ALAMOS GOLD INC.

Lynn Lake Gold Project
Environmental Impact Statement

Federal IR Responses Round 4
Final Submission

Stantec

Prepared by:

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September 15, 2022

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Introduction

The Impact Assessment Agency of Canada (the Agency) provided the fourth round (Round 4) of Information Requests (IRs) on August 26, 2022, for the Lynn Like Gold Project Environmental Impact Statement (EIS) submitted by Alamos Gold Inc. (Alamos) on May 25, 2020. Upon review of the EIS and Alamos' responses to the Round 1, Round 2, and Round 3 Information Requests, the Agency and federal authorities identified one area where additional information would be required. The Agency directed that this additional information is necessary to determine whether the Project is likely to cause significant adverse environmental effects and to inform the Agency's preparation of the Environmental Assessment (EA) Report under the *Canadian Environmental Assessment Act, 2012* (CEAA 2012).

Alamos confirms that the single IR provided in Round 4 has been fully addressed and answered as clearly and succinctly as possible. A fulsome response to the IR is provided in the following section in reference to the original request. Attachments to the response have been provided in Appendix A.

Alamos has followed the Agency's direction and has considered the following while responding to the Information Request:

- The context and rationale for the required information for the question.
- Applied a precautionary approach, given that some of the detailed engineering may not be complete at this time.
- Provided additional information (wherever possible) to assuage uncertainty and to provide clearly defined, detailed follow-up program measures, including proposed further mitigation and adaptive management measures.
- Presented complete or summarized information and discussion within the IR response, rather than a limited response with references to applicable reports.

Alamos trusts that this package provides the Agency with all of the required information to conclude the technical review phase.

RESPONSE TO IAAC-R4-01

ID:	**IAAC-R4-01**
Expert Department or Group:	Natural Resources Canada and Mathias Colomb Cree Nation – Technical Review of Round 3 Information Request Responses
Context and Rationale:	The Environmental Impact Statement Guidelines (EIS Guidelines) require Alamos Gold Inc. (the Proponent) to provide an appropriate hydrogeological model for the Lynn Lake Gold Project (the Project) area, which discusses the hydrostratigraphy and groundwater flow systems. The model should include the delineation of key stratigraphic and hydrogeological boundaries and the physical properties of the hydrogeological units. The Proponent is also required to perform a sensitivity analysis to test model sensitivity to hydrogeological parameters (e.g., hydraulic conductivity). In its response to IAAC-R3-01, the Proponent presented data and sensitivity analysis results to support the conceptualization presented as the base case scenario for effects to groundwater at the MacLellan site. Natural Resources Canada noted that the data provided did not support the conceptualization presented as the base case scenario. Though the Proponent indicated that the rock quality designation (RQD) increases (i.e. corresponding to a decrease in hydraulic conductivity) with depth in the conceptual groundwater model, based on existing literature, the data presented in Figure IAAC-R3-01-1 did not support a differentiation in RQD between the intermediate bedrock unit (i.e. the hydrostratigraphic unit from approximately 50 metres to 200 metres below the top of bedrock) and deep bedrock unit (i.e. the hydrostratigraphic unit deeper than 200 metres below the top of bedrock). The data presented in Figure IAAC-R3-01-2, which depicted the measured hydraulic conductivity as a function of depth at the MacLellan site, included limited hydraulic conductivity data for the deep bedrock unit. The hydraulic conductivities presented for the deep bedrock unit are within the range of hydraulic conductivities presented for the intermediate bedrock unit, which did not support a 40% decrease in hydraulic conductivity with depth at the MacLellan site. As the hydraulic conductivity of the deep bedrock unit can affect the amount, timing, and location of groundwater discharges to surface water features, and therefore effects to other valued components (VCs), updated modelling using a more conservative hydraulic conductivity value for the deeper bedrock unit is required. This information is required to support the Impact Assessment Agency of Canada's (the Agency) understanding of potential effects of the Project to fish and fish habitat, migratory birds, species at risk, Indigenous Peoples, and other VCs that may be affected by changes in groundwater and, through groundwater-surface water interactions, surface water quality and quantity.
Information Request:	a. Provide the results of an updated calibrated groundwater model using a uniform hydraulic conductivity for all bedrock units more than 50 metres below the top of bedrock for the MacLellan site, to represent a conservative scenario for the groundwater assessment relative to baseline. b. Compare the results of the updated model referred to in a) with the original modelling results presented in response to IAAC-R3-01 and clearly describe any differences in the amount, timing, and location of groundwater discharges to surface water features. c. Provide an updated assessment of potential Project effects, including residual and cumulative effects, for all relevant VCs to account for any changes identified in question b. Include a description of any changes to the predicted residual

