hydraulic Conductivity versus Depth in the Boreholes Drilled in 2021, the OPM wells and the HT wells

Ground Penetrating Radar Survey

A ground penetrating radar (GPR) survey was conducted in January 2022 to verify the locations of the historical underground workings. The survey was focused on the western side of the open pit mine, between the Moose River and the open pit.

The GPR data collected demonstrated good variation in the wavelengths between the known rock formation and the anticipated void spaces in the vicinity of the known, historical underground workings. The interpreted void spaces were added to the three-dimensional model and are shown on Figure 5. The GPR survey provided confidence in the understanding of the location and lateral extent of the underground workings, and validated the geological model developed by AMNS.

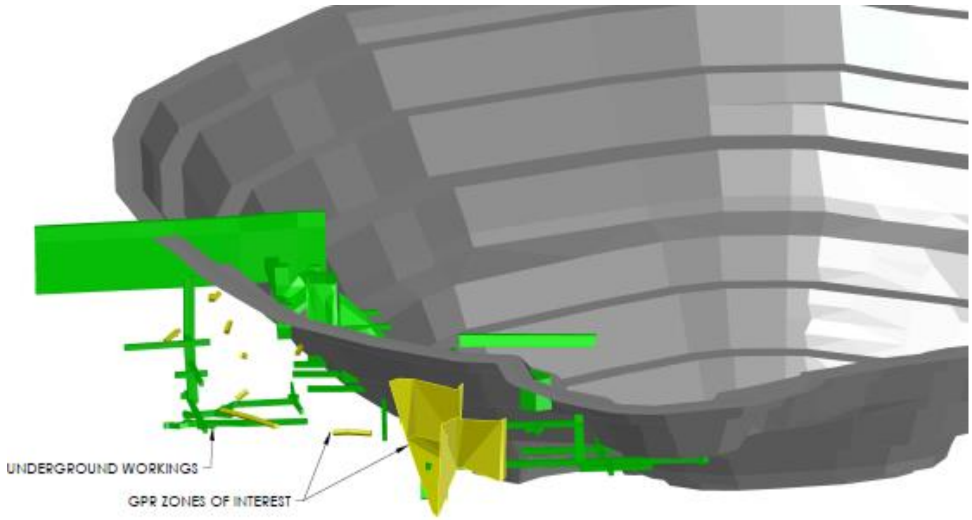


Figure 5 **Three-Dimensional Model of the Historical Underground Workings from the GPR Survey**

Seepage Mitigation Liner – Underground Workings Mitigation

Although there is no indication that seepage from the pit toward Moose River will result in unacceptable environmental impacts, to address any uncertainty related to the presence and interconnectivity of the underground workings, a low permeability clay liner along the southwestern face of the pit from the crest of the pit to the rock bench at an approximate elevation of 60 masl is proposed. Figure 6 shows the extent of the clay liner and Figure 7 shows a cross section.

The clay that will be used is currently stockpiled at the clay borrow area. Permeability testing of the material indicated estimated hydraulic conductivity values of < 1×10^{-8} m/s, which is similar to the lower hydraulic conductivity values that were observed during the packer testing program described above.

Reference: AMNS EA IR Request 1.b: Hydraulic Connectivity Testing

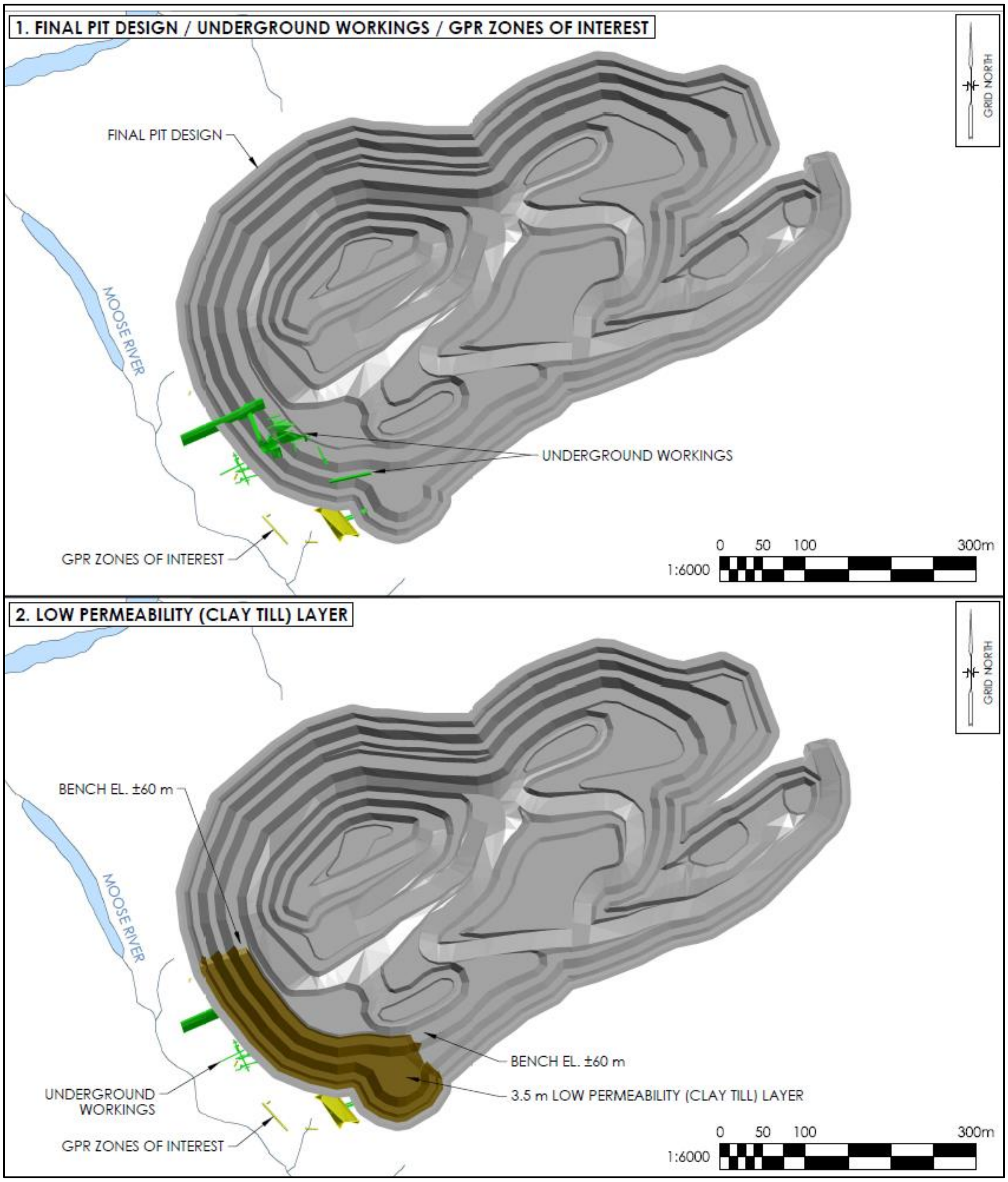


Figure 6 Plan View of the Low Permeability Clay Liner

Reference: AMNS EA IR Request 1.b: Hydraulic Connectivity Testing

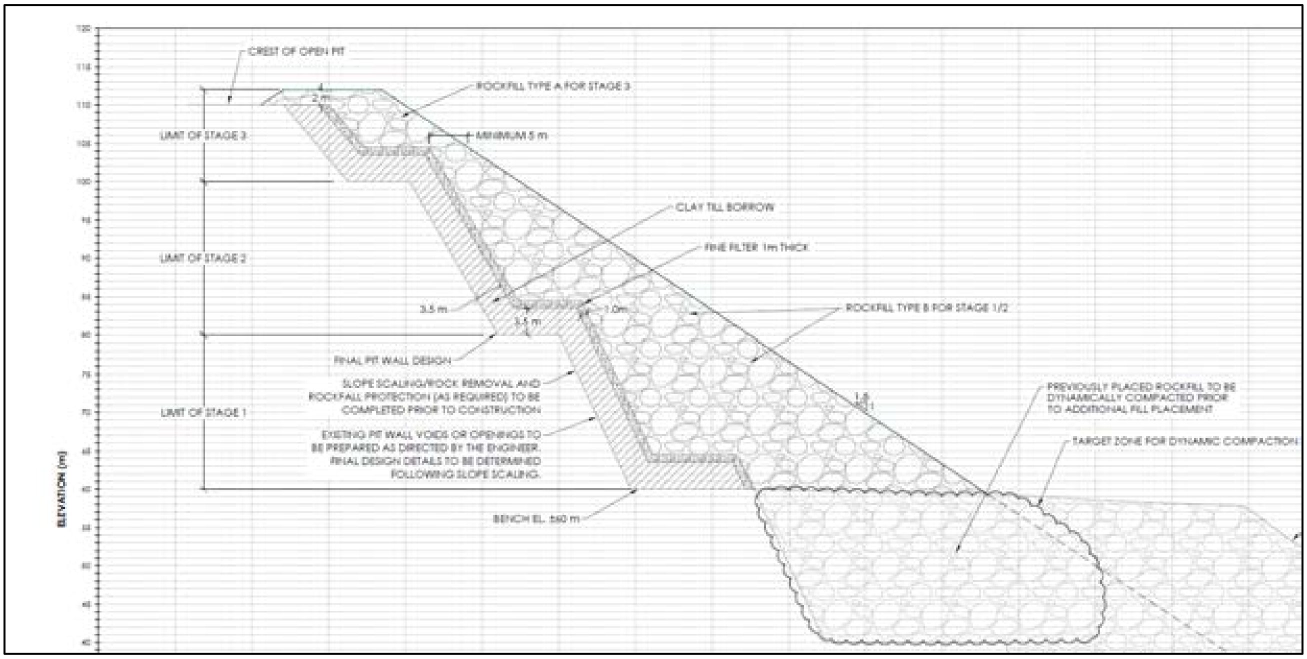


Figure 7 **Cross Section of Pit Slope Seepage Mitigation Liner Typical Section**

Structural Geology

The structural model of the open pit has been developed by AMNS throughout the evolution of the pit. Initially, faults were designated primary, secondary or tertiary based on the age/order of occurrence of the faults. However, based on the recent investigations and discussions with AMNS, the main structural faults (i.e., geological structures that are evident from blocky or rubble zones or pit wall instabilities) that represent potential preferred seepage pathways and were identified based on pit wall mapping and subsurface investigations.

The “main faults” are presented on Figure 8. As noted in this figure, these faults have been investigated through borehole drilling and testing. The results of these investigations show there is no significant increase in hydraulic conductivity along these structures, indicating that the faults will not act as preferred seepage pathways. Therefore, it is highly likely that smaller or less evident geological structures that do not exhibit blocky rock conditions would not serve as preferred seepage paths.

Reference: AMNS EA IR Request 1.b: Hydraulic Connectivity Testing

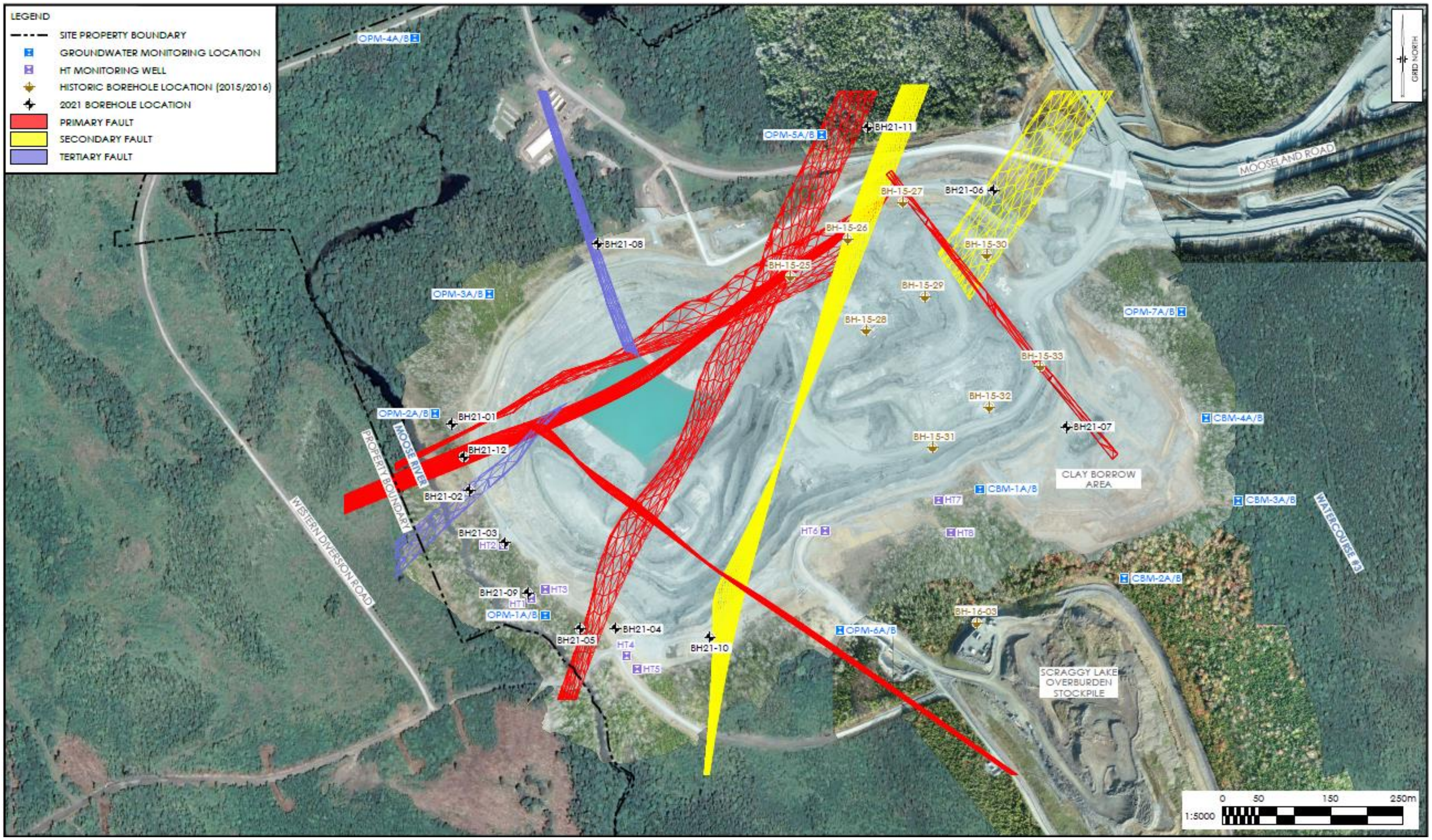


Figure 8 Geological Faults Cutting the Open Pit.

SITE VISIT

A site visit to the Touquoy Mine was conducted on August 30, 2022 by Titia Praamsma from Stantec that included a tour of the pit, the monitoring well and borehole locations described above, the Moose River and the surface expressions of the underground mine workings (e.g. depressions in the ground surface). At the time of the site visit, water levels in the Moose River were observed to be low, which was expected with the preceding dry and hot summer.

The tour of the open pit mine was particularly useful for observing areas of potential groundwater connectivity with the surrounding environment. From an overlook on the eastern edge of the pit, it was possible to see the sump in the deepest portion of the pit. The single pump was off at the time of the site visit and AMNS staff noted that it had not been running often during the summer of 2022, which was also attributed to the preceding dry and hot summer with limited surface water run off into the pit. AMNS staff indicated that managing groundwater flows into the pit was not a significant part of their open pit dewatering activities. Groundwater staining was observed on the northern and eastern walls in fractured rocks associated with both bedding and structural geological features. Groundwater staining was also observed on the fractured rock walls of the southwest corner of the pit, when viewed from inside the pit. The location of this staining coincides with the location of the historical underground workings and the planned low permeability clay liner.

Overall, no substantial flow was observed within the rock walls at the few locations where water staining was observed, with very few locations contributing to groundwater flow into the pit. Both the folding and faulted geological structures within the rock faces provided interesting insight with respect to groundwater flow into the pit, which may also be extrapolated to the nearby geology surrounding the pit. While the folding and faulting are considerable within the greywacke and argillite rock, where these zones were observed to be highly fractured which resulted in broken rock pieces, most of these highly fractured sections did not contribute to any of the observed flow in the rock walls. Upon closer inspection, the rock pieces were short and friable, appearing to cut off potential flow paths rather than creating pathways for water flow.

These observations support the results of the hydraulic testing and the water level data, whereby the hydraulic testing data collected using packers to isolate zones indicate that most of the rock exhibits low hydraulic conductivity and/or does not contribute groundwater flow through the fractured rock system. The long-term water level data in the wells around the pit show very little drawdown, despite the 100 m head differential from the Moose River and background water levels to the sump at the bottom of the pit.

DISCUSSION

Hydraulic conductivity data have been collected around the open pit mine at Touquoy since 2016, starting with the OPM monitoring well series, which was later expanded to include the HT well, as well as the deep boreholes that were drill in 2021. The monitoring well network is distributed evenly around the pit. The deep boreholes drilled in 2021 were strategically positioned to fill in gaps within the pre-existing monitoring well network, as well as to intersect the faults identified in the pit wall.

The highest density of boreholes and corresponding hydraulic conductivity data are concentrated in the southwest corner of the open pit, between the pit and the Moose River, as well as in the vicinity of the historical underground workings. In this area, wells or borehole locations are located between 40 to 100 m from each other, which provides further discretization of the hydraulic conductivity in the portion of the pit that exhibits the most groundwater seepage. As an aside, these data points for hydraulic conductivity testing are closer in proximity to each other than standard exploration drilling practices.

As described above, the additional bedrock and overburden geology data that were collected in 2021 are consistent with the conceptual models described in previous reporting and that are represented in the continued modelling efforts performed by Stantec. These conceptual models generally include a shallow overburden layer overlying a shallow, weathered/fractured bedrock system and more competent deep bedrock. The results of the hydraulic testing in the shallow overburden and shallow weathered bedrock system (less than 10 mbgs) report hydraulic conductivity values that are generally within an order of magnitude of each other, between 1×10^{-6} m/s and 1×10^{-5} m/s, while the hydraulic conductivity of the deep bedrock system is < 1×10^{-7} m/s (greater than 10 mbgs). At depths greater than 40 mbgs, the hydraulic conductivity values were < 1×10^{-8} m/s.

The overburden/bedrock interface is also well characterized surrounding the open pit, with particular emphasis on the area between the pit and the Moose River. Depths to bedrock in the OPM, HT and boreholes range from between 0.8 m to 6.7 m below ground surface, with bedrock elevations ranging from 102.1 to 115.8 m amsl. The mean depth to bedrock in those wells (n=33) is 3.3 m and the mean bedrock elevation is 110.7 m amsl. Given the shallow bedrock conditions, and the maximum planned water level elevation of 108 m amsl of the planned in-pit tailings at full closure, there will be a very shallow gradient that will occur through the ~10^{-6} m/s overburden material (that was conservatively modelled with a hydraulic conductivity of 10^{-4} m/s) towards the Moose River (109 m asl at the northeast corner of the open pit and 106 m asl at the southeast corner of the open pit) at full closure. The attached memo entitled “Touquoy In-Pit Tailings Deposition – Normal Operating Water Levels and Pit Crest” discusses the planned operating water levels of the In-Pit Tailings Disposal area and demonstrates that the In-Pit Tailings area will act as a groundwater sink with normal operating water levels of 106.5 m amsl during which time active water treatment will be completed.

Groundwater flow in the weathered bedrock/uppermost layer will generally be towards the pit. Groundwater elevations in most wells surrounding the open pit are above 108 masl which is the maximum proposed elevation for tailings in the pit (Figures 2 and 3). The average operating level is planned to be 106.5 masl. Since there is generally no gradient into the overburden, the overall groundwater flow direction will be from the higher (>108 masl) elevation groundwater near the wells towards the pit (between 106.5 and 108 masl). Water is not anticipated to flow into the till/overburden layer. Except for the OPM-2 wells (located in the northwest corner of the pit), the only monitoring wells with recorded groundwater levels below 108 masl are located within close proximity to the proposed clay liner. Overburden near the OPM-2 wells is not recorded at depths of 108 masl, therefore any flow out of the pit, will have limited flow through the uppermost weathered bedrock. This limited flow rate will be governed by a very shallow anticipated gradient between the pit and OPM-2 (0.25m head difference over a distance of ~50 m from the pit edge to OPM-2 wells) and the hydraulic conductivity in the upper weather bedrock in that area (10^{-6} m/s). Any groundwater that did migrate towards the OPM-2 wells could reach the Moose River in 100 years if this gradient was maintained, though water levels will be lower than the Moose River.

The updated groundwater model that was completed in 2022 included all the borehole and HT data collected in 2021 and in previous years. The model was successfully calibrated to available water level data. The hydraulic conductivity values resulting from the calibration process provided a reasonable fit to the hydraulic conductivity values collected during the hydraulic testing programs.

Given the model was completed in MODFLOW, which is an equivalent porous media model, it is important to assess whether fracture flow in the vicinity of the open pit mine may not be well represented by the model. As discussed in the site visit section, very limited discrete zones of flow and/or seepage were observed on the rock walls of the open pit, which is in good agreement with the borehole data collected since and prior to the current open pit mining operations. Operational data and site observations show that isolated zones are responsible for small contributions to the relatively low rates of pumping required to maintain pit dewatering. Based on observations, calibration results, hydraulic conductivity estimates and the lack of correlation between hydraulic conductivity and RQD the use of an equivalent porous medium approach is appropriate for this site.

Geological structures, such as faults and anticline/syncline structures, are important parts of the geological models for the site. Given the structural control on the ore body, the structures have been studied in detail for those purposes. Hydrogeologically, the structures were considered within the 2021 borehole investigations to determine if faulting resulted in an increased transmission of groundwater through the fractured rock system. As noted above, folding and faulting was not observed to be related to groundwater flow and transport. The rock is friable and highly fractured in these zones, but the fractures were observed to be short in length and the structural controls resulted in shortening the actual pathways between each fracture.

The borehole data suggests there are few fracture connections that actively transmit groundwater flow, including the main structural fault zones identified in the pit. This is supported by the low hydraulic conductivity values, as discussed above, as well as the long-term water level data that is available for the OPM wells. The data from the OPM wells adequately and actively demonstrates a lack of connectivity between individual faults or fractures. Despite the approximately 100 m hydraulic gradient that is controlled by dewatering the pit, only one well exhibited dewatering effects (OPM-1B) and those effects are limited to a 10 m decrease in groundwater head between 2016 and 2020. Groundwater elevations in this well have since stabilized and fluctuate around an average elevation of 101 masl since early 2020. A deeper monitoring well is planned in this location to evaluate further effects.

Another way of looking at the effects of faults on the fracture connectivity in the hydrogeological system is to plot the rock quality designation (RQD) that was collected during borehole logging with the hydraulic conductivity data that was calculated from the hydraulic testing using packers (Figure 9). Typically, low RQD represents fractured, broken rock and increased hydraulic conductivity. Conversely, high RQD represents more intact rock and lower hydraulic conductivity. Since RQD is often used as an indicator of structurally controlled rock systems, a linear relationship with the hydraulic conductivity would be expected if groundwater flow was related to the fault systems. Based on the data from the investigations, there was no observed linear relationship, indicating that RQDs are not related to hydraulic conductivity and therefore suggesting there is a limited relationship with structural geological controls and groundwater flow in the Touquoy open pit mine.

Reference: AMNS EA IR Request 1.b: Hydraulic Connectivity Testing

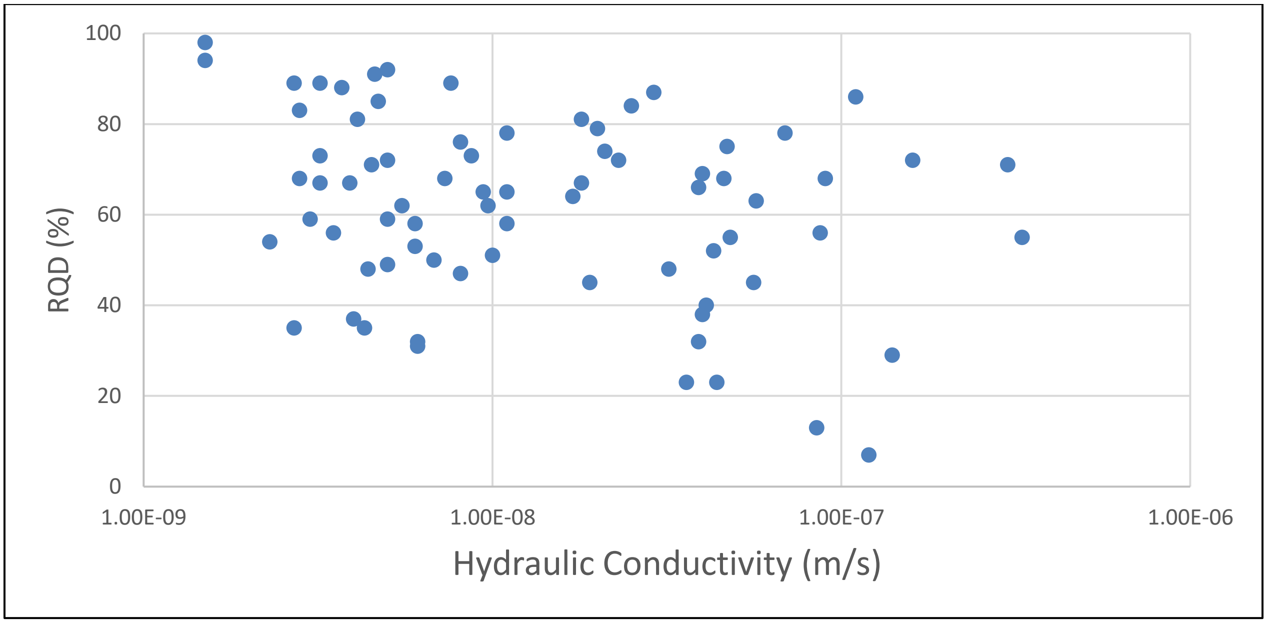


Figure 9 Rock Quality Designation vs. Hydraulic Conductivity.

The historical underground workings represent zones of potentially elevated hydraulic conductivity. In the groundwater flow model, these areas are represented with the highest hydraulic conductivity values on site, with values of 1×10^{-4} m/s. The ground penetrating radar survey was used to create a three-dimensional model of the historical underground workings to supplement the mapping provided by AMNS. The locations are supported by data collected at borehole BH21-09 that indicated large void spaces with broken core occurred between 36 to 55 m from the top of the borehole, at a 60 degree angle from horizontal towards the northwest. Observations of groundwater seepage on the northeastern wall of the pit in the vicinity of the underground workings also support the locations shown in the three-dimensional model.

Based on these data, the three-dimensional model is considered representative of underground conditions and further drilling into the historical underground workings is not recommended for two reasons. The first reason is that the data are adequate for their purpose (understanding flow and transport around the pit) and the second is that drilling through the historical mine workings has the potential to create more flow pathways, which could increase the potential to dewater surface water features in the vicinity of the open pit (e.g. the Moose River). Since no significant dewatering effects have occurred in six years of mining, it is considered prudent to limit the number of potentially available pathways between surface water features and the pit. In addition, the low permeability clay liner will provide mitigation in the case of direct connection between the pit and historical underground workings and GPR anomalous areas.

CONCLUSIONS AND RECOMMENDATIONS

Background information and analyses were provided as to respond to the Nova Scotia Department of Environment and Climate Change (NSECC) IR request #1.b, which includes the following:

> Complete hydraulic connectivity testing in all fracture/fault zones, identified underground mine workings, Ground Penetrating Radar anomalous areas and the overburden and upper weathered bedrock layers surrounding the pit.

The information and analyses provided in this memo and supporting reports show that sufficient hydrogeological characterization has been completed to understand the hydraulic conductivity and connectivity surrounding the open pit mine at Touquoy. Hydraulic testing indicated that faults in the area do not indicate increased water flow. Concentrated data collection occurred in the vicinity of the historical underground workings, including deep borehole logging, hydraulic testing using packers and a GPR survey and a low permeability clay liner was included to mitigate uncertainty in this area.

At this point in the project, the available data is considered adequate to understand the potential for connectivity between isolated fractures and the pit. Additional boreholes in the vicinity of the historical underground workings are not recommended for this reason, as well as the increased potential for creating flow pathways by drilling into the historical workings.

Current recommendations include the following:

- Continued monthly water level monitoring in the OPM and HT wells;
- Continued quarterly water quality monitoring; and
- Continued interpretation of monitoring data as they become available, including water level and water quality data.

Reference: AMNS EA IR Request 1.b: Hydraulic Connectivity Testing

Attachment: Attachment A: Borehole Data
Attachment B: Touquoy In-Pit Tailings Deposition – Normal Operating Water Levels and Pit Crest

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REFERENCES

GHD. 2016. Borehole logs.

Stantec Consulting Ltd. (Stantec). 2022. Factual Data Report. Hydrogeological Site Investigations, Touquoy In-Pit Tailings Disposal.

ATTACHMENT A

Borehole Data

Table 1 Well completion and hydraulic conductivity data for the OPM wells.

Monitoring Well	Coordinates		Elevation		Borehole Depth	Tested Interval		Hydraulic Conductivity
	Easting	Northing	Ground Surface	Top of Casing		Top of Interval Depth	Bottom of Interval Depth	
	m	m	m AMSL	m AMSL	m BGS	m BGS	m BGS	m/s
OPM-1A	504335.79	4980786.63	111.49	112.15	6.1	1.5	6.1	9.00E-06
OPM-1B	504336.72	4980786.62	111.36	112.02	13.2	12.2	13.2	1.66E-05
OPM-2A	504188.09	4981053.98	110.70	111.28	6.1	1.5	6.1	1.83E-05
OPM-2B	504187.28	4981053.49	110.61	111.21	15.3	12.2	15.3	6.91E-06
OPM-3A	504262.96	4981218.45	116.58	117.34	6.1	1.5	6.1	9.34E-07
OPM-3B	504262.66	4981219.65	116.55	117.19	15.3	12.2	15.3	1.84E-06
OPM-4A	504143.76	4981577.53	114.15	115.10	6.1	1.5	6.1	4.17E-06
OPM-4B	504144.23	4981576.21	114.22	115.19	15.3	12.2	15.3	6.06E-06
OPM-5A	504694.48	4981500.84	118.59	119.61	6.1	0.10	4.70	9.45E-06
OPM-5B	504694.34	4981502.40	118.6	119.57	15.3	12.2	15.3	2.00E-05
OPM-6A	504747.95	4980761.88	115.58	116.50	6.1	1.5	6.1	3.78E-06
OPM-6B	504746.37	4980762.29	115.57	116.52	15.3	12.2	15.3	5.96E-06
OPM-7A	505214.85	4981198.93	116.06	117.10	6.1	1.5	6.1	2.19E-06
OPM-7B	505215.53	4981197.87	116.02	116.96	15.3	12.2	15.3	9.99E-06
HT-1	504318.2	4980804	112.09	113.16	5.9	1.32	5.9	-
HT-2	504278.9	4980877	113.09	114.12	5.72	1.15	5.72	-
HT-3	504337.2	4980816	111.91	112.88	7.6	1.22	7.6	-
HT-4	504449.6	4980725	112.23	113.14	5.76	1.19	5.76	2.82E-08
HT-5	504464.3	4980706	111.71	112.77	6.15	1.58	6.15	8.38E-07
HT-6	504724.4	4980897	117.1	118.15	5.9	1.33	5.9	3.20E-08
HT-7	504881.4	4980940	117.82	118.88	5.77	1.22	5.77	3.28E-07
HT-8	504898.4	4980895	117.11	118.05	8.94	1.32	8.94	9.29E-07

Reference: AMNS EA IR Request 1.b: Hydraulic Connectivity Testing

Table 2 Borehole Hydraulic Conductivity and Rock Quality Designation Data

Borehole ID	Packer Test Interval		Hydraulic Conductivity (m/s)	RQD (%)
	From (m BGS)	To (m BGS)		
BH21-01	4.11	11.91	1.4×10^{-6}	77
	11.93	19.73	2.9×10^{-8}	87
	19.73	27.52	4.7×10^{-8}	75
	27.50	35.29	5.0×10^{-9}	72
	35.32	43.11	4.1×10^{-9}	81
	43.11	52.83	2.5×10^{-8}	84
BH21-02	6.57	14.37	5.6×10^{-8}	45
	14.37	22.16	4.3×10^{-8}	52
	22.16	29.96	3.9×10^{-8}	66
	29.96	37.75	2.3×10^{-8}	72
	37.75	45.54	9.0×10^{-8}	68
	45.54	53.34	4.8×10^{-8}	55
BH21-03	17.06	26.06	1.1×10^{-7}	86
	26.06	35.06	4.6×10^{-8}	68
	35.06	44.06	2.0×10^{-8}	79
	44.06	53.06	2.7×10^{-9}	89
	53.06	62.06	7.6×10^{-9}	89
	62.06	71.06	4.7×10^{-9}	85
	71.06	80.06	5.0×10^{-9}	92
	80.06	89.06	1.5×10^{-9}	94
	89.06	98.06	4.6×10^{-9}	91
	98.06	107.06	1.5×10^{-9}	98
	107.06	120.15	2.8×10^{-9}	83
BH21-04	5.33	12.82	4.1×10^{-8}	40
	13.12	20.26	4.3×10^{-9}	35
	20.91	28.06	6.1×10^{-9}	31
	26.98	35.85	4.0×10^{-9}	37
	34.77	43.65	3.2×10^{-9}	67
	44.30	52.31	2.8×10^{-9}	68

Reference: AMNS EA IR Request 1.b: Hydraulic Connectivity Testing

Table 2 Borehole Hydraulic Conductivity and Rock Quality Designation Data

Borehole ID	Packer Test Interval		Hydraulic Conductivity (m/s)	RQD (%)
	From (m BGS)	To (m BGS)		
BH21-05	6.43	14.23	$1.1x10^{-8}$	58
	14.23	22.02	$6.8x10^{-9}$	50
	22.02	29.82	$5.0x10^{-9}$	59
	29.82	37.61	$3.9x10^{-9}$	67
	37.61	45.41	$3.2x10^{-9}$	73
	45.41	53.20	$3.7x10^{-9}$	88
BH21-06	8.8	17.05	$1.1x10^{-8}$	65
	17.8	26.05	$5.7x10^{-8}$	63
	26.08	35.05	$4.5x10^{-9}$	71
	35.8	44.05	$6.9x10^{-8}$	78
	44.8	53.05	$9.4x10^{-9}$	65
	53.8	60.05	$3.2x10^{-9}$	89
BH21-07	8.23	14.55	$1.2x10^{-7}$	7
	15.11	22.34	$3.9x10^{-8}$	32
	22.91	30.14	$3.6x10^{-8}$	23
	30.66	35.33	$1.8x10^{-8}$	67
BH21-08	3.9	11.69	$8.7x10^{-8}$	56
	12.34	19.49	$8.7x10^{-9}$	73
	20.14	27.28	$2.1x10^{-8}$	74
	27.28	35.07	$7.3x10^{-9}$	68

ATTACHMENT B

Touquoy In-Pit Tailings Deposition – Normal Operating Water Levels And Pit Crest

Memo

To:	Sara Wallace, Head of Permitting	From:	Jeff Gilchrist, P.Eng.
Cc	Paul Deering, P.Eng., Mark Flynn, P.Eng.		
File:	121619250.5500	Date:	October 25, 2022
Doc No.	**MEM-016-5500-A-25OCT22**	Revision:	A

Reference: Touquoy In-Pit Tailings Deposition – Normal Operating Water Levels and Pit Crest

In response to a letter received from Nova Scotia Environment and Climate Change dated May 12, 2022, we provide the following additional information regarding water levels in the pit in relation to the top of the bedrock around the pit perimeter.

WATER LEVELS

In-Pit tailings deposition from Touquoy ore is expected to extend ore processing by 24 months. At the end of 24 months the water level in the pit is anticipated to reach an elevation of 90.0 m (Touquoy Integrated Water and Tailings Management Plan – Touquoy Gold Project" (Stantec 2022)).

Following deposition of Touquoy tailings, the pit will continue to fill with additional tailings/process water and/or naturally through ground and surface water inputs to a final maximum water level of 108.0 m, which is controlled by a spillway. However, prior to the final elevation, the pit water levels will be managed below 108.0 until the pit lake water quality meets regulatory requirements for discharge to environment through the spillway into Moose River. To account for flood management and freeboard below the spillway invert, the normal operating water level, is to be managed at a maximum elevation of 106.5 m, as presented in the figure below.

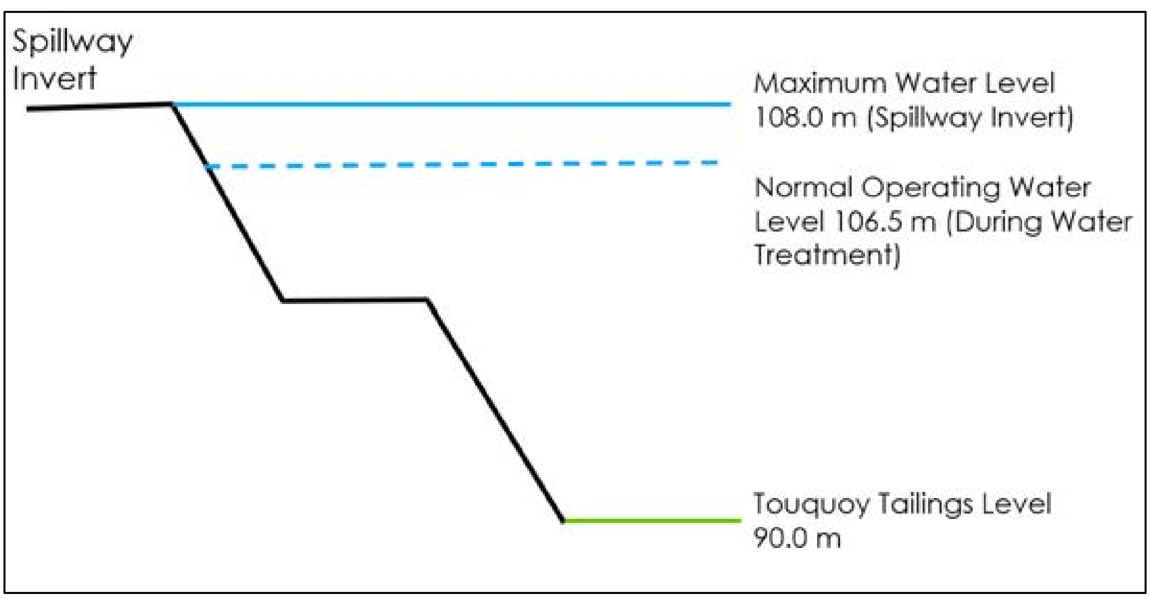


Figure 1 - Schematic of Normal and Maximum Water Levels in the Touquoy Pit

Reference: Touquoy In-Pit Tailings Deposition – Seepage Mitigation Measures

Routine water quantity and quality monitoring will be conducted to determine when water levels in the pit can be allowed to raise to 108.0 m and discharge to the environment which is consistent with the water management strategy for reclamation and closure for the existing Touquoy mine.

PIT CREST

Using available information from LIDAR, site investigations, blast hole drilling and site observations, a series of cross sections (Figure 10, 11 and 12), plan and profile views (Figure 13) were created showing the top of the bedrock around the pit perimeter, maximum water level and normal operating water levels. These figures were provided in memo Doc.No.MEM-017-5500-A-20OCT22, dated October 20, 2022 and are attached for reference.

As presented on the figures, under normal operating water levels at 106.5 m the water levels are maintained below the top of the bedrock and in most areas water levels at 108.0 m are also maintained below the top of the bedrock except for two isolated areas (Figure 13). These areas are both located near the spillway location and are also in the zone behind the low permeability clay liner.

SUMMARY

Prior to water quality in the pit meeting regulatory requirements to be discharged into the environment, the normal operating water level in the pit will be maintained at maximum elevation of 106.5 m. Elevation 106.5 m is 1.5 m below the spillway invert and below the top of the bedrock around the perimeter of the pit.

Water levels will be allowed to increase to the maximum water level (spillway invert) at 108.0 m, when pit water can meet regulatory requirements (e.g., through natural attenuation or treatment). At the 108.0 m elevation, water levels remain below the top of the bedrock around the perimeter of the pit except for the spillway area, which is within the area covered by the proposed low permeability clay liner.

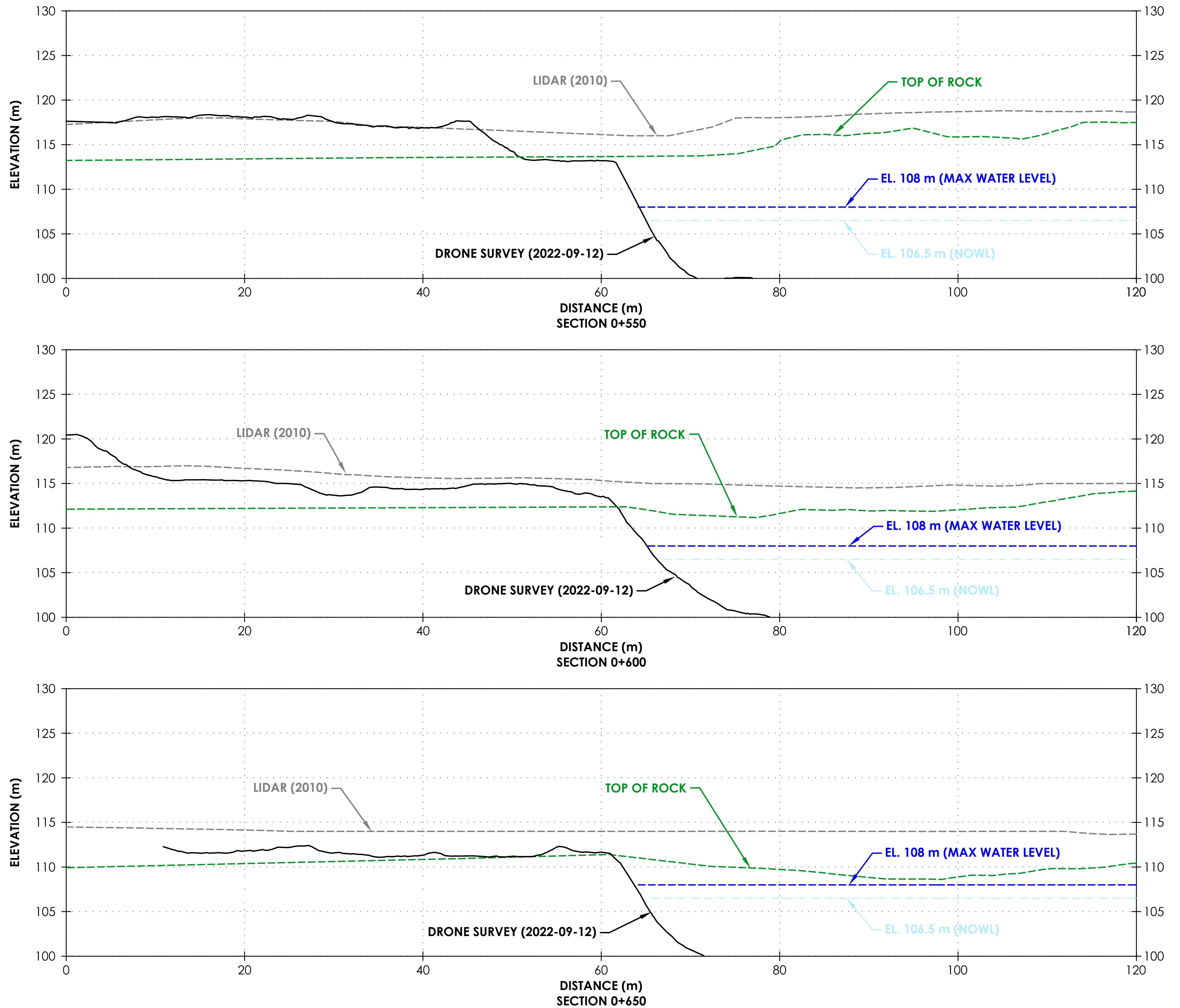
CLOSURE

We trust the information provided within this memorandum meets your current requirements. If you have any questions, please contact us at your convenience.