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	effects criteria and extent of significance for each relevant VC.
Response:	a. The hydraulic conductivity of the intermediate bedrock model layer (50 to 200 m below ground surface [bgs]), was based on 16 packer tests with estimates of hydraulic conductivity that ranged from $2x10^{-7}$ m/s to $3x10^{-9}$ m/s. The hydraulic conductivity of the deep bedrock model layer (200 m to 350 m bgs), was based on 6 packer tests with estimates of hydraulic conductivity that ranged from $6x10^{-8}$ m/s to $9x10^{-9}$ m/s. Based on Figure IAAC-R3-01-1 and Figure IAAC-R3-1-2 that were provided in the response to IAAC-R3-01, there is a clear decreasing trend in hydraulic conductivity and rock quality designation (RQD) with depth below top of bedrock at the MacLellan site. Alamos agrees that within the intermediate and deep bedrock (i.e., greater than 100 m bgs), the estimates of hydraulic conductivity are within a similar range of values. As part of the base case model calibration, the intermediate and deep bedrock model layers were assigned a range of hydraulic conductivity values that were similar. The hydraulic conductivity of each of these model layers were allowed to vary within a similar range of hydraulic conductivity using an automated parameter estimation tool (PEST) (Doherty 2009) until model predictions matched field measured values within a pre-established range of error. The resulting, calibrated, hydraulic conductivity of the intermediate and deep bedrock were the same order of magnitude at $3.4x10^{-8}$ m/s and $1.3x10^{-8}$ m/s, respectively, which is a quarter of an order of magnitude difference. Despite the similarity in model parameters of intermediate and deep bedrock, an additional sensitivity analysis has been completed as requested for IAAC-R4-01 (i.e., a replacement 'sensitivity scenario 1') to assess the prediction of effects of the Project on groundwater if the intermediate and deep bedrock model layers are assigned the same hydraulic conductivity. The recharge rate was kept consistent with the base case at 120 mm/year. As stated in the response to IAAC-R3-01, the recharge value is consistent with the upper end of the range of recharge estimated for the site through monitoring of base flow and accounting for the catchment area and therefore, increasing recharge beyond 120 mm/year is not reflective of the site characterization. The results of the uniform intermediate and deep bedrock sensitivity scenario were compared with the average annual end-of-mine groundwater inflow rate to the open pit as well as the fate (quantity and timing) of seepage from the tailings management facility (TMF). In sensitivity scenario 1, the hydraulic conductivity of the intermediate and deep bedrock was modelled as uniform, at $3.4x10^{-8}$ m/s compared with the base case as summarized in Table IAAC-R4-01-1 (Attachment IAAC-R4-01). The results of the sensitivity scenario for the end of operation (pit fully dewatered with no seepage collection systems) are summarized in the following tables and map presented in Attachment IAAC-R4-01 with comparison with the base case: - Table IAAC-R4-01-1: Summarizing groundwater inflow to the open pit for the sensitivity scenario compared with the base case. - Table IAAC-R4-01-2: Summarizing fate of seepage from the TMF and mine rock storage area (MRSA) for the sensitivity scenario compared with the base case. - Table IAAC-R4-01-3: Summary of residual between observed and predicted water levels for the sensitivity scenario compared with the base case.

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	- Map IAAC-R4-01-1: Particle tracks from TMF and MRSA for the sensitivity scenario. b. It was not entirely clear what was requested as part of the IAAC-R3-01 sensitivity scenario and so the hydraulic conductivity of the intermediate and deep bedrock layer was modelled in the IAAC-R3-01 sensitivity scenario as an order of magnitude greater than that estimated based on field data. As stated in the response to IAAC-R3-01, this sensitivity model run for IAAC-R3-01 is not reflective of the field characterization of the MacLellan site and the results contrast with the conceptual model of hydrogeology for the site. Accordingly, the results of this IAAC-R4-01 new sensitivity scenario requested are not compared with the sensitivity scenario presented in IAAC-R3-01, but instead compared only with the base case result. With a uniform hydraulic conductivity of the intermediate and deep bedrock model layers, groundwater flows further into the intermediate and regional flow systems (intermediate and deep bedrock model layers) as opposed to flowing through the local or shallow bedrock system and discharging to nearby surface water features as in the base case. The total groundwater seepage to the receiving environment (surface water), as presented in Table IAAC-R4-01-2, decreased compared with the base case, which indicates that more recharge from the TMF and MRSA is not predicted to discharge to surface water, rather the discharge flows to the intermediate and deep bedrock. Note the travel times in Table IAAC-R4-01-2 for the base case are different than that previously reported. The travel times previously reported appear to have been originally extracted as days but reported in years, along with other minor post-processing errors. The corrected travel times for the base case in Table IAAC-R4-01-2 are similar to those for sensitivity scenario 1. Regardless of the reduced travel times, the assessment of effects of groundwater discharge to surface water was completed using total groundwater discharge, did not include travel time, and conservatively assumed groundwater seepage from mine features arrived at receptors instantaneously. Consequently, travel time did not influence the assessment of effects for groundwater or other relevant VCs. In addition, Alamos has committed in the Environmental Impact Statement, with additional details provided through a series of Information Request responses (specifically IAAC-62, IAAC-108, IAAC-R2-02, IAAC-R2-12, IAAC-R2-Appendix 20B, IAAC-R2-77), a Groundwater Management and Monitoring Plan that will be in place following Project approval that includes monitoring of potential seepage from mine infrastructure. Alamos' commitment includes: - Installation of a series of monitoring well fences to account for different travel times of seepage from the mine infrastructure. For example, monitoring wells immediately downgradient of the MRSA/TMF to understand source seepage concentrations, with monitoring wells at a series of downgradient distances from the source to confirm groundwater flow pathways and travel times. - Water quality sampling at a frequency that will account for the range of travel times predicted through the groundwater flow modelling. - An adaptive management plan with a series of thresholds that will alert Alamos to changing conditions in groundwater that have the potential to affect surface water and the associated aquatic biota and/or wetlands. The trigger