Stantec Consulting Ltd.

Jeff Gilchrist P.Eng.
Senior Associate, Geotechnical Engineer

Attachment: Figures 10 to 13



THIS DRAWING ILLUSTRATES SUPPORTING INFORMATION SPECIFIC TO A STANTEC CONSULTING LTD. REPORT AND MUST NOT BE USED FOR OTHER PURPOSES.

Reference:
1. LIDAR DATA PROVIDED BY CONESTOGA-ROVERS & ASSOCIATES (2010)
2. DRONE SURVEY (2022-09-12) AND TOP OF ROCK DATA PROVIDED BY ATLANTIC MINING NS INC.

PIT PERIMETER SECTIONS 0+550 TO 0+650

TOUQUOY GOLD PROJECT
HALIFAX COUNTY, NOVA SCOTIA

Client: ATLANTIC MINING NS INC.

Job No.:	121619250
Scale:	1 : 500
Date:	2022 10 20
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App'd By:	PD
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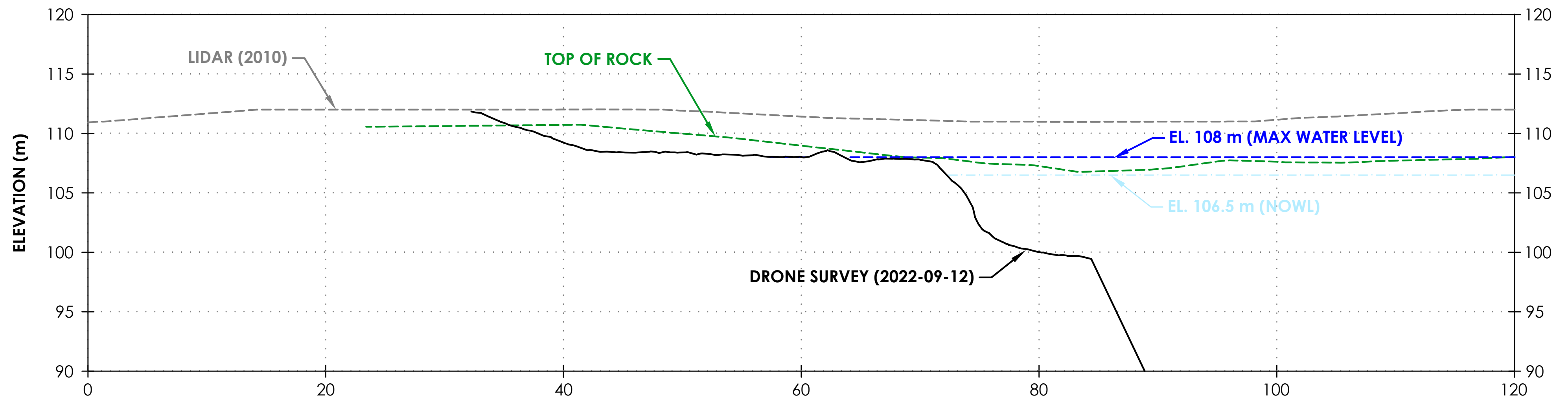

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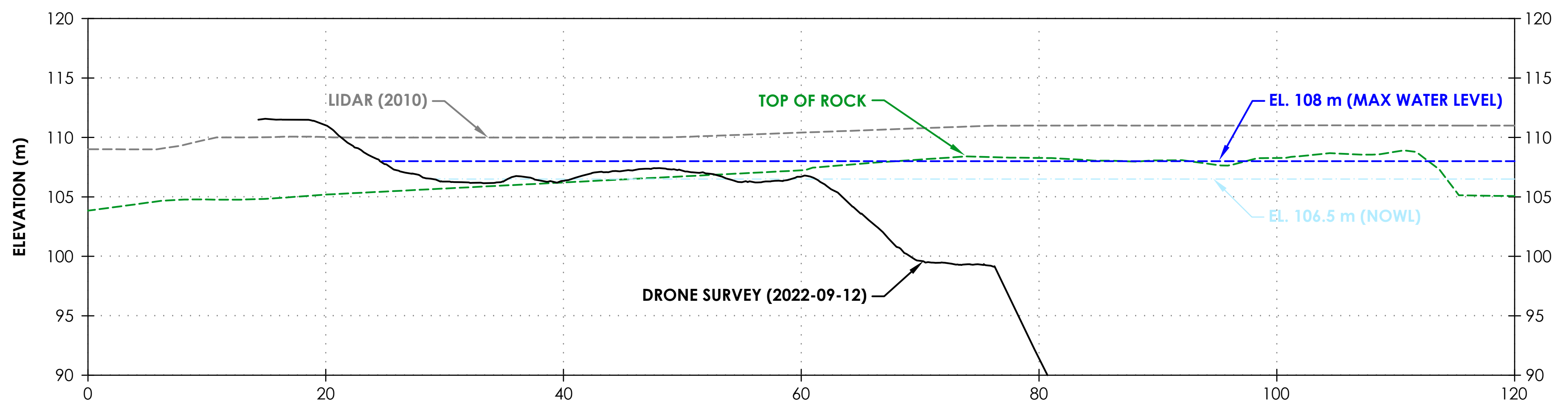

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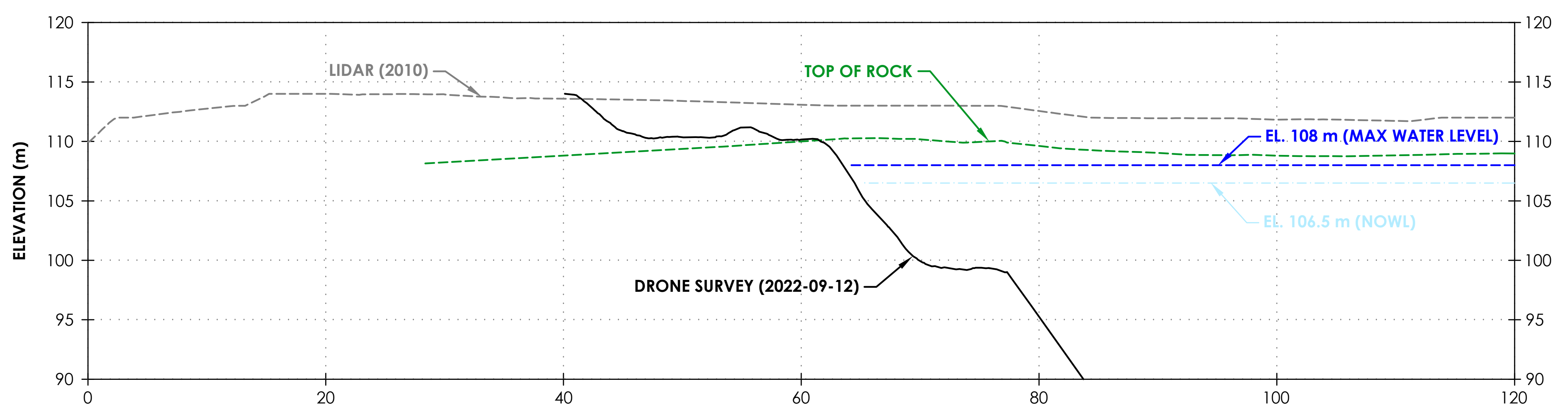

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Reference:
1. LIDAR DATA PROVIDED BY CONESTOGA-ROVERS & ASSOCIATES (2010)
2. DRONE SURVEY (2022-09-12) AND TOP OF ROCK DATA PROVIDED BY ATLANTIC MINING NS INC.

PIT PERIMETER SECTIONS 0+800 TO 1+000

TOUQUOY GOLD PROJECT
HALIFAX COUNTY, NOVA SCOTIA

Client: ATLANTIC MINING NS INC.

Job No.:	121619250
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Date:	2022 10 20
Dwn. By:	JL
App'd By:	PD
Dwg. No.	11
Rev. No.	0

Stantec

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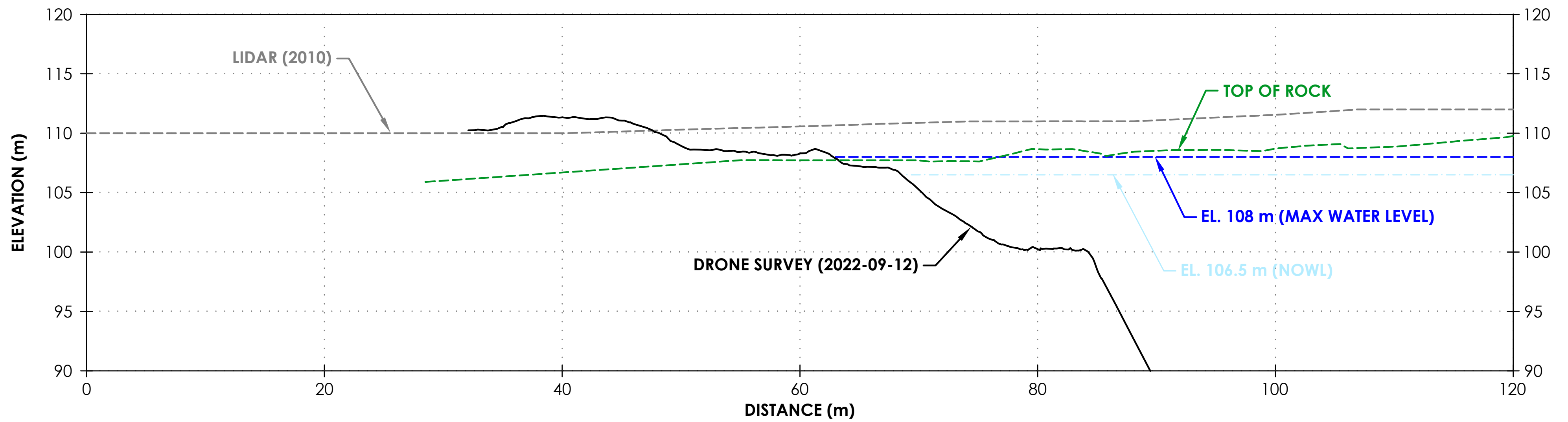

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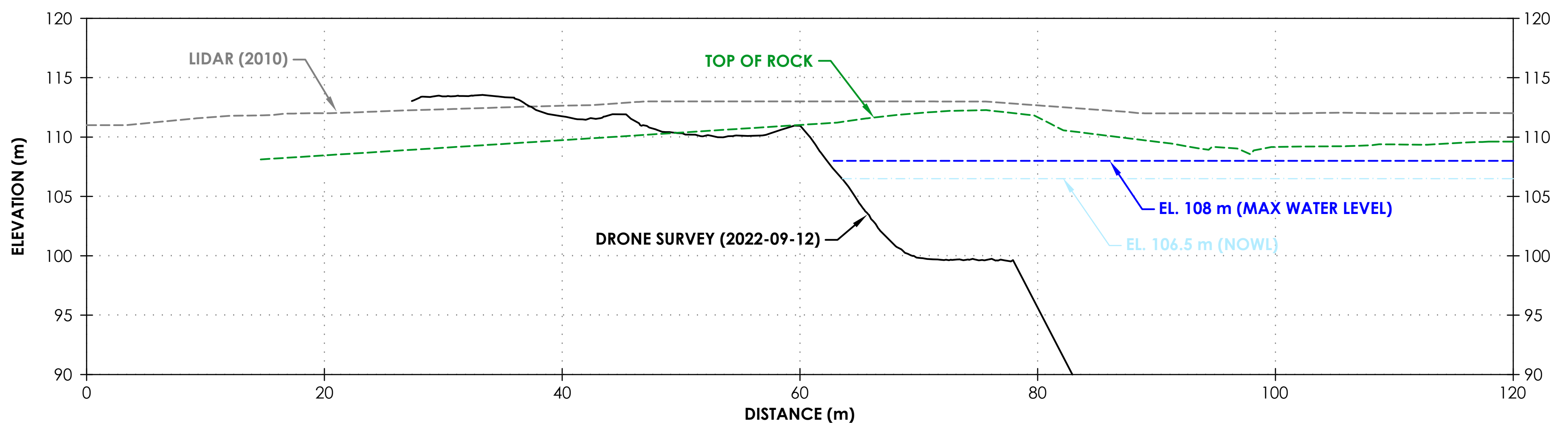

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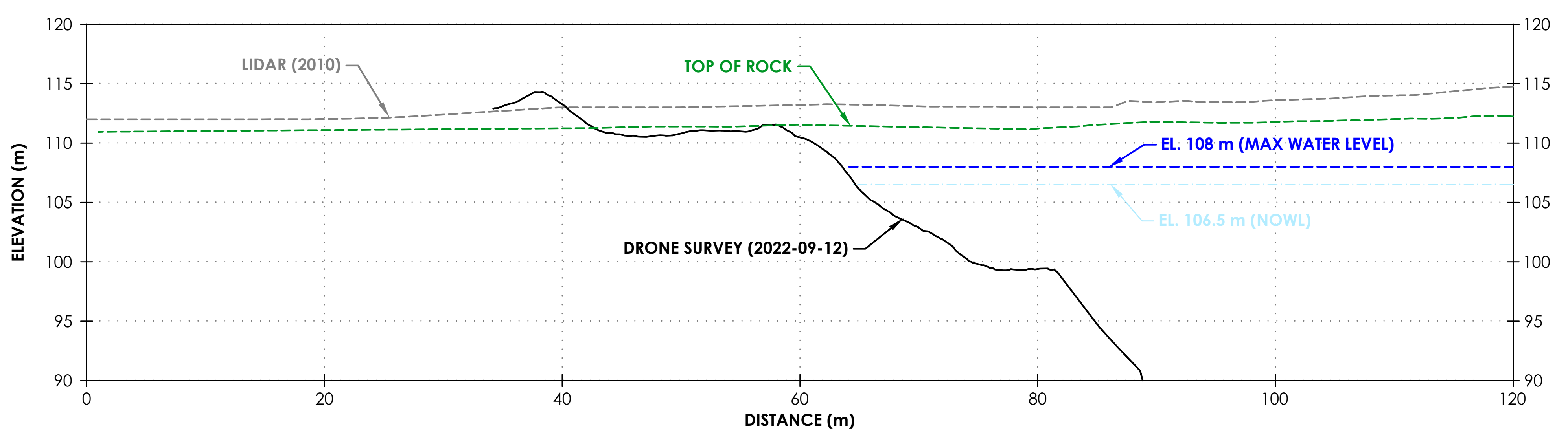

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Reference:
1. LIDAR DATA PROVIDED BY CONESTOGA-ROVERS & ASSOCIATES (2010)
2. DRONE SURVEY (2022-09-12) AND TOP OF ROCK DATA PROVIDED BY ATLANTIC MINING NS INC.

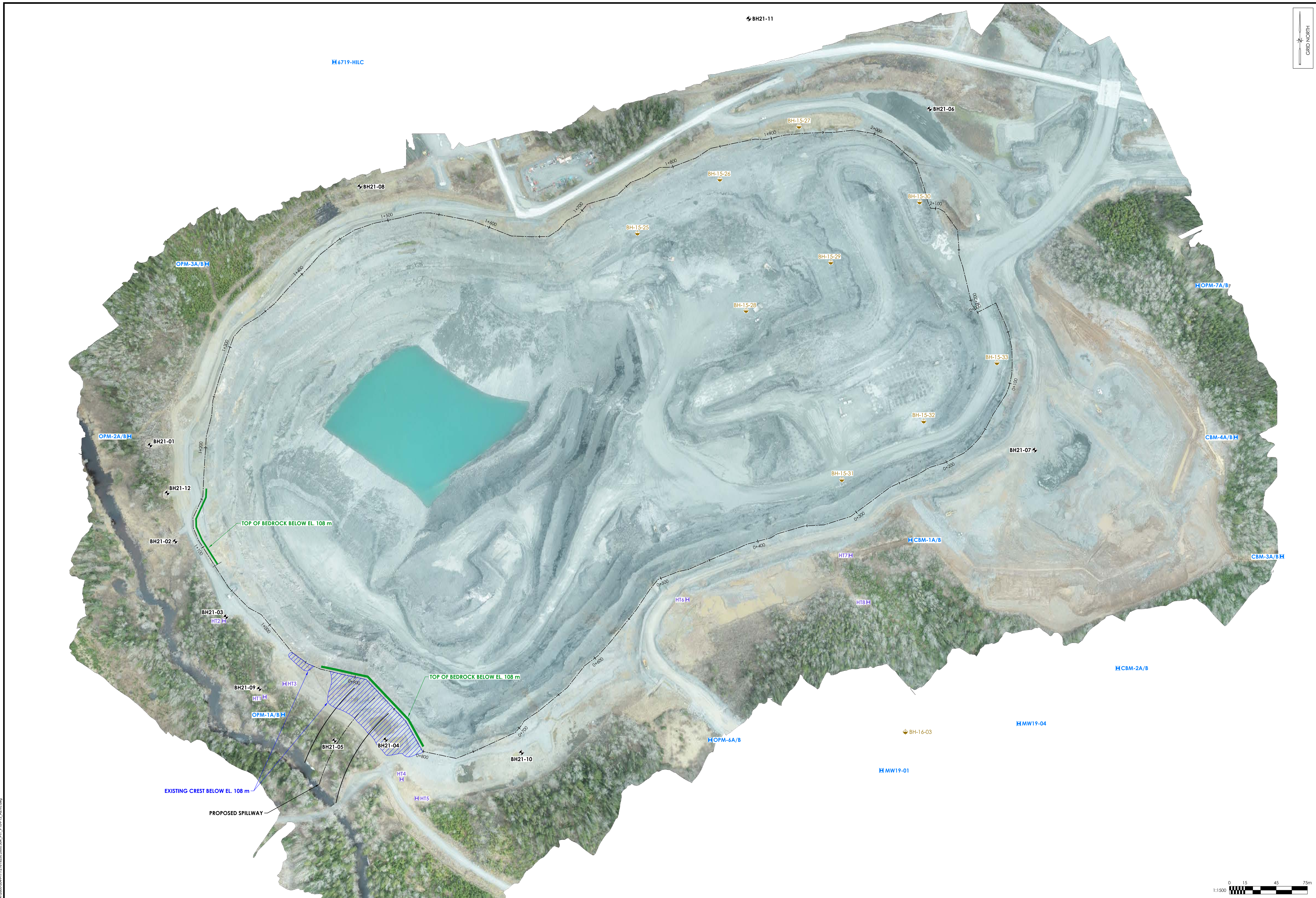
PIT PERIMETER SECTIONS 1+150 TO 1+250

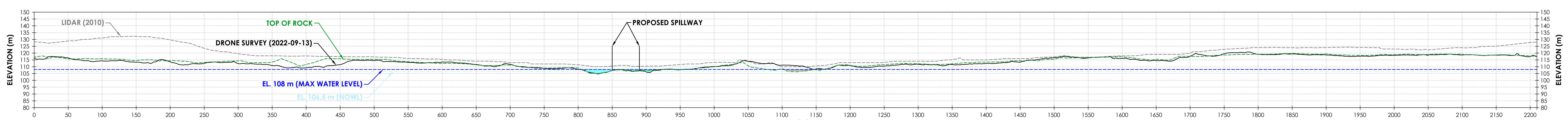
TOUQUOY GOLD PROJECT
HALIFAX COUNTY, NOVA SCOTIA

Client: ATLANTIC MINING NS INC.

Job No.:	121619250
Scale:	1 : 500
Date:	2022 10 20
Dwn. By:	JL
App'd By:	PD
Dwg. No.	12
Rev. No.	0

Stantec





PIT CREST PROFILE
VERTICAL SCALE: 1:1500
HORIZONTAL SCALE: 1:3000

Stantec
845 Prospect Street
Fredericton, New Brunswick, Canada, E3B 2T7
Tel. 506.452.7000
www.stantec.com

Legend

LEGEND

- PIT CREST BELOW EL. 108 m
- TOP OF BEDROCK AT CREST BELOW EL. 108 m
- PIT CREST BASELINE AND STATION REFERENCE (BASED ON DRONE 2022-09-12 SURVEY)
- GROUNDWATER MONITORING LOCATION
- HT MONITORING WELL
- HISTORIC BOREHOLE LOCATION (2015/2016)
- 2021 BOREHOLE LOCATION

Notes

1. LIDAR DATA PROVIDED BY CONESTOGA-ROVERS & ASSOCIATES (2010). ACTUAL FIELD CONDITIONS MAY VARY.
2. WATERCOURSES BASED ON NOVA SCOTIA PROVINCIAL (SNSMR, 2006) AND McCALLUM ENVIRONMENTAL DATA.
3. FINAL PIT DESIGN AND DRONE SURVEY PROVIDED BY ATLANTIC MINING NS INC.

STAMP

STAMP

No.	DETAILS	BY	APPD.	DATE
0	ISSUED FOR INFORMATION PURPOSES	PD	PD	2022-10-20

REVISIONS

CLIENT:
ATLANTIC MINING NS INC.