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	thresholds will be staged to accommodate levels of concern and a diversity of actions which allow timely and informative response, and mitigation if required, to be initiated before higher potential impact trigger thresholds are met or exceeded. Table IAAC-R4-01-3 presents the observed versus predicted water levels for the base case and sensitivity scenario 1. The average residual of the difference between the observed and predicted water levels increases from 0.95 m in the base case to 4.4 m in sensitivity scenario 1. For the majority of locations, particularly bedrock monitoring wells, the predicted water level elevation decreased, meaning the overall water table was flatter than the base case. This is a further indication that recharge was driven further into the intermediate and deep bedrock as opposed to discharging to nearby surface water features. The results of sensitivity scenario 1 are less conservative than the base case which was carried through the assessment of effects on relevant VCs. The mass balance error for the base case model is 0.007% and 0.0002% for sensitivity scenario 1. As stated in Konikow (1978), the mass balance error generally should be less than 0.1% and according to Anderson and Woessner (1992), a mass balance error of as much as 1% is generally considered acceptable. The mass balance error for both models are lower than typical thresholds and are acceptable. Note the scenarios simulated are steady state to provide conservative estimates of potential Project effects. c. As indicated above, the modeled hydraulic conductivity of sensitivity scenario 1 in IAAC-R4-01 results in an average residual of the difference between the observed and predicted water levels that is greater than the base case model. The results of sensitivity scenario 1 decreases the total seepage from the TMF and MRSA that discharge to surface water features, which means the estimate of mass loading to the receiving environment is less conservative than the base case. In addition, travel time did not influence the assessment of effects previously completed. Consequently, an updated assessment of potential Project effects, including residual and cumulative effects is not warranted. **References:** Anderson, M. P. and W. W. Woessner. 1992. Applied Groundwater Modeling Simulation of Flow and Advective Transport. New York: Academic Press, 381 p. Doherty, J. 2009. PEST: Model-Independent Parameter Estimation, User Manual (5th Edition). Watermark Numerical Consulting. Konikow, L. F. 1978. Calibration of Ground-water Models; Verification of Mathematical and Physical Models in Hydraulic Engineering. New York, NY: American Society of Civil Engineers, pp. 87-93.
Attachment:	Appendix A, Attachment IAAC-R4-01

Appendix A ATTACHMENTS

ATTACHMENT IAAC-R4-01

Table IAAC-R4-01-1 MacLellan Site Intermediate and Deep Bedrock Hydraulic Conductivity and Recharge Sensitivity Scenario – Predicted Open Pit Inflow at End of Operation

Scenario	Hydraulic Conductivity (m/s) / Porosity				Recharge (mm/yr)	Total Pit Inflow (m^3/s)
	Shallow Bedrock	Upper Bedrock	Intermediate Bedrock	Deep Bedrock		
Base Case	8.1×10^{-6} / 0.0001	2.0×10^{-7} / 0.0001	3.4×10^{-8} / 0.0001	1.3×10^{-8} / 0.0001	120	0.22
1	8.1×10^{-6} / 0.0001	2.0×10^{-7} / 0.0001	3.4×10^{-8} / 0.0001	3.4×10^{-8} / 0.0001	120	0.30