PROJECT:
TOUQUOY GOLD PROJECT

PROJECT LOCATION:
HALIFAX COUNTY, NOVA SCOTIA

JOB No.:	SCALE:	DATE:
121619250	AS NOTED	2022-10-20
DRAWN BY: JDL	DESIGNED BY: PDD	APPROVED BY: PDD

DRAWING TITLE:
OPEN PIT PLAN AND PIT CREST PROFILE

DRAWING No.: **13**
REVISION No.: **0**

Attachment 3
Groundwater Modelling Information

Memo

To:	Sara Wallace/Christian Deveau	From:	Walter Weinig, PG, PMP, QP Mark Flinn, P.Eng., MBA
	Atlantic Mining Nova Scotia Inc.		Stantec Consulting Ltd.
File:	121619250	Date:	December 6, 2022

Reference: Updated Environmental Assessment Responses – Questions 1.C and 1.D. Touquoy Gold Project Site Modifications Addendum – Groundwater Modeling

In response to the letter from Nova Scotia Environment and Climate Change (NSECC) dated May 12, 2022 and further comments provided in a memorandum dated November 14, 2022 pertaining to the Touquoy Gold Project Site Modifications Addendum, Stantec is pleased to provide the following additional information to address questions 1.C and 1.D as related to the groundwater modeling work.

1.C

Provide a clear conceptual outline with all significant processes for the groundwater flow of a conservative solute from the pit to the Moose River.

The conceptual basis for the Touquoy Pit groundwater flow and solute transport model are described in two previous reports (Stantec, 2021 and Stantec, 2022). Information provided below is summarized from those two documents.

The groundwater flow and solute transport system between the Touquoy Pit and the Moose River is dominated by the processes of advection and dispersion. Advection refers to the transport of solutes due to the movement of groundwater within which those solutes are dissolved. Dispersion refers to the effects of pore-scale variability of flow paths through the aquifer matrix which causes a natural scattering or spreading of the solute along the flow path.

For the Touquoy transport evaluation, all solutes have been modeled as conservative species. The assumption of a conservative solute means that effective transport velocities are the same as groundwater velocities, with no interaction between the dissolved solute and the aquifer matrix. The shallowest zone of groundwater flow and corresponding solute transport in the vicinity of the Touquoy Pit is anticipated to be the uppermost weathered bedrock unit.

Chemical diffusion is accounted for in the Touquoy solute-transport model but is a relatively minor component of the overall flow and transport system. Chemical diffusion refers to the process of solute transport from areas of high concentration to areas of low concentration due to the concentration gradient independent of the hydraulic gradient.

As described more fully below, results of the groundwater flow model indicate that conservative solutes would move very slowly between the Touquoy Pit and the Moose River in response to the processes of advection and dispersion. This is due to the combined effect of a small hydraulic gradient and the hydraulic conductivity of the aquifer. Depending on the relationship between pit water surface elevations and Moose River elevations, gradients could be either from the pit toward the river, or from the river toward the pit. Slow groundwater velocities are consistent with the conceptual model for the site and observed conditions during mining.

Evaluate the hydraulic attenuation factors being assumed and describe how these are incorporated into the groundwater model.

Hydraulic attenuation refers to changes in groundwater concentrations that occur along a flow path due to natural processes such as sorption onto aquifer solids, geochemical reactions, dilution, and chemical or radiological decay. Hydraulic attenuation factors do not play important roles in the predicted movement of solutes between the Touquoy Pit and the Moose River. Conservative solutes move slowly due to the processes of advection and dispersion as described above. Because they move slowly, conservative solutes do not move very far past the southwestern pit wall, the flow path is short, and the effects of attenuation processes are limited.

For completeness in the solute transport evaluation, attenuation factors were estimated based on the assumption of a conservative solute as described above. Hydraulic attenuation factors incorporated into the modeling process include dispersion, diffusion, and dilution due to groundwater recharge. Because dissolved species considered in the evaluation are assumed to be conservative other potential attenuation factors such as sorption, geochemical reactions along the flow path, and decay are not incorporated into the numerical flow and transport model.

Dispersion was represented in the groundwater flow and transport model through dispersivity parameters. The longitudinal dispersivity factor was set at 5 meters (m) while transverse and vertical dispersivity were each set at 1 m (Stantec, 2022). Dispersivity values were assumed based on the scale of the transport distance between the Touquoy pit and the Moose River.

Diffusion was represented in the groundwater flow and transport model through a diffusion coefficient. The solute was assumed to have the diffusion coefficient of chloride, which generally behaves as a conservative solute in groundwater flow systems. The value of the diffusion coefficient was set at 1.4×10^{-9} meters squared per second based on the values used for chloride, although chloride is not a constituent of concern for Touquoy (Stantec, 2022).

Areal recharge due to precipitation is represented through a spatially distributed recharge value. Recharge from precipitation is assumed to contain no dissolved constituents, consistent with rainwater or snow. The process of recharge therefore gradually attenuates concentrations through dilution as a solute moves away from the Touquoy pit. Because solutes are only predicted to move a limited distance past the southwestern portion of the pit wall, the practical effect of dilution as an attenuation factor is limited in this case.

Describe what mechanisms in the model would result in limitations to non-reactive solute transport. If the new evaluation indicates a change in conceptual approach, update and re-run the groundwater solute transport model.

Non-reactive (i.e. conservative) solute transport is calculated in the groundwater flow and solute transport model based on the processes described above. While the Touquoy Pit is being filled with tailings, groundwater gradients are inward toward the pit due to the effects of dewatering during active mining. Solute transport away from the Touquoy Pit would not be expected to occur as the groundwater flow is toward the pit during that period.

Rates and directions of solute transport in the post-closure time frame will depend on the magnitude and direction of the hydraulic gradient between the pit and the Moose River and the significant processes described above. Expected gradients between the Touquoy Pit and the Moose River can be calculated. The estimated water surface elevations of the Moose River reach where it passes closest to the Touquoy Pit range from 107.07 masl near where the outlet of the proposed outflow structure would connect to the river to 108.71 masl at a point about 300 meters upstream from the proposed outlet. The distance between the Moose River and the pit wall is about 100 meters along that reach.

Tables 1 and 2 present the calculated groundwater gradients between the Touquoy Pit and the Moose River under two post-closure scenarios: 1) water level elevation in the pit at its maximum of 108 masl (Table 1); and 2) water level elevation in the pit at its normal post-closure level of 106.5 masl (Table 2). As seen in Table 1, gradients under the 108 masl water elevation assumption range from 0.0071 meters per meter (m/m) toward the pit in the upstream portion of the Moose River reach to 0.0098 (m/m) toward the river in the downstream portion of the reach. Values presented in Table 2 show that gradients under the 106.5 masl pit water elevation range from 0.0052 m/m to 0.0221 m/m from the Moose River toward the Touquoy Pit.

This evaluation indicates that under normal post-closure conditions the pit would act as a hydraulic sink and dissolved solutes would not move from the pit toward the Moose River. If water levels rise above 107.02 masl and up to the spillway elevation of 108 masl there would be a small groundwater gradient toward the Moose River from the southwestern corner of the pit. A clay liner has been proposed for installation in this area to further minimize the potential for solutes from the pit to impact groundwater in the area between the pit and the Moose River. The direction of the groundwater gradient would remain toward the pit in the northwestern portion of the pit wall, where the Moose River water elevation would be above 108 masl.

Table 1 Calculated Groundwater Gradients Between Touquoy Pit and Moose River, Pit Water Level 108 masl

Location	River Elevation (masl)	Pit Water Surface (masl)	Distance (m)	Gradient (m/m)	Direction
Upstream Moose River	108.71	108	100	0.0071	Toward Pit
Downstream Moose River	107.02	108	100	0.0098	Toward River

Table 2 Calculated Groundwater Gradients Between Touquoy Pit and Moose River, Pit Water Level 106.5 masl

Location	River Elevation (masl)	Pit Water Surface (masl)	Distance (m)	Gradient (m/m)	Direction
Upstream Moose River	108.71	106.5	100	0.0221	Toward Pit
Downstream Moose River	107.02	106.5	100	0.0052	Toward Pit

No other mechanisms in the model limit the calculations of non-reactive solute transport. Significant processes and mechanisms are captured in the numerical model and no further runs are necessary.

1.D

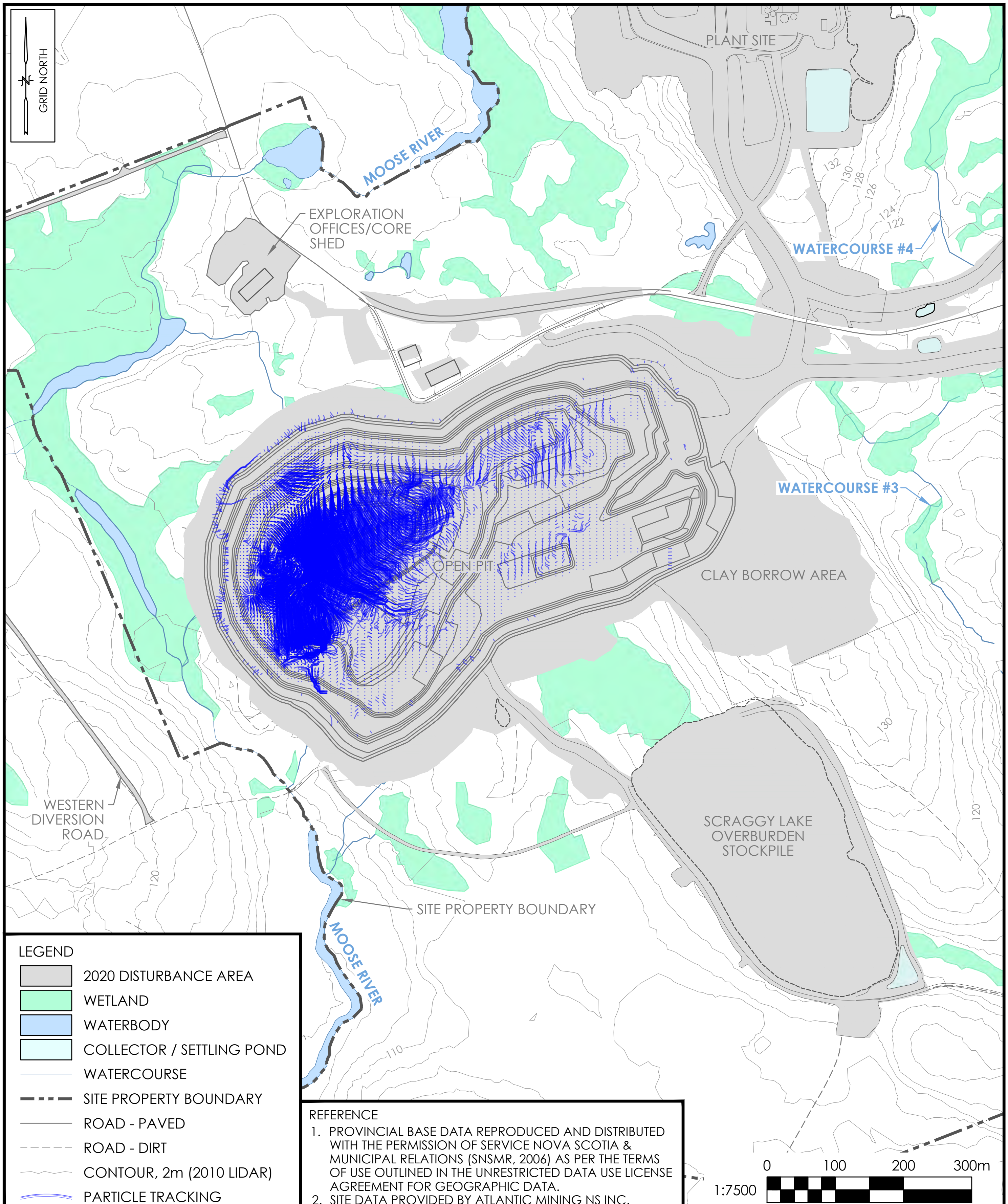
Provide particle flow path tracking for the area of the groundwater model between the pit and Moose River.

In response to this request the updated groundwater flow and solute transport model described in Stantec (2022) was used to develop particle tracks represented in the figures below. Particles shown in the figures were started in each cell representing tailings in Layer 4 of the model and run for 500 years post closure. Layer 4 represents the uppermost portion of the weathered bedrock and is the shallowest layer exhibiting saturated groundwater conditions. This is consistent with the site conceptual model.

Figures 1 and 2 illustrate the predicted particle tracks. Figure 1 shows particle tracks within the full extent of the Touquoy Pit and the portion of the Moose River that flows nearest the pit. Figure 2 shows the same information but focuses on the western portion of the Touquoy Pit to better visualize the predicted distances and directions that particles moving with groundwater would cover.

The particle tracks in the interior of the pit show movement within the tailings due to hydraulic conditions within the pit. Particle tracks along the northern, eastern, and southern edges of the pit show that solutes would not be expected to move from the pit into the adjacent aquifer. Particle tracks along the western and southwestern edges of the pit indicate that transport velocities are small and the resulting transport distances are low. This is due to a combination of relatively small hydraulic gradient between the pit and the Moose River as presented in Table 1 above and the estimated hydraulic conductivity of the uppermost portions of the aquifer in that region. We consider the particle track results to be consistent with the conceptual site model based on the available information, data, and model output.

The groundwater flow model and the particle tracking results shown below indicate that groundwater has the potential to moves slowly out of the western edge of the pit toward the Moose River. While impacts to the Moose River are predicted to be small and would only occur if water levels in the pit are above the normal design operating level of 106.5 masl, placement of a clay liner along the western wall of the pit has been proposed as a mitigation measure. Design drawings for the clay liner have been included in a previous submittal.



THIS DRAWING ILLUSTRATES SUPPORTING INFORMATION SPECIFIC TO AN ATLANTIC GOLD CORPORATION MEMO AND MUST NOT BE USED FOR OTHER PURPOSES.

PARTICLE TRACKS FOR FULL EXTENT OF TOUQUOY PIT

TOUQUOY GOLD PROJECT
HALIFAX COUNTY, NOVA SCOTIA

Job No.:	121619250
Scale:	1 : 7,500
Date:	2022 12 05
Dwn. By:	JL
App'd By:	WW
Fig. No.:	1

Client: ATLANTIC MINING NS INC.

Stantec

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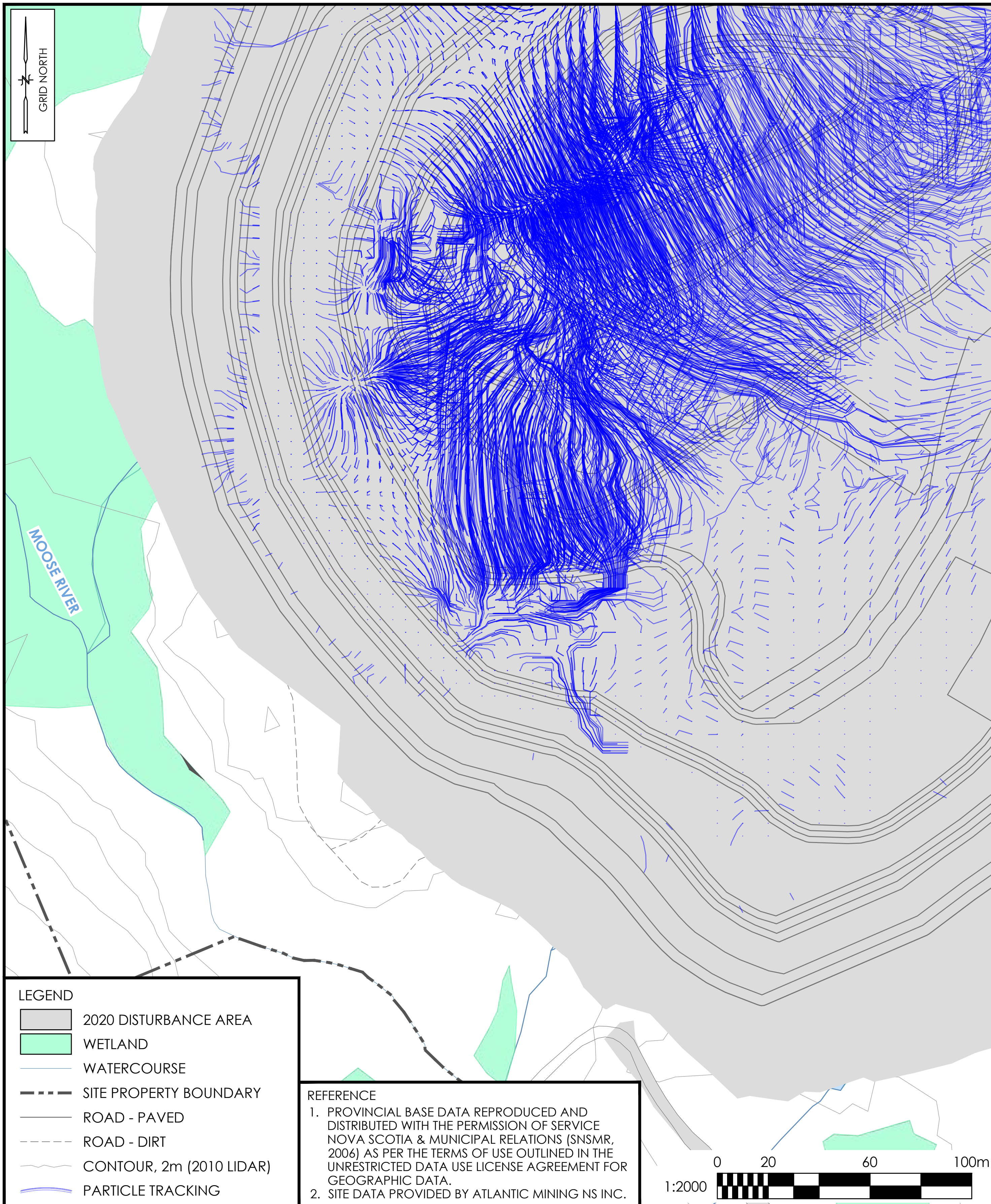

LEGEND

- 2020 DISTURBANCE AREA
- WETLAND
- WATERCOURSE
- SITE PROPERTY BOUNDARY
- ROAD - PAVED
- ROAD - DIRT
- CONTOUR, 2m (2010 LIDAR)
- PARTICLE TRACKING

REFERENCE

1. PROVINCIAL BASE DATA REPRODUCED AND DISTRIBUTED WITH THE PERMISSION OF SERVICE NOVA SCOTIA & MUNICIPAL RELATIONS (SNSMR, 2006) AS PER THE TERMS OF USE OUTLINED IN THE UNRESTRICTED DATA USE LICENSE AGREEMENT FOR GEOGRAPHIC DATA.
2. SITE DATA PROVIDED BY ATLANTIC MINING NS INC.

THIS DRAWING ILLUSTRATES SUPPORTING INFORMATION SPECIFIC TO AN ATLANTIC GOLD CORPORATION MEMO AND MUST NOT BE USED FOR OTHER PURPOSES.

PARTICLE TRACKS FOR WESTERN PORTION OF TOUQUOY PIT

TOUQUOY GOLD PROJECT
HALIFAX COUNTY, NOVA SCOTIA

Client:	ATLANTIC MINING NS INC.
Job No.:	121619250
Scale:	1 : 2,000
Date:	2022 12 05
Dwn. By:	JL
App'd By:	WW
Fig. No.:	2

Stantec

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If hydraulic conductivities closer to actual; field measured k values are used, as well as assuming pit lake levels of 108 masl, how do the particle flowpaths change? (Additional question from the November 14, 2022 NSECC memorandum)

Under this hypothetical scenario, the general directions of flowpaths between the Touquoy Pit and the Moose River would be similar to those presented in Figures 1 and 2 above. This is the case because the calculated gradients between the pit and the river would be the same in both magnitude and direction.

With respect to hydraulic conductivity (K) values, those used in the calibrated model are generally within the expected range as shown in Table 2.4 of the udpated modelling memo (Stantec, 2022). K values for the overburden in the calibrated model are at the upper end of the expected range and for the weathered bedrock are near the low end of the expected range. K values in the calibrated model are only below the expected range for the deepest competent bedrock layers, where K values were anticipated to be very low already. The effects on particle tracks in the upper, more permeable zones of using K values near the bottom of the expected range in deep layers would likely be minimal.

The model calibration process results in K estimates over a broader area than individual aquifer tests and incorporates additional information from measured water levels. Thus, the K estimates in the calibrated model are considered representative of conditions at an appropriate scale for the project area. Using a different set of K values would most likely result in a model that is less well calibrated. In other words, the model using different K values selected from individual field tests would likely not represent measured heads and gradients as well as the calibrated model. There would be limited value in assessing particle tracks resulting from a model that is not as representative of project-scale conditions as the calibrated model.

References:

Stantec, 2021. Groundwater Flow and Solute Transport Modelling to Evaluate Disposal of Tailings in Touquoy Open Pit: Final Report. Prepared for Atlantic Mining NS Inc., July.

Stantec, 2022. Report Update: Groundwater Flow and Solute Transport Modelling to Evaluate Disposal of Tailings in Touquoy Open Pit. Prepared for Atlantic Mining NS Inc, March.

Attachment 4

Pore Water Quality, Open Pit Discharge Water Quality

Stantec

Memo

To:	Sara Wallace	From:	Mark Flinn, P.Eng., MBA Rachel Jones, P.Eng.
	Atlantic Mining Nova Scotia Inc.		Stantec Consulting Ltd.
File:	121619250	Date:	October 21, 2022

Reference: Environmental Assessment Responses – Questions 1.e. Touquoy Gold Project Site Validate Predicted Tailings Pore Water Quality and Predicted Open Pit Lake Discharge Water Quality

In response to the letter from Nova Scotia Environment and Climate Change (NSECC) dated May 12, 2022, pertaining to the Touquoy Gold Project Site Modifications Addendum, we provide the following information to address the following comment:

> *"Present information to validate predicted tailings pore water quality and predicted open pit lake discharge water quality. Compare predicted values against water quality within the existing Tailings Management Facility." (NSECC 2022)*

Water quality predictions for the Pit Lake are presented for the first year of effluent discharge once the Pit Lake is full. These predictions also account for 2.5 Mt of waste rock at the bottom of the pit and consideration of the proposed pit slope low permeability liner. Two water quality predictions were modelled:

Base Case:

- The predictions presented in the Touquoy EARD only considered the Touquoy Pit Expansion tailings.
- Based on the water quality modelling that was presented in the integrated water and tailings management plan attached to the EARD (2021), the annual mean water quality concentration of the Pit Lake was calculated in the base case at year 6 when it is predicted that the base case pit will fill and excess water discharge will be required

Continued Operations:

- The base case predictions were revised to consider continued tailings deposition from other deposits, such as Beaver Dam or FMS, until the pit is full (i.e., tailings surface reaches an elevation of 106.0 m). For example, the Touquoy expansion tailings deposited in the pit in addition to tailings deposited from proposed project.In the continued operations case the pit water level will reach the excess overflow level in 4 years.

For both the base case and continued operations, without water treatment the Pit Lake water quality will improve overtime. To facilitate Pit Lake discharge earlier than the time required for natural water quality improvements, water treatment is planned.

Reference: Environmental Assessment Responses – Questions 1.e. Touquoy Gold Project Site Validate Predicted Tailings Pore Water Quality and Predicted Open Pit Lake Discharge Water Quality

As summarized in Table 1, water quality predictions are compared to historical water quality for the parameters that had elevated concentrations near or above MDMER effluent end of pipe and NSE receiving water guidelines. In reference to Table 1, we provide the following comments.

- As expected, the mean predicted water quality concentrations based on the base case tailings pore-water source terms (Lorax 2008) are higher than the historical mean of the exiting TMF water quality. This is a result of how the source terms were derived which conservatively assumed loading of parameter concentrations overtime. This conservative assumption was made since there was limited TMF water quality data available when the source terms were derived (Lorax 2018).
- The historical TMF quality shows the mill treatment circuit has been effective at maintaining consistent process water quality. Therefore, it is concluded that the Pit Lake water quality will also improve as it is reclaimed and treated in the mill . The mill has an air SO_2 cyanide destruct circuit process that oxidizes cyanide and metal cyanide complexes in the tailings prior to discharge to the TMF, this results in lower concentrations of both cyanide and arsenic. These predictions are currently being used to design water treatment strategies to meet MDMER limits and other regulatory criteria.
- Based on the historical water quality in the TMF, the water quality predictions, without considering process water treatment, were adjusted to represent the expected water quality when considering the improved reclaim process water quality. The adjustment was applied by multiplying the water quality predictions by the ratio of mean water quality predictions without water treatment by the mean TMF water quality. The expected water quality is presented in Table 1. The justification of water quality predictions with and without process water treatment is also summarized in Table 1 for each parameter.

Table 1 Base and Continued Operation Case Predictions

Parameter	Units	NSE Tier 1 EQS/ CCME FAL	Existing TMF Water Quality	Mean Predicted Pit Lake Water Quality Not Considering Process Water Treatment [2]		Expected Pit Lake Water Quality Considering Process Water Treatment	
			SW-DW Station[1] (2019-2022)	Base Case (Year 6)	Continued Operations (Year 4)	Base Case	Continued Operations
Nitrite (N)	mg/L	0.06	0.77	3.00	3.26	0.71	0.77
Weak Acid Dissociable Cyanide (CN)	mg/L	0.005	0.034	0.239	0.383	0.014	0.022
Dissolved Aluminum (Al)	µg/L	10	89	127	140	69	76
Total Arsenic (As)	µg/L	5	477	1,663	2,650	191	304
Total Cadmium (Cd)	µg/L	0.01	0.02	0.02	0.03	0.01	0.02
Total Cobalt (Co)	µg/L	10	86	126	200	34	54
Total Copper (Cu)	µg/L	2	35	70	112	14	22
Total Iron (Fe)	µg/L	300	590	65	75	65	75
Total Lead (Pb)	µg/L	1.00	1.10	0.46	0.65	0.46	0.65

Table 1 Notes: 1 = The TMF water quality was based on weekly water quality sampling at station SW-DW from January 1, 2019, to July 12, 2022. The first operational year of data was excluded from the statistical mean, median, max and min as the water quality treatment was optimized during the commissioning phase. 2 = The tailings quality is based on the base case tailings pore-water source terms (Lorax 2018 &2022). The waste rock stored in the bottom of the pit will be incapsulated from the water and tailings in the pit limiting oxidation potential, the deposited waste rock material is expected to insignificantly change the water quality in the Pit Lake. The base case water quality predictions have been presented in the Water and Tailings Management Plan (Stantec 2021); please refer to this document for how the predicted water quality not considering process water treatment were derived.
Cyanide & Nitrite - Mean annual water quality predictions without treatment at the time the Pit Lake is full for Cyanide is almost 100% higher than the average observed TMF water quality and approximately 20% higher than that observed for Nitrite. The air SO_2 destruct circuit oxidizes and degrades Cyanide species into cyanate, ammonia, nitrates, and nitrites. As discussed above, based on a review of the historical TMF water quality, additional loading of these parameters overtime has not been observed and source term predictions result in higher predicted concentrations to what we now expect of Pit Lake quality. The existing air SO_2 destruct circuit process is effective at reducing Cyanide species concentrations of reclaimed tailings effluent for processing. As natural degradation occurs in the Pit Lake during filling, the cyanide concentrations significantly decrease overtime until finally degraded into nitrates and nitrites.
Dissolved aluminum – Predictions of dissolved aluminum concentrations are higher than historical water quality but within the maximum ranges measured in the TMF. As the pit fills quicker with continued operation, the predicted aluminum concentration without treatment is higher compared to the Base Case. The predicted concentration of Dissolved Aluminum continues to decrease overtime and with treatment.
Arsenic & Lead – Mean annual water quality predictions without treatment at the time the Pit Lake is full for Arsenic is approximately 80% higher than the mean observed TMF water quality. Predicted concentrations of Lead were within the expected range of the observed TMF water quality. Arsenic is a metalloid that is naturally occurring in the ore rock that has an affinity with elements such as lead. Lower Arsenic concentrations will in-turn result in lower Lead concentrations. In addition, the expected water quality did not consider the processing of lower grade ore that is planned for the pit expansion. The low-grade ore has lower arsenic concentrations than what is naturally occurring in the high-grade ore that has been processed thus far. Therefore, the low-grade ore will contain lower concentrations of Arsenic, further improving water quality of tailings effluent than the predictions. This assumption results in a conservatively higher concentration of Arsenic than predicted. The Base case concentration with effluent discharge in year 6 is lower than the with continued operation as effluent discharge occurs in year 4 and Arsenic concentrations decrease overtime.
Cadmium – Cadmium forms to mineral particles in the water column and is reduced through sedimentation and by PH adjustment. Water quality predictions are within the historical water quality ranges measured in the TMF for this parameter. The concentration of Cadmium decreases overtime; as the time to fill the pit is accelerated under continued operations.
Cobalt - Mean annual water quality predictions without treatment at the time the Pit Lake is full for Cobalt is approximately 60% higher than the average observed TMF water quality. As Cobalt forms a strong bond with cyanide, cobalt concentrations are expected to reduce overtime as cyanide degrades and cobalt precipitates. Contrary to the source term assumptions, elevated concentrations of cobalt and lead overtime are not expected. Cobalt concentrations are lower in the Base Case predictions without treatment than continued operations as Cobalt concentrations decrease overtime with further sedimentation and dilution.

Reference: Environmental Assessment Responses – Questions 1.e. Touquoy Gold Project Site Validate Predicted Tailings Pore Water Quality and Predicted Open Pit Lake Discharge Water Quality

Copper- Mean annual water quality predictions at the time the Pit Lake is full for Copper is approximately 70% higher than the mean observed TMF water quality. The cyanide metallic complexes of copper and other parameters such as Magnesium, Aluminum, Iron, and Sodium are also oxidized in the mill treatment circuit (i.e., air SO2 process) which has been found to be effective. As discussed above, based on a review of the historical TMF water quality, additional loading of these parameters overtime has not been observed and source term predictions result in higher predicted concentrations to what is expected of Pit Lake quality. The base case concentration with effluent discharge in year 6 is lower than with continued operations as effluent discharge occurs in year 4 and concentrations decrease overtime.
Iron - Mean annual water quality predictions without treatment at the time the Pit Lake is full for Iron is an order of magnitude lower than the average observed TMF water quality. In addition, source terms were developed based on dissolved concentrations, not considering the suspended particles in the water column thus resulting in lower iron concentrations. Measured total iron concentrations in the TMF are elevated due to iron precipitate TSS levels in the pond, shorter residence time and a remnant of the location of the water quality sampling near the decant pumps. The iron concentration in the Pit Lake is expected to be lower than what has been observed in the TMF, the Pit Lake pond area is expected to be larger than the TMF pond promoting sedimentation, the Pit Lake residence time is much longer than the TMF (i.e. up to 4 to 6 years) and the tailings will be covered by water limiting potential oxidation and iron participate rather than perimeter beaches at the TMF. Discharge from the Pit Lake through the spillway will not occur with process water reclaim.

References:

Lorax Environmental Services Ltd. 2018. Beaver Dam Project Geochemical Source Term Predictions for Waste Rock, Low-Grade Ore, Tailings and Overburden. Prepared for Atlantic Gold Corporation.

Lorax Environmental Services Ltd. 2022. Touquoy Gold Mine - TMF Geochemical Source Term Update (2022). Prepared for Atlantic Gold Corporation on May 4, 2022.

Stantec. 2022. Report Update: Groundwater Flow and Solute Transport Modelling to Evaluate Disposal of Tailings in Touquoy Open Pit. Prepared for Atlantic Mining NS Inc. March 20222.

Stantec Consulting Ltd. 2021. Touquoy Integrated Water and Tailings Management Plan.

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Attachment 5

Stratigraphic Sections

Stantec

Memo

To:	Sara Wallace	From:	Paul Deering, P.Eng.
Cc	Mark Flinn, P.Eng.		
	Titia Praamsma PhD, P.Geo.		
	Jeff Gilchrist, P.Eng.		
File:	121619250.5500	Date:	December 9, 2022
Doc No.	**MEM-017-5500-B-9DEC22**	Revision:	D

Reference: Touquoy In-Pit Tailings Deposition – NSECC IRs – Stratigraphic Sections

In response to a letter received from Nova Scotia Environment and Climate Change dated May 12, 2022, we provide the following in response to the Minster's request to additional information regarding the geological layers and corresponding hydraulic conductivity measures in the open pit area. The specific request under the heading *Water Modeling* is as follows:

> *Define the stratigraphy geologic layers (including overburden and upper weathered bedrock layers) and corresponding hydraulic conductivity measurements within and surrounding the open pit mine show how these are matched with the layers used in the groundwater model.*
>
> *Provide in graphical cross-section format, data showing stratigraphic layering through the southern pit wall including geology, fault zones, underground working zones, elevations of the final pit water level, groundwater level and Moose River seasonal water elevations.*

In response to this request attached please find 17 drawings that include the following:

- Figure 1. Drilling and Section Locations - Open Pit
- Figure 2. Geological Section A-A' - View Facing Southwest
- Figure 3. Geological Section B-B' - View Facing Northwest
- Figure 4. Geological Section C-C' - View Facing Northwest
- Figure 5. Geological Section D-D' - View Facing Northwest
- Figure 6. Hydrostratigraphic Section A-A' - View Facing Southwest
- Figure 7. Hydrostratigraphic Section B-B' - View Facing Northwest
- Figure 8. Hydrostratigraphic Section C-C' - View Facing Northwest
- Figure 9. Hydrostratigraphic Section D-D' - View Facing Northwest
- Figure 10. Pit Perimeter Sections 0+550 to 0+650
- Figure 11. Pit Perimeter Sections 0+800 to 1+000
- Figure 12. Pit Perimeter Sections 1+150 to 1+250
- Figure 13. Open Pit Plan and Pit Crest Profile
- Figure 14. Underground Workings and GPR Features Including Drilling Locations
- Figure 15. 3d Model Showing Underground Workings and GPR Zones of Interest
- Figure 16. 3-D Interrelationship of Pit, Underground Workings and 2021 Series Boreholes, Facing Northeast
- Figure 17. 3-D Interrelationship of Pit, Underground Workings and 2021 Series Boreholes, Facing North-Northeast

Reference: Touquoy In-Pit Tailings Deposition – Seepage Mitigation Measures

The modelled and measured range of hydraulic conductivity values for each of the hydrostratigraphic units depicted on Figures 6 through 9 are included in the Table below.

Parameter	Modeled Value	Measured Range	
Hydraulic Conductivity (m/s)			
Stony Till Plain	5.0×10^{-5}	3.78×10^{-6}	9.45×10^{-6}
Weathered Tangier & Moose River Members	1.6×10^{-7}	1.1×10^{-8}	1.4×10^{-6}
Weathered Moose River Member	1.3×10^{-8}	1.1×10^{-8}	1.4×10^{-7}
Competent Tangier & Moose River Members	8.4×10^{-10}	2×10^{-9}	1.6×10^{-7}
Competent Moose River Member	7.4×10^{-12}	2×10^{-9}	3.3×10^{-7}

Modelled as compared to measured hydraulic conductivity values vary by a minimum of an order of magnitude difference because the modelled values are refined through the calibration process. Model calibration is the process of iteratively adjusting the model parameters (such as recharge, hydraulic parameters like conductivity) so that the modeled groundwater flow most closely reflects what is measured in the real world. Aquifer tests, particularly slug tests, provide bulk parameter estimates for a small zone immediately around the well screen with uncertainty in the estimate results. Through model calibration, these well scale results are extended over a much larger area and then tweaked to incorporate the results of multiple water-level observations and other site-specific constraints. As a result, it is not unusual for parameter values in a calibrated model to have variations from the measured values. In this case, the modeled hydraulic conductivity values are in some cases higher than (stony till plain), lower than (competent Tangier & Moose River Members) or within (Weathered Tangier & Moose River Members) the measured range. Both the measured and modeled output values support the conceptual site model which suggests that flow in the competent bedrock will be limited and any groundwater flow at the site will predominantly occur in the weathered bedrock zone and/or at the bedrock – overburden interface. Given that the modeled hydraulic conductivity values in the areas where groundwater flow is most likely to occur are slightly higher than the measured values, the model outputs for flow in these areas will be conservative.

We trust the information provided within this memorandum meets your current requirements. If you have any questions, please contact us at your convenience.

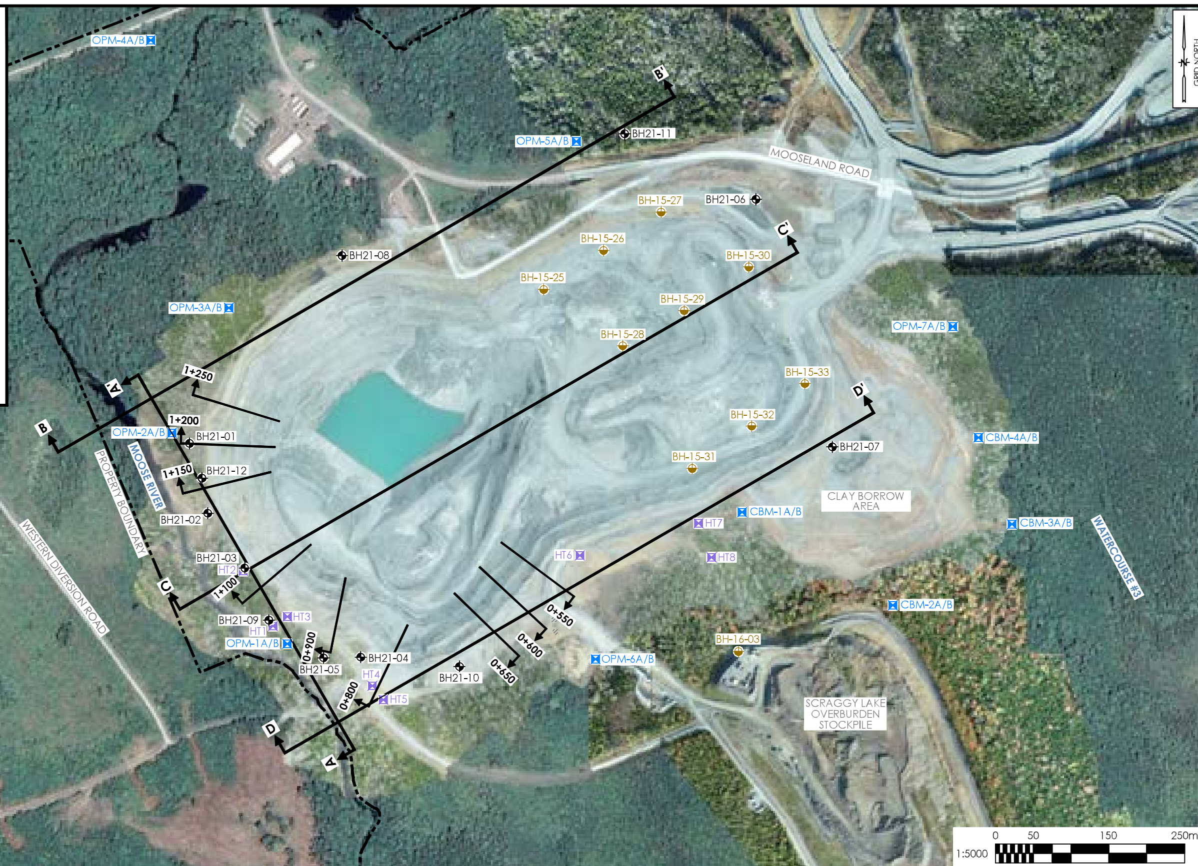
Stantec Consulting Ltd.

Senior Principal

LEGEND

- SITE PROPERTY BOUNDARY
- GROUNDWATER MONITORING LOCATION
- HT MONITORING WELL
- HISTORIC BOREHOLE LOCATION (2015/2016)
- 2021 BOREHOLE LOCATION

SECTION ID	FIGURE REFERENCE
A-A'	SEE FIGURE 2 (GEOLOGICAL) SEE FIGURE 6 (HYDROSTRATIGRAPHIC)
B-B'	SEE FIGURE 3 (GEOLOGICAL) SEE FIGURE 7 (HYDROSTRATIGRAPHIC)
C-C'	SEE FIGURE 4 (GEOLOGICAL) SEE FIGURE 8 (HYDROSTRATIGRAPHIC)
D-D'	SEE FIGURE 5 (GEOLOGICAL) SEE FIGURE 9 (HYDROSTRATIGRAPHIC)
0+550	SEE FIGURE 10
0+600	SEE FIGURE 10
0+650	SEE FIGURE 10
0+800	SEE FIGURE 11
0+900	SEE FIGURE 11
1+000	SEE FIGURE 11
1+150	SEE FIGURE 12
1+200	SEE FIGURE 12
1+250	SEE FIGURE 12



THIS DRAWING ILLUSTRATES SUPPORTING INFORMATION SPECIFIC TO A STANTEC CONSULTING LTD. REPORT AND MUST NOT BE USED FOR OTHER PURPOSES.

Reference:
1. MINE SITE DRONE IMAGES PROVIDED BY ATLANTIC MINING NS INC. (2020-2022).
2. BACKGROUND IMAGERY: GOOGLE, © 2022 CNES / AIRBUS.

DRILLING AND SECTION LOCATIONS - OPEN PIT

TOUQUOY GOLD PROJECT
HALIFAX COUNTY, NOVA SCOTIA

Client: ATLANTIC MINING NS INC.

Job No.:	121619250
Scale:	1 : 5000
Date:	2022 10 19
Dwn. By:	JL
App'd By:	PD
Fig. No.	1
Rev. No.	0

Stantec

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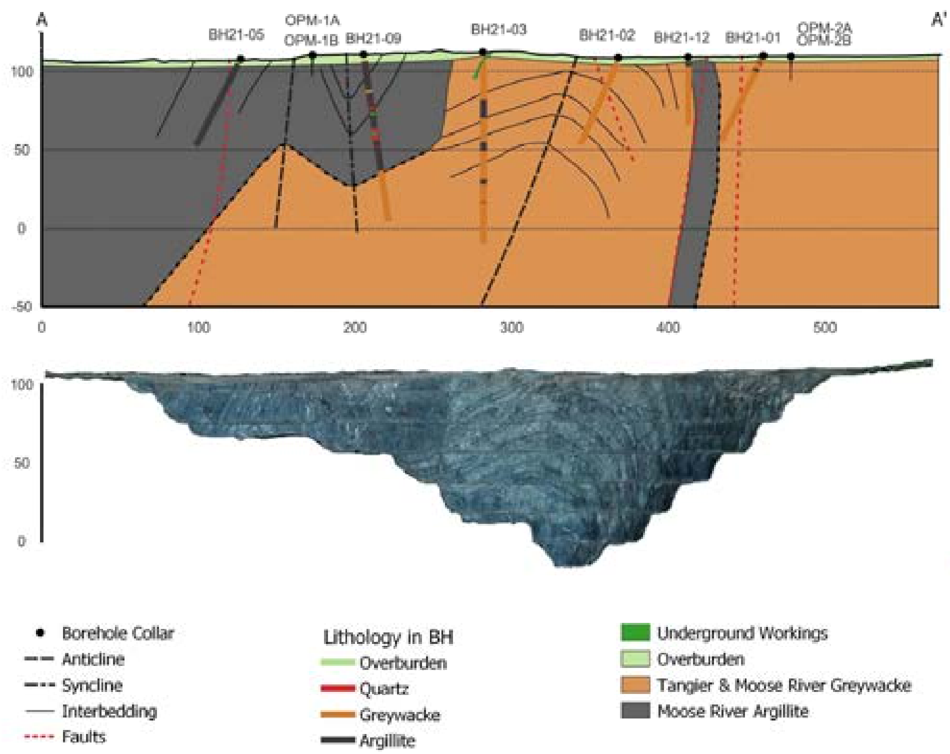

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VERTICAL SCALE 1:2500
HORIZONTAL SCALE 1:2500

THIS DRAWING ILLUSTRATES SUPPORTING INFORMATION SPECIFIC TO A STANTEC CONSULTING LTD. REPORT AND MUST NOT BE USED FOR OTHER PURPOSES.