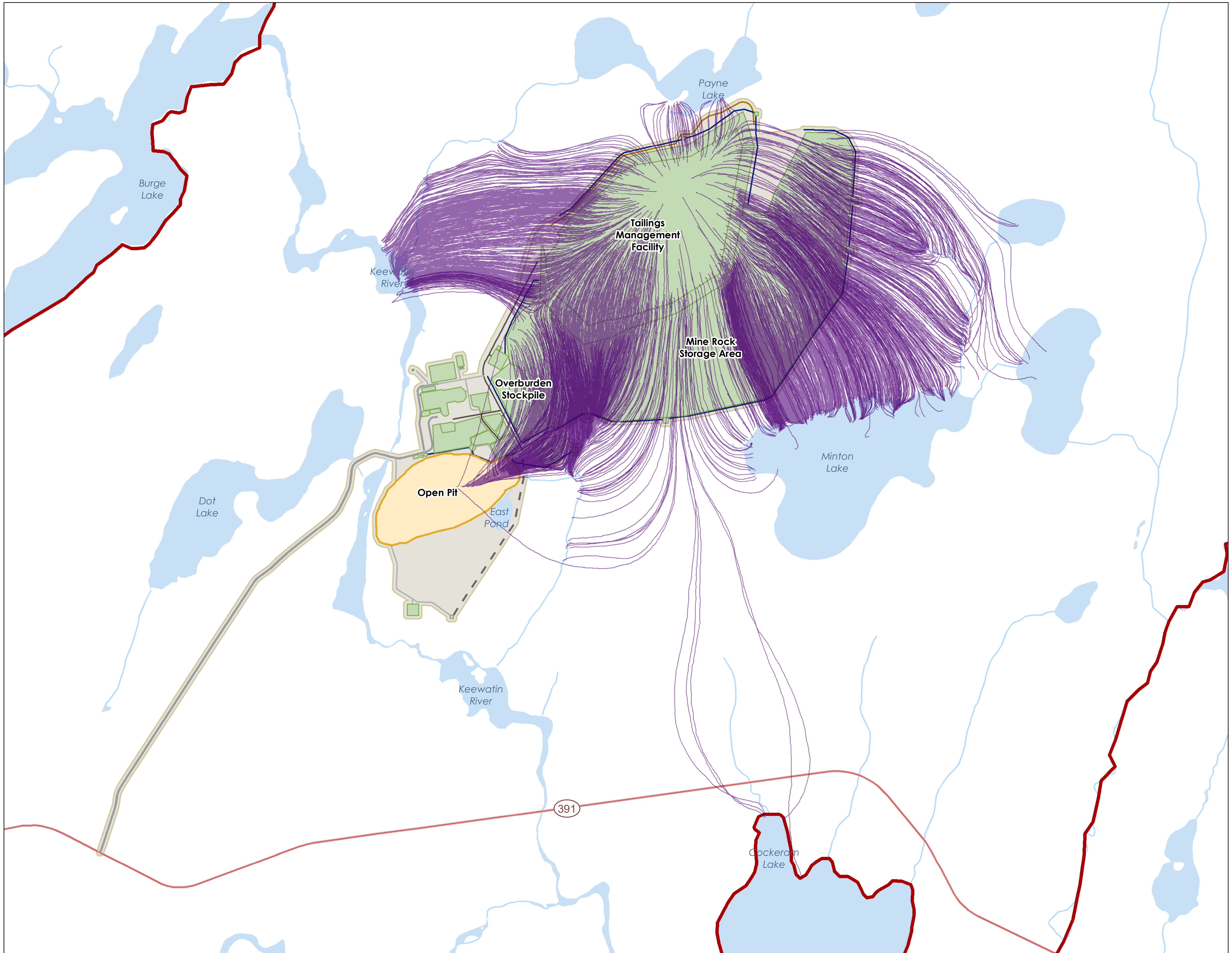
Table IAAC-R4-01-2 MacLellan Site Intermediate and Deep Bedrock Hydraulic Conductivity Sensitivity Scenario – Predicted Fate of Seepage from TMF and MRSA at End of Operation (no seepage collection ditches)

Source	Receptor	Base Case				Sensitivity Scenario 1 – Uniform Intermediate and Deep Bedrock Hydraulic Conductivity			
		Discharge (m^3/s)	Travel Time (years)			Discharge (m^3/s)	Travel Time (years)		
			Minimum	Mean	Maximum		Minimum	Mean	Maximum
TMF	Subsurface Seepage to Fen	7.3E-05	n/a	n/a	n/a	1.0E-04	<1	45	105
	Keewatin River	2.3E-04	1.2	8.4	38	8.5E-04	2	21	175
	Watercourse connecting Payne Lake and Keewatin River (Kee3-Pay1)	1.2E-04	1.9	5.5	16	6.2E-05	5	25	125
	Minton Lake	1.1E-03	2.7	11	56	1.1E-03	2	26	100
	Open Pit	3.0E-04	1.0	7.1	55	2.7E-04	3	31	145
	Tributary of Keewatin River (Kee3-B1)	3.0E-03	0.50	5.6	45	1.0E-03	<1	29	98
	Cockeram Lake	8.2E-05	n/a	n/a	n/a	5.1E-03	35	53	102
	Payne Lake	n/a	<1	5.3	45	1.8E-04	6	23	72
	Deep Regional Groundwater Flow	3.6E-03	n/a			4.8E-03	n/a		
	Sum to Receptors (excluding the Open Pit and Deep Regional Groundwater Flow)	4.6E-03	n/a			3.4E-03	n/a		
MRSA	Keewatin River	6.5E-05	1.7	3.8	11	6.3E-05	2	6	18
	Tributary of Keewatin River (Kee3-B1)	1.3E-03	<1	2.7	49	1.5E-03	<1	4	42
	Minton Lake	4.5E-03	<1	8.2	40	3.3E-03	<1	8	95
	Open Pit	1.3E-03	0.25	3.1	35	7.9E-04	<1	5	60
	Cockeram Lake	8.0E-06	n/a	n/a	n/a	5.4E-05	<1	5	40
	Subsurface Seepage to Fen	n/a	1.9	14	60	5.1E-04	<1	20	95
	Deep Regional Groundwater Flow	6.4E-03	n/a			7.4E-03	n/a		
	Sum to Receptors (excluding the Open Pit and Deep Regional Groundwater Flow)	5.9E-03	n/a			5.4E-03	n/a		