Reference:
1. IMAGE: STANTEC, LEAPFROG 3D MODEL

GEOLOGICAL SECTION A-A' - VIEW FACING SOUTHWEST
TOUQUOY GOLD PROJECT
HALIFAX COUNTY, NOVA SCOTIA

Client: ATLANTIC MINING NS INC.

Job No.:	121619250	**Fig. No.** 2	**Rev. No.** 0
Scale:	1 : 2500		
Date:	2022 10 19	Stantec	
Dwn. By:	JL		
App'd By:	PD		

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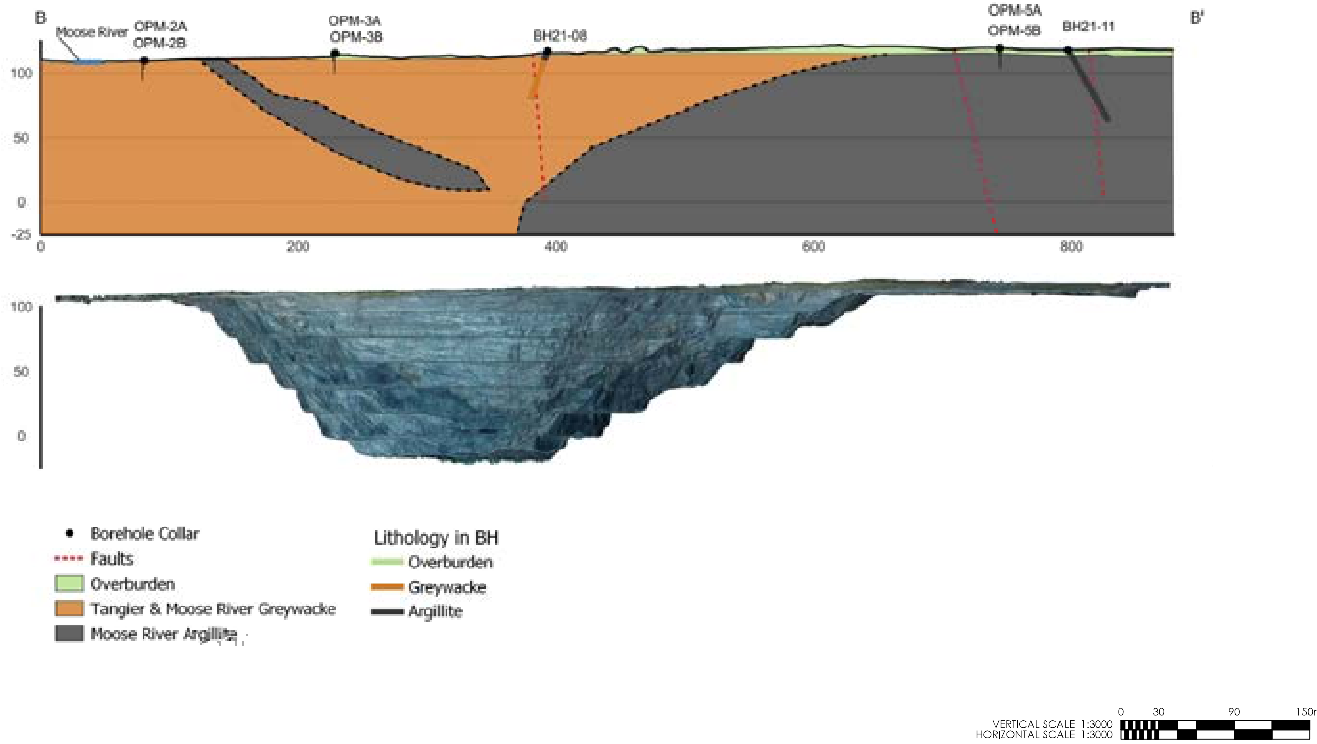

THIS DRAWING ILLUSTRATES SUPPORTING INFORMATION SPECIFIC TO A STANTEC CONSULTING LTD. REPORT AND MUST NOT BE USED FOR OTHER PURPOSES.

Reference:
1. IMAGE: STANTEC, LEAPFROG 3D MODEL

GEOLOGICAL SECTION B-B' - VIEW FACING NORTHWEST

TOUQUOY GOLD PROJECT

HALIFAX COUNTY, NOVA SCOTIA

Client: ATLANTIC MINING NS INC.

Job No.:	121619250
Scale:	1 : 3000
Date:	2022 10 19
Dwn. By:	JL
App'd By:	PD
Fig. No.	3
Rev. No.	0

Stantec

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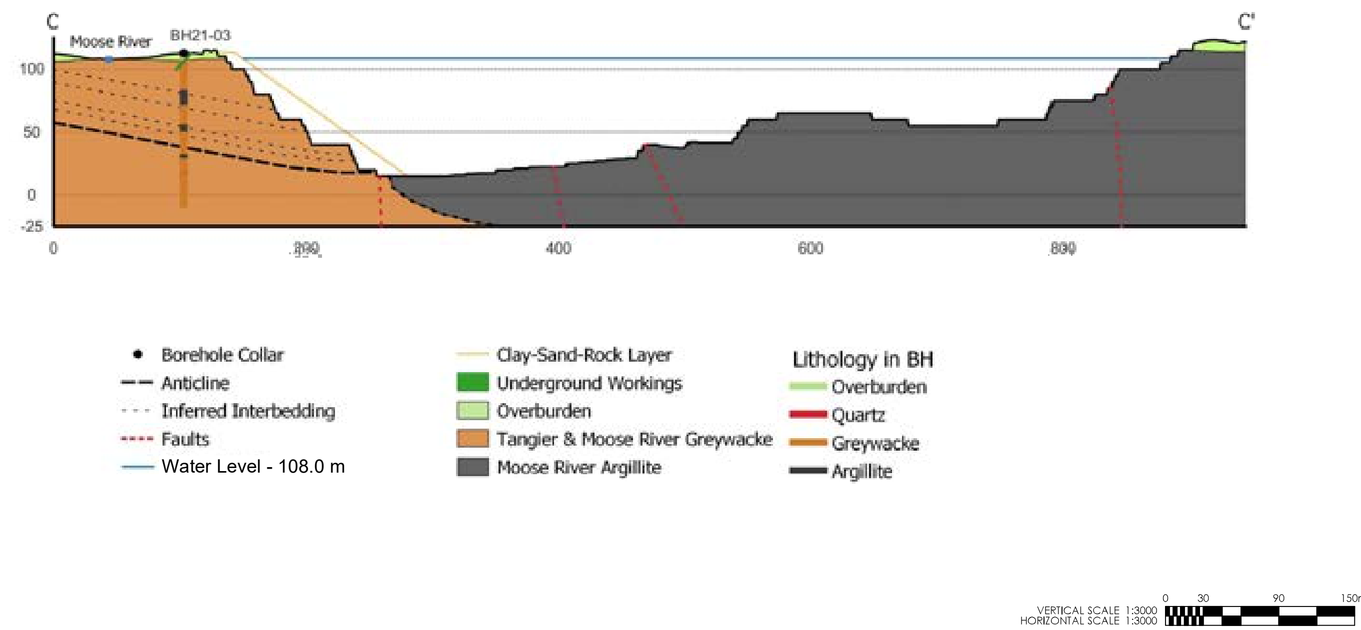

THIS DRAWING ILLUSTRATES SUPPORTING INFORMATION SPECIFIC TO A STANTEC CONSULTING LTD. REPORT AND MUST NOT BE USED FOR OTHER PURPOSES.

Reference:
1. IMAGE: STANTEC, LEAPFROG 3D MODEL

GEOLOGICAL SECTION C-C' - VIEW FACING NORTHWEST

TOUQUOY GOLD PROJECT

HALIFAX COUNTY, NOVA SCOTIA

Client: ATLANTIC MINING NS INC.

Job No.:	121619250
Scale:	1 : 3000
Date:	2022 10 19
Dwn. By:	JL
App'd By:	PD
Fig. No.	4
Rev. No.	0

Stantec

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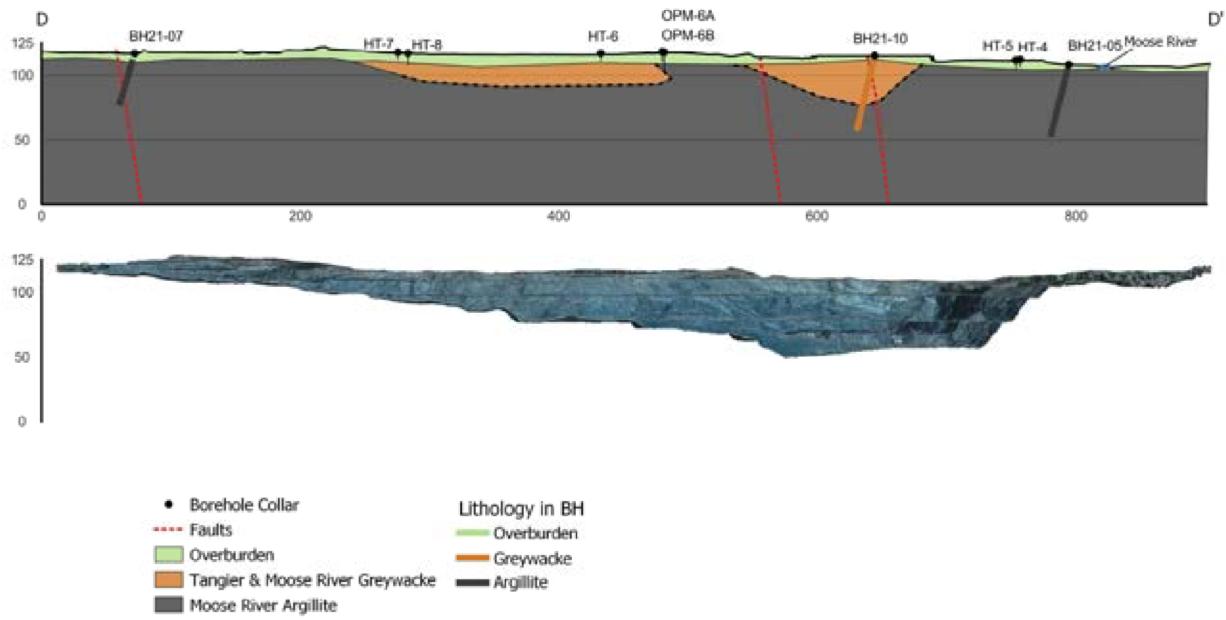

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VERTICAL SCALE 1:3000
HORIZONTAL SCALE 1:3000

THIS DRAWING ILLUSTRATES SUPPORTING INFORMATION SPECIFIC TO A STANTEC CONSULTING LTD. REPORT AND MUST NOT BE USED FOR OTHER PURPOSES.

Reference:
1. IMAGE: STANTEC, LEAPFROG 3D MODEL

GEOLOGICAL SECTION D-D' - VIEW FACING NORTHWEST
TOUQUOY GOLD PROJECT
HALIFAX COUNTY, NOVA SCOTIA

Client: ATLANTIC MINING NS INC.

Job No.:	121619250
Scale:	1 : 3000
Date:	2022 10 19
Dwn. By:	JL
App'd By:	PD
Fig. No.	5
Rev. No.	0

Stantec

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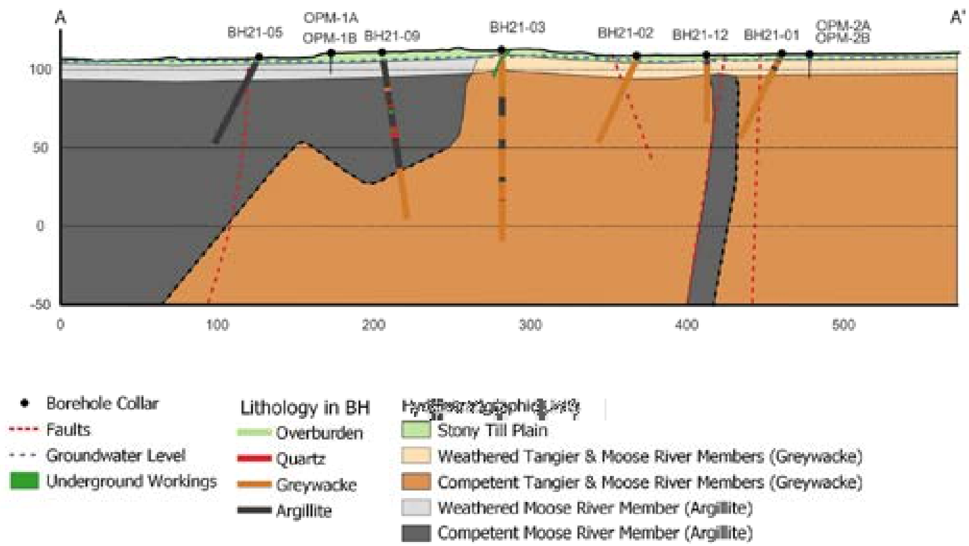

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Reference:
1. IMAGE: STANTEC, LEAPFROG 3D MODEL

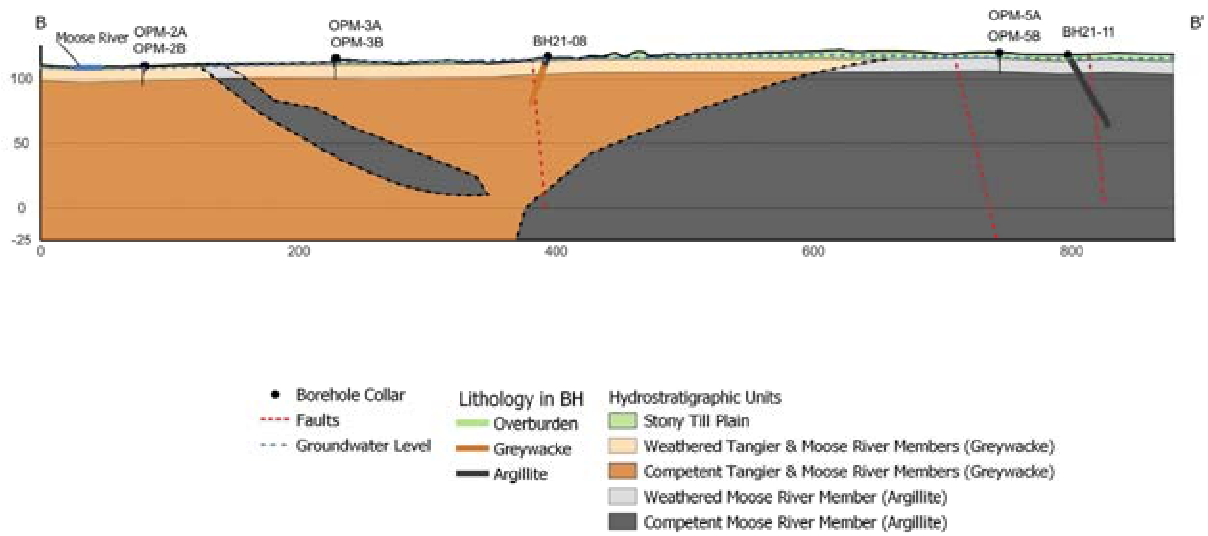
HYDROSTRATIGRAPHIC SECTION A-A' - VIEW FACING SOUTHWEST

TOUQUOY GOLD PROJECT
HALIFAX COUNTY, NOVA SCOTIA

Client: ATLANTIC MINING NS INC.

Job No.:	121619250
Scale:	1 : 2500
Date:	2022 10 19
Dwn. By:	JL
App'd By:	PD
Fig. No.	6
Rev. No.	0

Stantec



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HORIZONTAL SCALE 1:3000

THIS DRAWING ILLUSTRATES SUPPORTING INFORMATION SPECIFIC TO A STANTEC CONSULTING LTD. REPORT AND MUST NOT BE USED FOR OTHER PURPOSES.

Reference:
1. IMAGE: STANTEC, LEAPFROG 3D MODEL

HYDROSTRATIGRAPHIC SECTION B-B' - VIEW FACING NORTHWEST

TOUQUOY GOLD PROJECT

HALIFAX COUNTY, NOVA SCOTIA

Client: ATLANTIC MINING NS INC.

Job No.:	121619250	**Fig. No.** 7	**Rev. No.** 0
Scale:	1 : 3000		
Date:	2022 10 19	Stantec	
Dwn. By:	JL		
App'd By:	PD		

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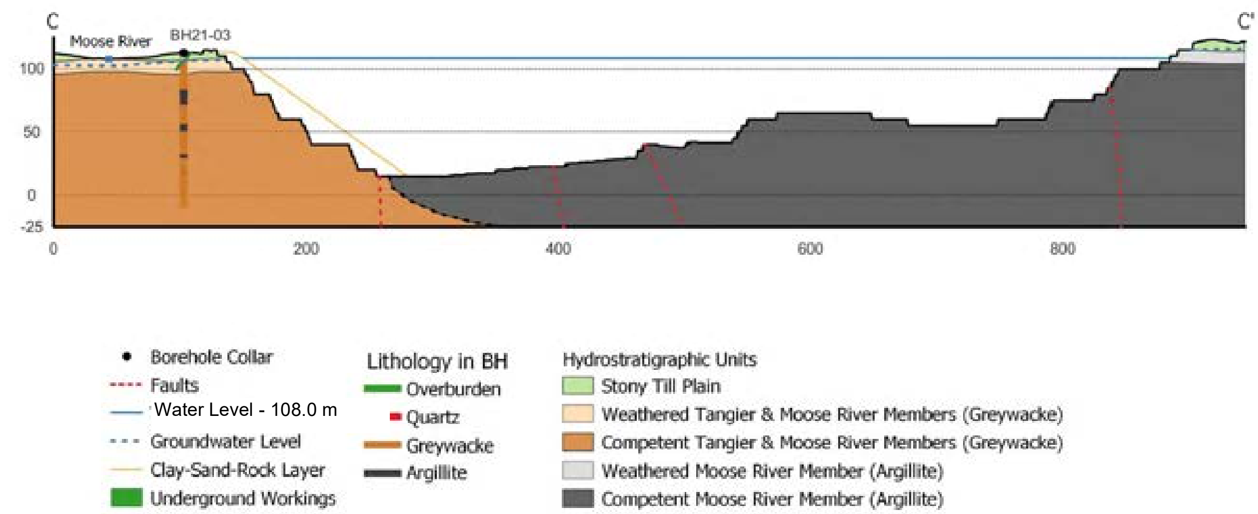

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VERTICAL SCALE 1:3000
HORIZONTAL SCALE 1:3000

THIS DRAWING ILLUSTRATES SUPPORTING INFORMATION SPECIFIC TO A STANTEC CONSULTING LTD. REPORT AND MUST NOT BE USED FOR OTHER PURPOSES. **Reference:** 1. IMAGE: STANTEC, LEAPFROG 3D MODEL	HYDROSTRATIGRAPHIC SECTION C-C' - VIEW FACING NORTHWEST TOUQUOY GOLD PROJECT HALIFAX COUNTY, NOVA SCOTIA	**Job No.:** 121619250 **Scale:** 1 : 3000 **Date:** 2022 10 19 **Dwn. By:** JL **App'd By:** PD	**Fig. No.** 8 **Rev. No.** 0 Stantec
	Client: ATLANTIC MINING NS INC.		

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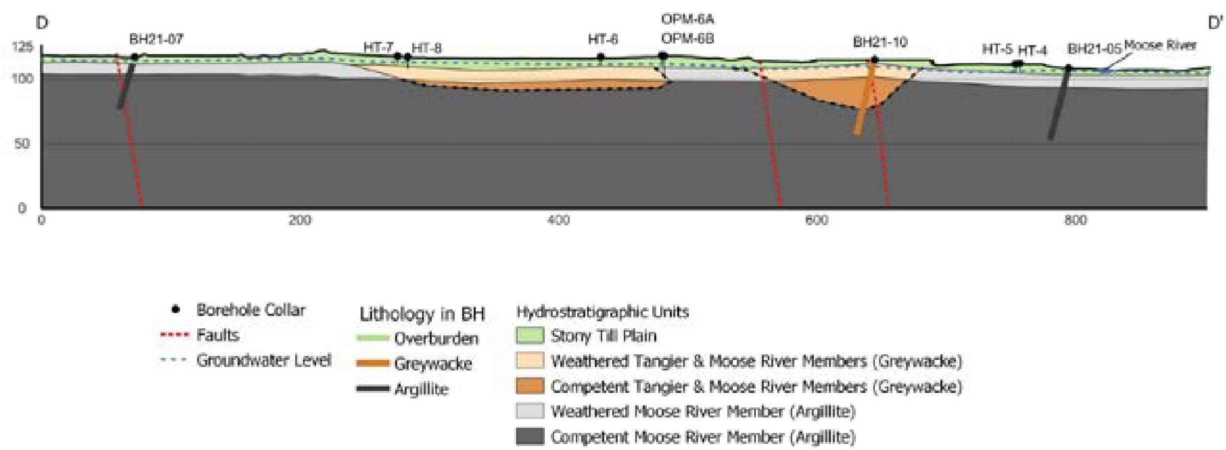

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Reference:
1. IMAGE: STANTEC, LEAPFROG 3D MODEL

HYDROSTRATIGRAPHIC SECTION D-D' - VIEW FACING NORTHWEST

TOUQUOY GOLD PROJECT

HALIFAX COUNTY, NOVA SCOTIA

Client: ATLANTIC MINING NS INC.

Job No.:	121619250	**Fig. No.** 9	**Rev. No.** 0
Scale:	1 : 3000		
Date:	2022 10 19	Stantec	
Dwn. By:	JL		
App'd By:	PD		

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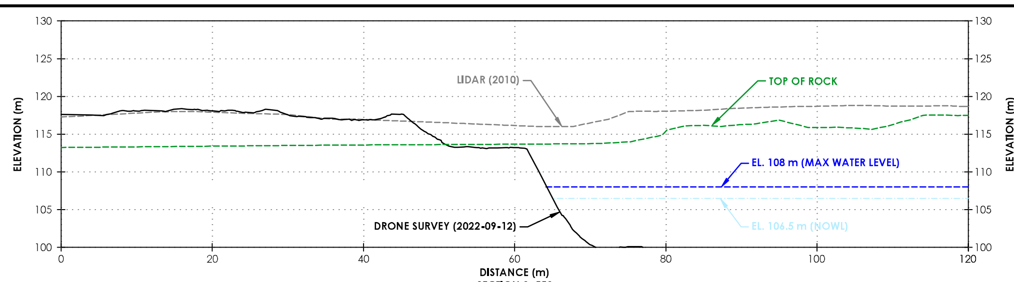

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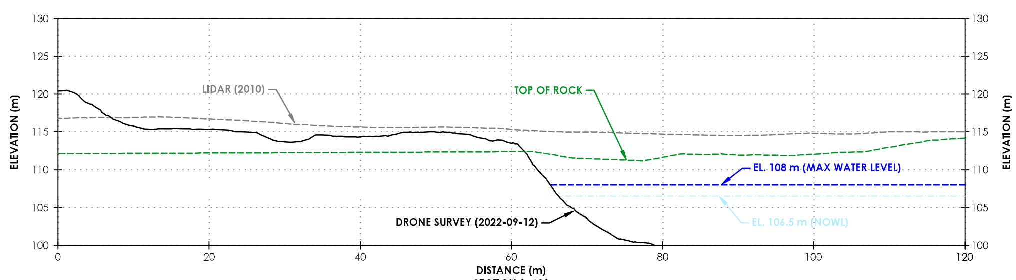

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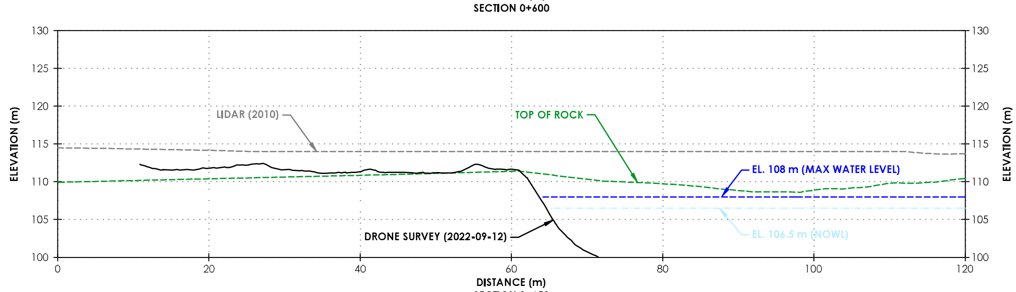

SECTION 0+650

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Reference:
1. LIDAR DATA PROVIDED BY CONESTOGA-ROVERS & ASSOCIATES (2010)
2. DRONE SURVEY (2022-09-12) AND TOP OF ROCK DATA PROVIDED BY ATLANTIC MINING NS INC.

PIT PERIMETER SECTIONS 0+550 TO 0+650

TOUQUOY GOLD PROJECT

HALIFAX COUNTY, NOVA SCOTIA

Client: ATLANTIC MINING NS INC.

Job No.:	121619250
Scale:	1 : 500
Date:	2022 10 20
Dwn. By:	JL
App'd By:	PD
Fig. No.	10
Rev. No.	0

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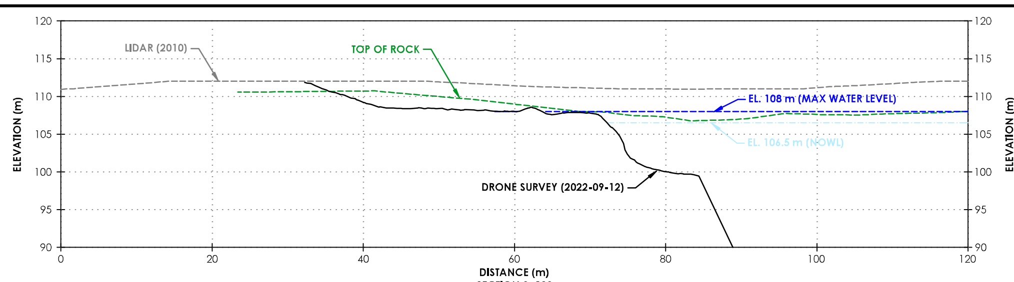

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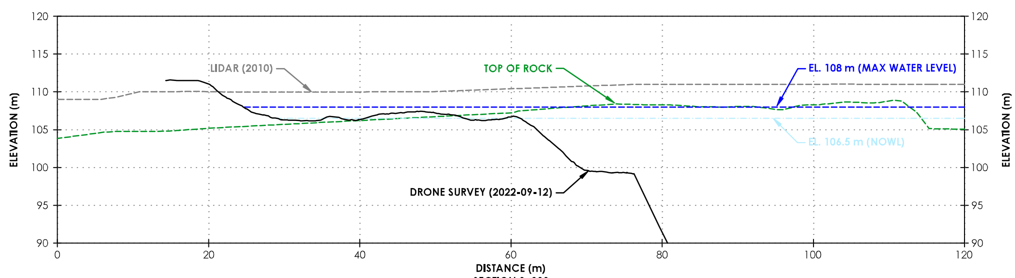

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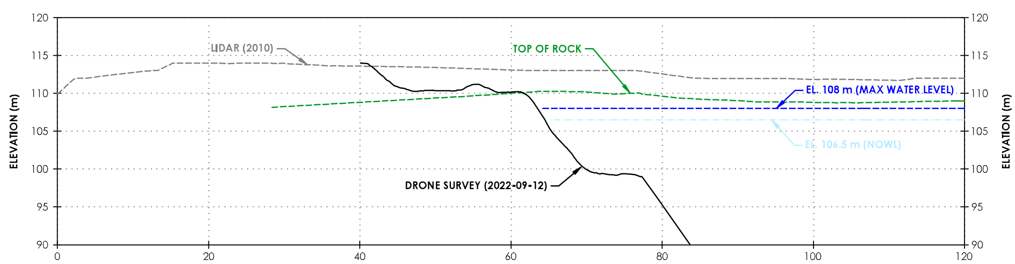

SECTION 1+000

Reference:
1. LIDAR DATA PROVIDED BY CONESTOGA-ROVERS & ASSOCIATES (2010)
2. DRONE SURVEY (2022-09-12) AND TOP OF ROCK DATA PROVIDED BY ATLANTIC MINING NS INC.

PIT PERIMETER SECTIONS 0+800 TO 1+000
TOUQUOY GOLD PROJECT
HALIFAX COUNTY, NOVA SCOTIA

Client: ATLANTIC MINING NS INC.

Job No.:	121619250
Scale:	1 : 500
Date:	2022 10 20
Dwn. By:	JL
App'd By:	PD
Dwg. No.	11
Rev. No.	0

Stantec

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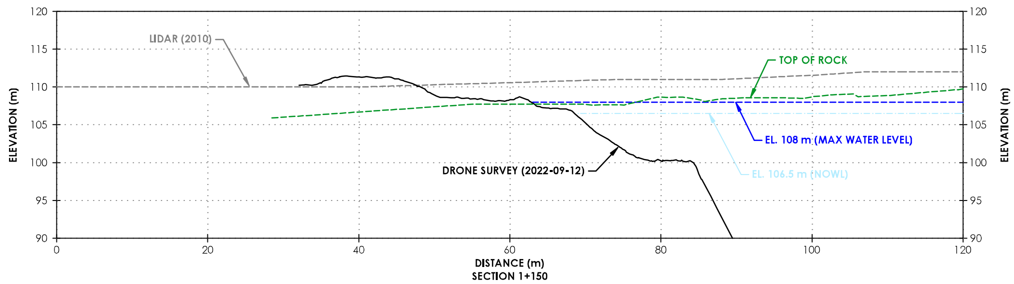

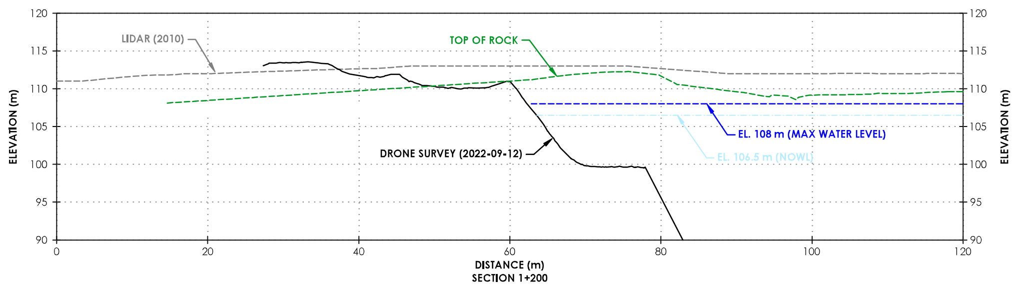

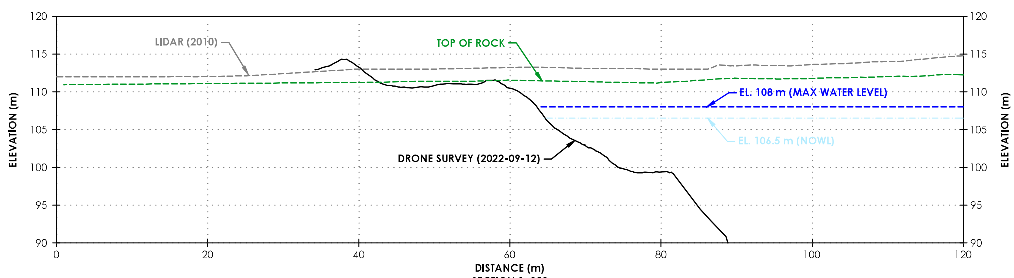

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Reference:
1. LIDAR DATA PROVIDED BY CONESTOGA-ROVERS & ASSOCIATES (2010)
2. DRONE SURVEY (2022-09-12) AND TOP OF ROCK DATA PROVIDED BY ATLANTIC MINING NS INC.

PIT PERIMETER SECTIONS 1+150 TO 1+250

TOUQUOY GOLD PROJECT
HALIFAX COUNTY, NOVA SCOTIA

Client: ATLANTIC MINING NS INC.

Job No.:	121619250
Scale:	1 : 500
Date:	2022 10 20
Dwn. By:	JL
App'd By:	PD
Dwg. No.	12
Rev. No.	0

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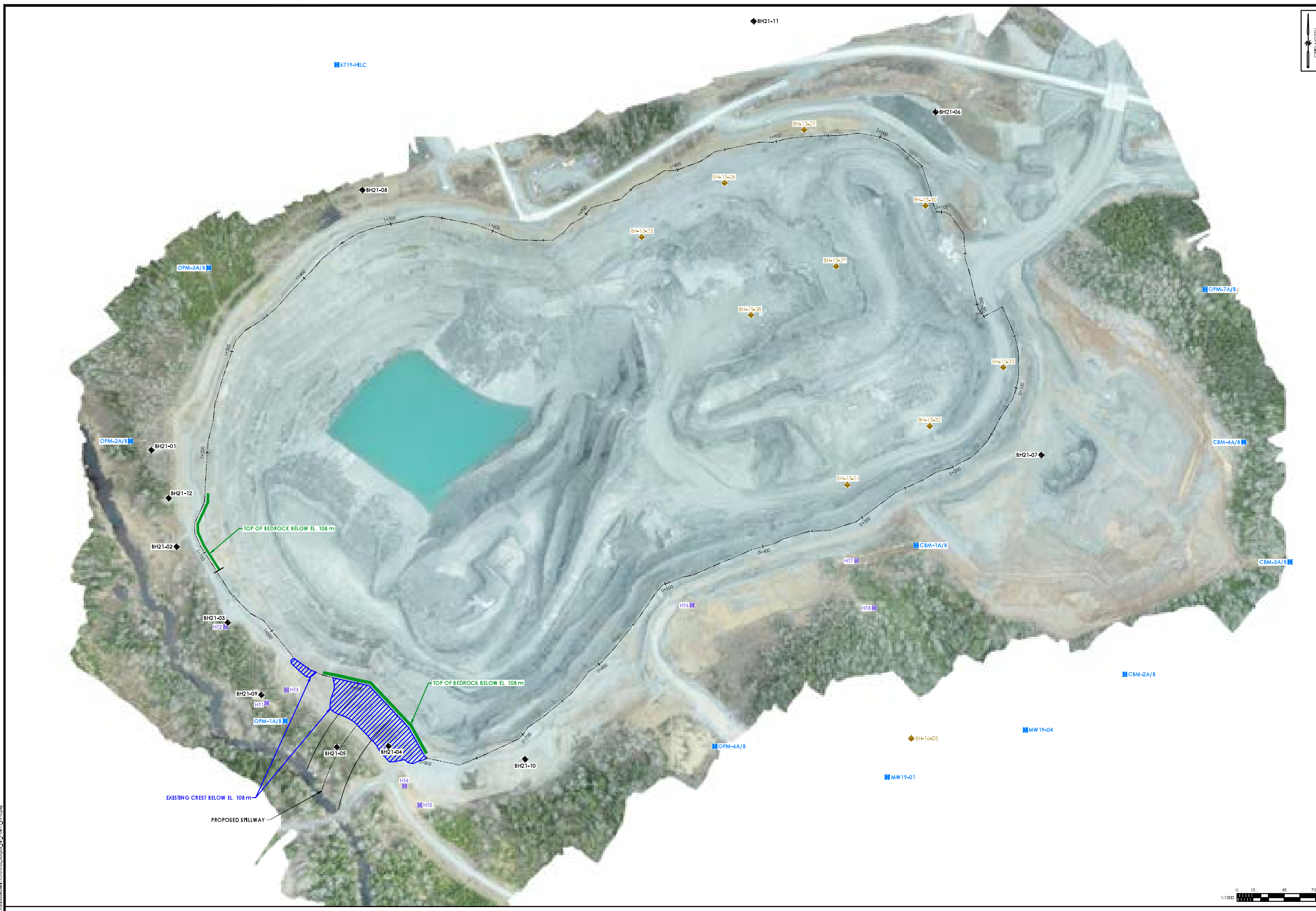
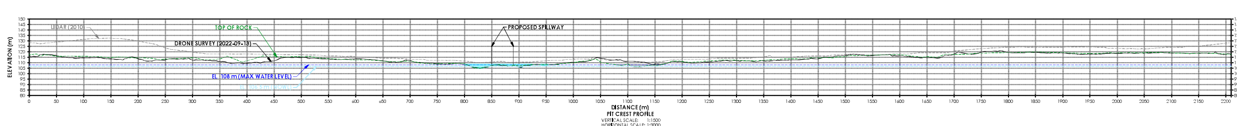




Stantec
845 Prospect Street
Fredericton, New Brunswick, Canada, E3B 2T7
Tel. 506.452.7000
www.stantec.com

Legend

LEGEND

- PIT CREST BELOW EL. 108 m
- TOP OF BEDROCK AT CREST BELOW EL. 108 m
- PIT CREST BASELINE AND STATION REFERENCE (BASED ON DRONE 2022-09-12 SURVEY)
- GROUNDWATER MONITORING LOCATION
- HT MONITORING WELL
- HISTORIC BOREHOLE LOCATION (2015/2016)
- 2021 BOREHOLE LOCATION

Notes

1. LIDAR DATA PROVIDED BY CONESTOGA-ROVERS & ASSOCIATES (2010). ACTUAL FIELD CONDITIONS MAY VARY.
2. WATERCOURSES BASED ON NOVA SCOTIA PROVINCIAL (SNSMR, 2006) AND McCALLUM ENVIRONMENTAL DATA.
3. FINAL PIT DESIGN AND DRONE SURVEY PROVIDED BY ATLANTIC MINING NS INC.

STAMP

STAMP

No.	DETAILS	BY	APPD.	DATE
0	ISSUED FOR INFORMATION PURPOSES	PD	PD	2022-10-20

REVISIONS

CLIENT: ATLANTIC MINING NS INC.

PROJECT: TOUQUOY GOLD PROJECT

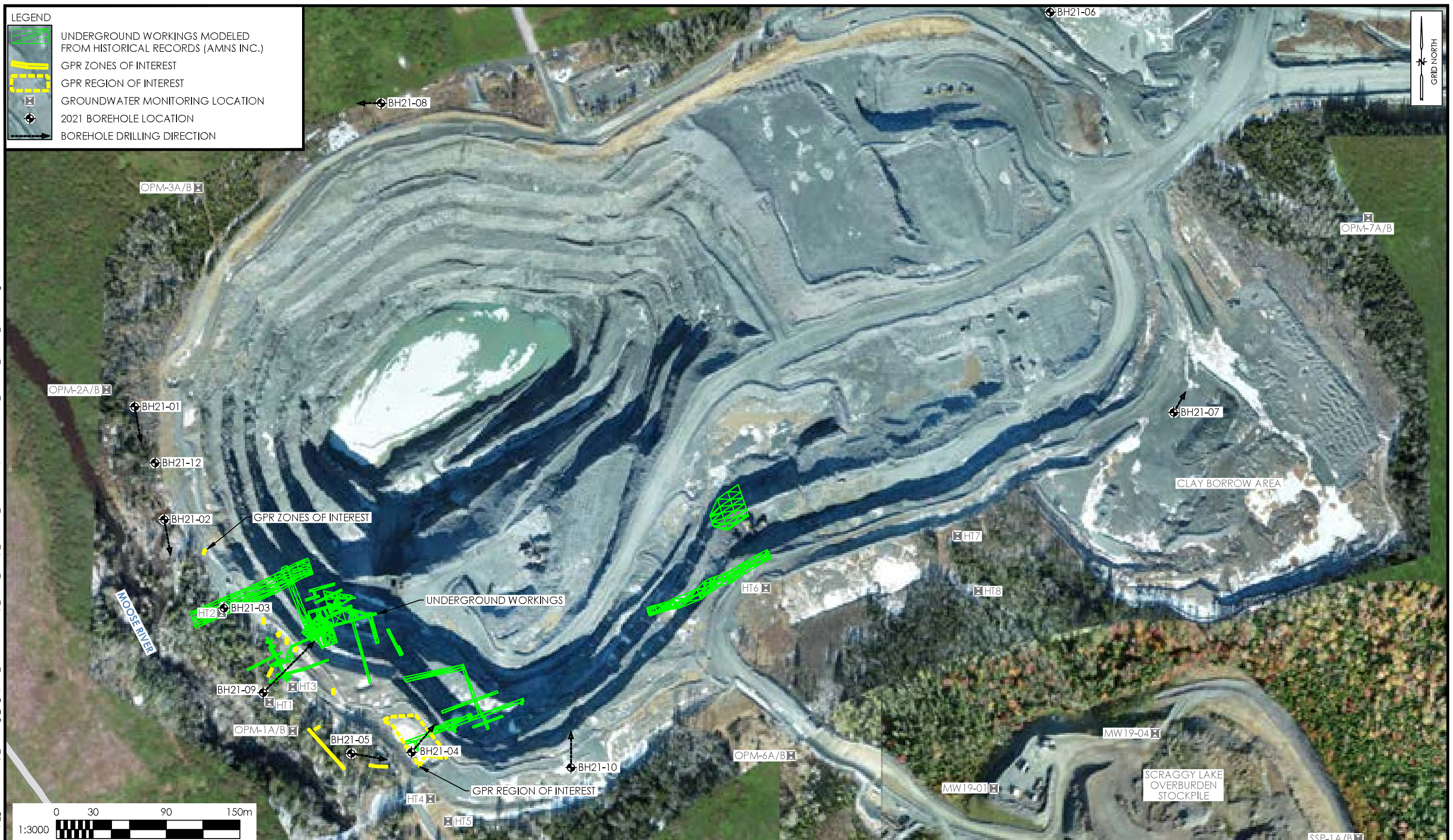
PROJECT LOCATION: HALIFAX COUNTY, NOVA SCOTIA

JOB No.	SCALE:	DATE
121619250	AS NOTED	2022-10-20
DRAWN BY: JDL	DESIGNED BY: PDD	APPROVED BY: PDD

DRAWING TITLE: OPEN PIT PLAN AND PIT CREST PROFILE

DRAWING No.: 13

REVISION No.: 0



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Reference:

1. MINE SITE DRONE IMAGES PROVIDED BY ATLANTIC MINING NS INC. (2020-2022).
2. BACKGROUND IMAGERY: © 2022 MICROSOFT CORPORATION, © 2022 MAXAR, © CNES (2022) DISTRIBUTION AIRBUS DS
3. UNDERGROUND WORKINGS PROVIDED BY ATLANTIC MINING NS INC.

UNDERGROUND WORKINGS AND GPR FEATURES INCLUDING DRILLING LOCATIONS

TOUQUOY GOLD PROJECT

HALIFAX COUNTY, NOVA SCOTIA

Client: ATLANTIC MINING NS INC.