Notes:
n/a – not applicable

Table IAAC-R4-01-3 MacLellan Site Water Level Residuals for Base Case Calibration Compared with Sensitivity Scenario

Monitoring Well	Observed Average Annual Water Level Target (m amsl)	Base Case – Calibrated Model		Scenario 1 – Uniform Intermediate and Deep Bedrock Hydraulic Conductivity	
		Simulated Average Annual Water Level Target (m amsl)	Residual (m)	Simulated Average Annual Water Level Target (m amsl)	Residual (m)
MWM01A	343.89	343.68	-0.21	342.60	-1.29
MWM02A	349.91	350.10	0.19	348.25	-1.66
MWM02B	349.48	350.03	0.55	348.33	-1.15
MWM04	349.92	342.75	-7.17	336.42	-13.50
MWM05A	332.16	332.72	0.56	332.29	0.13
MWM05B	332.11	332.68	0.57	332.35	0.24
MWM06A	331.27	331.64	0.37	331.45	0.18
MWM06B	331.51	331.67	0.16	331.48	-0.03
MWM09A	344.61	337.57	-7.04	331.03	-13.58
MWM09B	345.01	337.57	-7.44	331.02	-13.99
MWM10A	327.47	326.87	-0.60	326.09	-1.38
MWM10B	327.77	326.77	-1.00	326.09	-1.68
GBHM01B	333.93	334.74	0.81	333.30	-0.63
GBHM03A	336.46	336.60	0.14	329.95	-6.51
GBHM05A	330.71	331.98	1.27	329.58	-1.13
GBHM05B	330.70	332.00	1.30	329.58	-1.12
GBHM06A	344.28	335.93	-8.35	331.30	-12.98
GBHM08	351.34	349.18	-2.16	346.02	-5.32
GBHM09A	346.22	343.83	-2.39	336.67	-9.55
GBHM10A	338.61	339.57	0.96	333.82	-4.79
GBHM10B	338.20	339.68	1.48	333.82	-4.38
GBHM12	335.64	340.14	4.50	338.32	2.68
GBHM13A	343.21	343.61	0.40	336.67	-6.54
GBHM13B	343.21	343.50	0.29	336.65	-6.56
		Average:	-0.95	Average:	-4.36



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Project Infrastructure
- Project Development Area
- Proposed Open Pit
- Potential Infrastructure
- Access Road
- Haul Road
- Inplant Road
- Toe Road
- Future Access

Study Area
- Study
- Particle Tracks

Landbase
- Highway
- Existing Access Road
- Watercourse
- Waterbody

N

0 0.5 1 Kilometres
(At original document size of 11x17)
1:35,000

Notes
1. Coordinate System: NAD 1983 UTM Zone 14N
2. Base Data Sources: Government of Manitoba and Government of Canada.
3. Project Infrastructure features provided by QPit and Ausenco.

Project Location
Lynn Lake,
Manitoba

Prepared by AC on 2022-08-30
Technical Review by AC on 2022-08-30

Client/Project 111473012
ALAMOS GOLD INC.
Lynn Lake Gold Project

Map No.
IAAC-R4-01-1

Title
Particle Traces from the TMF to the Receiving Environment - End of Operation - MacLellan (no contact water collection ditches) Sensitivity Scenario 1

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