Job No.:	121619250
Scale:	1 : 3000
Date:	2022 03 10
Dwn. By:	JL
App'd By:	PD

Dwg. No. 14

Rev. No. 0

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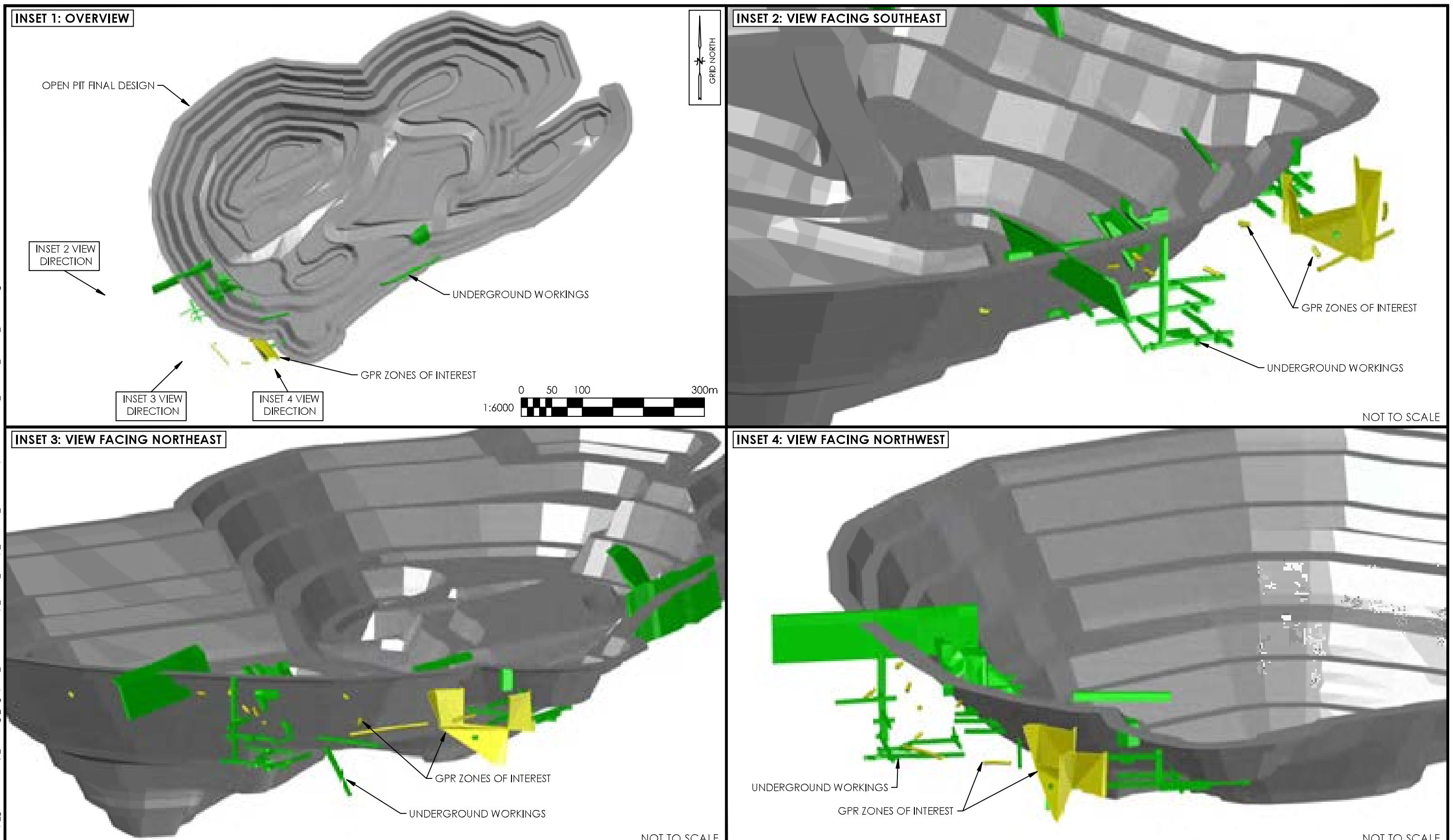

THIS DRAWING ILLUSTRATES SUPPORTING INFORMATION SPECIFIC TO A STANTEC CONSULTING LTD. REPORT AND MUST NOT BE USED FOR OTHER PURPOSES.

1. SITE DATA PROVIDED BY ATLANTIC MINING NS INC. AND d-ANALYTICS SERVICES INC.

3D MODEL SHOWING UNDERGROUND WORKINGS AND GPR ZONES OF INTEREST

TOUQUOY GOLD PROJECT

HALIFAX COUNTY, NOVA SCOTIA

Client: ATLANTIC MINING NS INC.

Job No.:	121619250	Dwg. No.	Rev. No.
Scale:	AS SHOWN	15	0
Date:	2022 03 10		
Dwn. By:	JL		
App'd By:	PD		

Stantec

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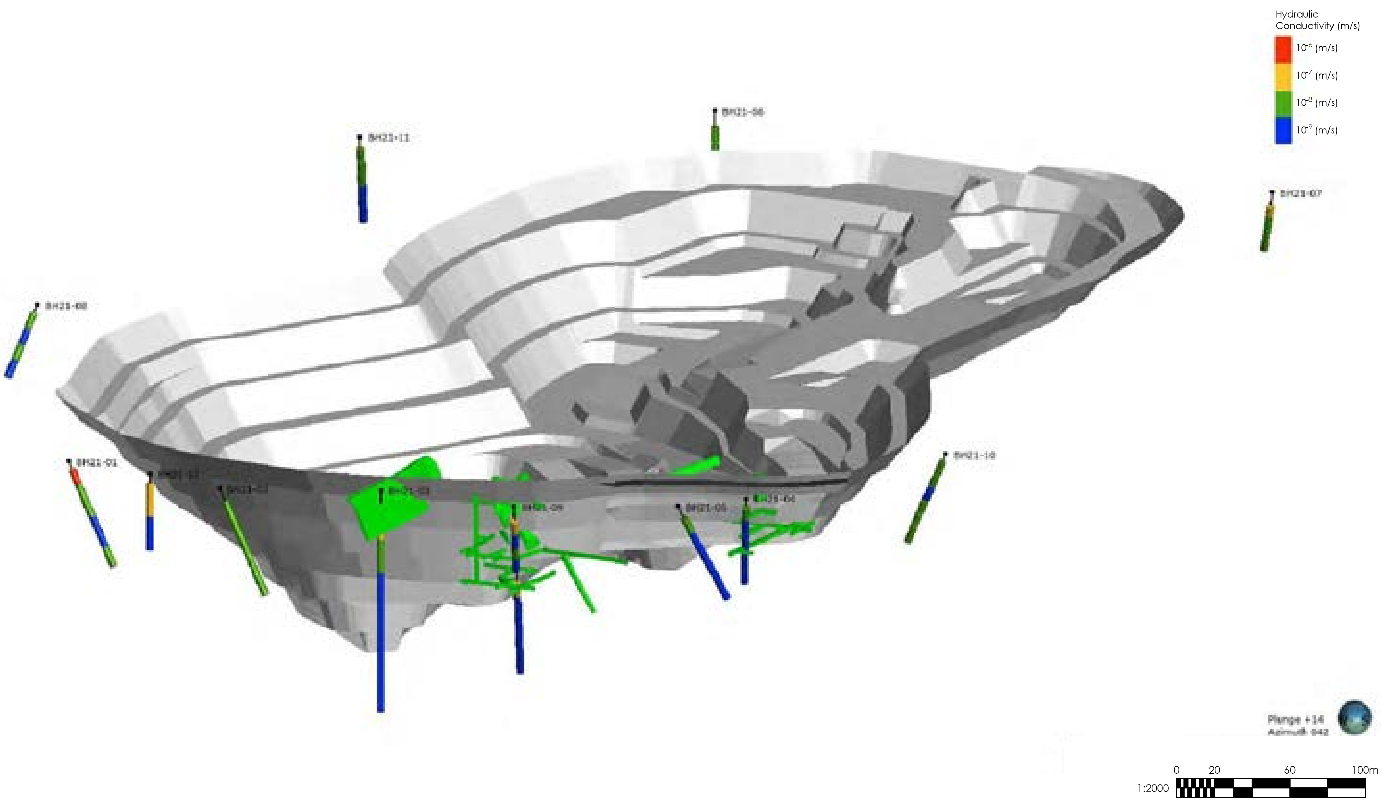

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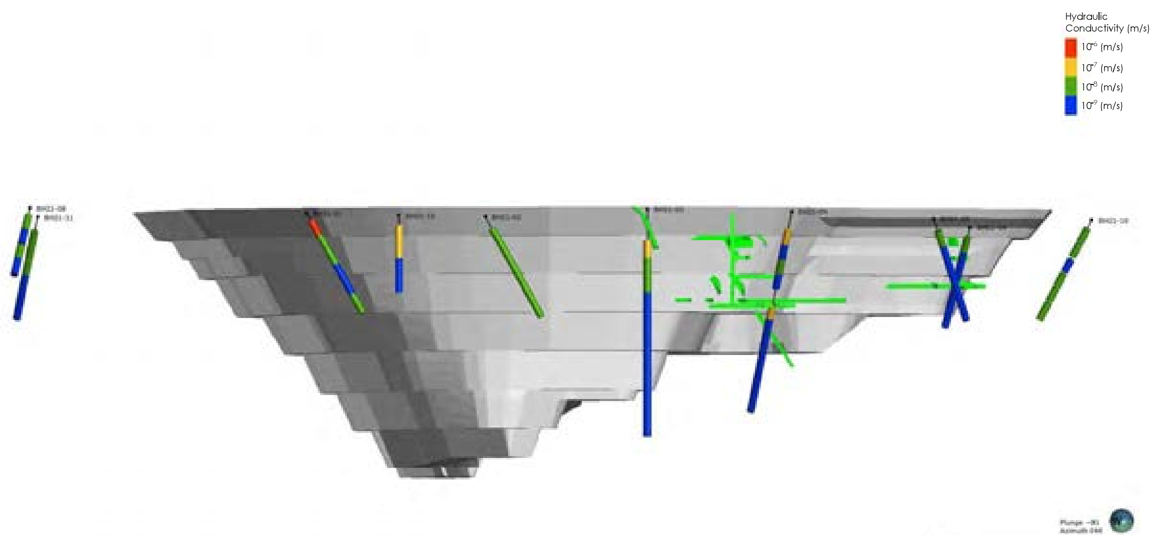
Reference:
1. IMAGE: STANTEC, LEAPFROG 3D MODEL

3-D INTERRELATIONSHIP OF PIT, UNDERGROUND WORKINGS AND 2021 SERIES BOREHOLES, FACING NORTHEAST

TOUQUOY GOLD PROJECT
HALIFAX COUNTY, NOVA SCOTIA

Client: ATLANTIC MINING NS INC.

Job No.:	121619250	**Fig. No.**	**Rev. No.**
Scale:	1 : 2000	16	0
Date:	2022 10 26	Stantec	
Dwn. By:	JL		
App'd By:	PD		



0 20 60 100m
1:2000

THIS DRAWING ILLUSTRATES SUPPORTING INFORMATION SPECIFIC TO A STANTEC CONSULTING LTD. REPORT AND MUST NOT BE USED FOR OTHER PURPOSES.

Reference:
1. IMAGE: STANTEC, LEAPFROG 3D MODEL

3-D INTERRELATIONSHIP OF PIT, UNDERGROUND WORKINGS AND 2021 SERIES BOREHOLES, FACING NORTH-NORTHEAST

TOUQUOY GOLD PROJECT
HALIFAX COUNTY, NOVA SCOTIA

Client: ATLANTIC MINING NS INC.

Job No.:	121619250
Scale:	1 : 2000
Date:	2022 10 26
Dwn. By:	JL
App'd By:	PD
Fig. No.	17
Rev. No.	0

Stantec

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Attachment 6
Groundwater Predictions Compared to Industrial Approval Requirements

Memo

To:	Sara Wallace/Christian Deveau	From:	Walter Weinig, PG, PMP, QP Mark Flinn, P.Eng., MBA
	Atlantic Mining Nova Scotia Inc.		Stantec Consulting Ltd.
File:	121619250	Date:	October 28, 2022

Reference: Environmental Assessment Responses – Question 3 Groundwater Predictions Compared to Industrial Approval Requirements, Touquoy Gold Project Site Modifications Addendum

In response to the letter from Nova Scotia Environment and Climate Change (NSECC) dated May 12, 2022, and pertaining to the Touquoy Gold Project Site Modifications Addendum, Stantec is pleased to provide the following information to address question 3 related to groundwater predictions and subsequent comparisons to of these predictions to groundwater criteria as laid out in the Industrial Approval (2012-084244-12).

Methods

The groundwater predictions were developed based on the March 2022 (Stantec, 2022) updated groundwater model, using a scaled-concentration method and assuming conservative transport. In this method, a constant source concentration of 1 milligram per cubic metre (mg/m^3) was applied to the model cells that represent tailings contained in the Touquoy pit. The solute transport model was run for a period of 500 years. Scaled concentrations at the location of interest were extracted from the transport model results. These scaled concentrations were then multiplied by the estimated in-pit source concentration for each dissolved constituent to calculate the predicted increase in concentration for that constituent over baseline conditions. Predicted concentrations can only be generated for those parameters with source terms. Source terms have not been developed for antimony, phosphorous, potassium and strong cyanide. As a result, predictions for these parameters could not be generated.

The data used to establish baseline concentrations were derived from historical analytical results from monitoring well location OPM-1B. This location was selected because it represents the closest downgradient monitoring point to the Touquoy pit. Analytical results from the period between March 2016 and September 2017, representing 12 monitoring events were reviewed. The baseline period for groundwater wells is defined as the period prior to operation of the various project facilities. Groundwater data collected prior to October 2017 are considered within the baseline period as outlined in an e-mail from NSECC (Christine Hynes) dated May 10, 2019. Using the baseline data from OPM-1B an average baseline concentration was developed for each parameter. Where select parameters were not detected above the laboratory detection limits a value of half the detection limit was used to develop the baseline concentration.

In previous discussions with NSECC it has been identified that surface water monitoring and associated data are available between 2004-2007 (CRA 2007). Included in this data set is groundwater information. There are a series of monitoring wells (WB series) installed and sampled in 2006. However, analytical results from these monitoring wells were only presented for one groundwater monitoring event in November 2006. The monitoring wells were also sampled for total metals as compared to the industry standard dissolved metals (for which groundwater guidelines have been derived). As there has been much discussion about baseline data for this site, Stantec acknowledges the availability of this data; however, based on the reasons outlined above, they were not considered in the assessment of baseline concentrations for OPM-1B for the purposes of this memo.

Reference: Environmental Assessment Responses – Question 3 Groundwater Predictions Compared to Industrial Approval Requirements, Touquoy Gold Project Site Modifications Addendum

Prediction Results

Groundwater predictions were generated for location OPM-1B for two time periods; 5 years and 500 years from the time tailings are placed in the Touquoy pit. The results are presented in Table 1, attached, and are compared to the criteria specified by Condition 8 of the IA.

In general, the calculated Baseline results indicated that:

- arsenic and manganese exceeded criteria listed in Appendix K, columns A, B and C; and,
- iron exceeded criteria in Appendix K, columns A and C

The order of magnitude predicted additional concentrations above baseline concentrations ranged from 0.00834 ug/L (dissolved sulphate in the 500-year scenario) to 0.00000000000000043 ug/L (dissolved silver in the 5-year scenario). That is to say that the predicated incremental concentration increase resulting from the placement and storage of tailings in the Touqouy pit is extremely small and therefore minimally increases parameter concentrations from baseline. In many cases these increases are too low to be distinguishable from baseline by current laboratory detection methods.

The baseline concentration, plus the predicted incremental concentration increase resulting from the placement and storage of tailings in the pit, are not materially increased from the average groundwater baseline concentrations.

References:

Conestoga Rovers & Associates (CRA). 2007. Environmental Assessment Registration Document (EARD) for the Touquoy Gold Project, Moose River Gold Mines, Nova Scotia in March 2007.

Stantec, 2022. Report Update: Groundwater Flow and Solute Transport Modelling to Evaluate Disposal of Tailings in Touquoy Open Pit. Prepared for Atlantic Mining NS Inc, March.

TABLE 1

Groundwater Predictions
Atlantic Mining NS Inc.
Touquoy Gold Project
Stantec Consulting Ltd. Project No. 121619250.2000

Parameter	Appendix K Column A (ug/L)	Appendix K Column B (ug/L)	Appendix K Column C (ug/L)	Average Baseline Concentration NearPit, Monitoring Well OPM1-B (2016-2017)	Predicted Additional Concentration (ug/L)		Predicted GW Concentrations - Downgradient of Pit, MW OPM-1B (ug/L)	
Elapsed Time (years)					**5**	**500**	**5**	**500**
Dissolved Aluminum (Al)	5 (if pH <6.5); 100 (if pH>6.5)	-	5 (if pH <6.5); 100 (if pH>6.5)	14.58	2.02E-12	4.36E-07	14.58	14.58
Dissolved Antimony (Sb)	6	6	20	0.5	No Source Term	No Source Term	-	-
Dissolved Arsenic (As)	5	10	5	***3633.33***	1.32E-10	2.86E-05	***3633.33***	***3633.33***
Dissolved Cadmium (Cd)	0.04-0.37[1] (hardness dep)	7	0.04-0.37[1] (hardness dep)	0.005	8.61E-16	1.86E-10	0.0050	0.0050
Dissolved Calcium (Ca)	-	-	-	39083.33	3.74E-09	8.08E-04	39083.33	39083.33
Dissolved Chloride (Cl)	120,000	250,000	120,000	11,276.92	No Source Term	No Source Term	-	-
Dissolved Chromium (Cr)	-	50	-	0.5	8.61E-15	1.86E-09	0.50	0.50
Dissolved Cobalt (Co)	10	10	10	0.2	1.13E-12	2.44E-07	0.20	0.20
Dissolved Copper (Cu)	2-4[2] (hardness dep)	2,000	2-4[2] (hardness dep)	1	4.03E-13	8.72E-08	1.00	1.00
Dissolved Iron (Fe)	300	-	300	***719.17***	1.40E-12	3.03E-07	***719.17***	***719.17***
Dissolved Lead (Pb)	1-7[3] (hardness dep)	5	1-7[3] (hardness dep)	0.38	1.07E-15	2.31E-10	0.38	0.38
Dissolved Magnesium (Mg)	-	-	-	4850	6.37E-10	1.38E-04	4850.00	4850.00
Dissolved Manganese (Mn)	120	120	820	***1035***	1.59E-11	3.44E-06	***1035.00***	***1035.00***
Dissolved Nickel (Ni)	25-150[4] (hardness dep)	-	25-150[4] (hardness dep)	1	2.60E-12	5.61E-07	1.00	1.00
Dissolved Phosphorus (P)	-	-	-	50	No Source Term	No Source Term	-	-
Dissolved Potassium (K)	-	-	-	1106.67	No Source Term	No Source Term	-	-
Dissolved Selenium (Se)	1	50	1	0.5	8.31E-15	1.80E-09	0.50	0.50
Dissolved Silver (Ag)	0.25	-	0.25	0.05	4.30E-16	9.30E-11	0.05	0.05
Dissolved Sodium (Na)	200,000	200,000	-		No Source Term	No Source Term	-	-
Dissolved Uranium (U)	15	20	15	0.21	8.74E-14	1.89E-08	0.21	0.21
Dissolved Zinc (Zn)	equation[5] (hardness,pH,DOC)	5,000	equation[5] (hardness,pH,DOC)	2.5	4.13E-13	8.93E-08	2.50	2.50
Dissolved Sulphate (SO4)		500,000		11846.15	3.86E-08	8.34E-03	11846.15	11846.16
Ammonia Nitrogen (NH3-N)	-	-	-	98.33	1.46E-09	3.16E-04	98.33	98.33
Total (Strong Acid Dissociable) Cyanide (SAD CN)	-	-	-	85	No Source Term	No Source Term	-	-
Weak Acid Dissociable Cyanide (WAD CN)	5[6]	200[6]	5[6]	1.5	2.15E-13	4.65E-08	1.50	1.50

NOTES:

1. Cadmium criteria equation: 0.04 (if hardness is <17 mg/L); $10^{(0.83[\log[\text{hardness}]]-2.46)}$ (if hardness is >17mg/L to <280 mg/L; 0.37 (if Hardness is >280 mg/L)
2. Copper criteria equation: 2 (if Hardness is <82 mg/L); $0.2 * e^{(0.8549[\ln(\text{hardness})]-1.465)}$ (if hardness is >82 mg/Lto <180mg/L); 4 (if hardness is >180 mg/L)
3. Lead criteria equation: 1 (if hardness is <60 mg/L); $e^{(1.273[\ln(\text{hardness})]-4.705)}$ (if hardness is >60 mg/L to <180 mg/L); 7 (if hardness is >180 mg/L)
4. Nickel criteria equation: 25 (if hardness is <60 mg/L); $e^{(0.76[\ln(\text{hardness})]+1.08)}$ (if hardness is >60 mg/L to <180 mg/L); 150 (if Hardness is >180 mg/L)
5. Zinc criteria equation: $\exp^{(0.947[\ln(\text{hardness mg/L})]-0.815(\text{pH})) + 0.398[\ln(\text{DOC mg/L})] + 4.625)}$ (if hardness is 23.4 to 399 mg/L, pH is 6.5 to 8.13 & DOC is 0.3 to 22.9 mg/L)
   In the absence of hardness, pH, DOC the CCME fact sheet for dissolved Zinc was consulted (2018).
   Based on conservative assumptions the guideline for the protection of Freshwater Aquatic Life for short term zinc exposure is 37 ug/L.
   The guidance for longer term exposure of Freshwater Aquatic life is 7.0 ug/L
6. Criteria is specifically for free cyanide.
7. **Bold:** Exceeds Appendix K Column A
8. highlight: Exceeds Appendix K Column B
9. *italics*: Exceeds Appendix K Column C