

**TECHNICAL MEMORANDUM**

DATE 08 March 2021

Project No. 19127735-613-01\_E

TO [REDACTED] Department for Infrastructure

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**DALRADIAN PROPOSED CURRAGHINALT GOLD MINE PROJECT - WATER BALANCE REVIEW****1.0 INTRODUCTION**

Outlined in this memorandum are the findings of our independent third-party review of the water balance models used to support assessment of the possible impacts to surface water quantity from the proposed Curraghinalt underground gold mining project.

This review has been undertaken with consideration given to the stated purpose of the models, applicable requirements of the “Water Framework Directive (Classification, Priority Substances and Shellfish Waters) Regulations (Northern Ireland) 2015”, Regulations 9 and 10 of the “Planning (Management of Waste from Extractive Industries) Regulations (Northern Ireland) 2015”, EC Directives 2000/60/EC, 2006/11/EC and 2006/118/EC, and good international industry practice.

A review of the modelling undertaken to support the assessment of the potential impacts to surface water quality is presented in a separate technical memorandum, “Dalradian Proposed Curraghinalt Project Surface Water Quality Review”<sup>1</sup>.

**2.0 DATA PROVIDED**

Surface water quantity modelling for the proposed Curraghinalt Gold Mine project was carried out for both operations and closure conditions. Surface water quantity modelling for mine operations consisted of a mine water balance which is reported in “Curraghinalt Gold Mine Project – Site Water Balance – 2020 Update”<sup>2</sup>. This report is also included as Annex A of the “Surface Water Impact Assessment for the Curraghinalt Gold Project, County Tyrone, Northern Ireland” report<sup>3</sup>.

Water inputs, outputs, and internal transfers for the mine site during operations were assessed by Kaya Consultants using GoldSim™ Monte Carlo Simulation Software. Table 1 outlines the GoldSim™ models which have been provided to Golder.

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<sup>1</sup> Golder Associates. 2020. Dalradian Proposed Curraghinalt Project Surface Water Quality Review. Document No. 19127735-614-01\_E.

<sup>2</sup> Kaya Consulting Ltd. 2020. Curraghinalt Gold Mine Project – Site Water Balance – 2020 Update. October 2020.

<sup>3</sup> SRK Consulting. 2020. Surface Water Impact Assessment for the Curraghinalt Gold Project, County Tyrone, Northern Ireland. October 2020.

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**Table 1: Water Quantity (Flow) Models**

Model Name	Model Description
Curraghinalt_WB_Oct_2020_Monthly_FINAL_Base.gsm	Base Case
Curraghinalt_WB_Oct_2020_Monthly_FINAL_S1-1.gsm	Sensitivity S1-1
Curraghinalt_WB_Oct_2020_Monthly_FINAL_S1-2.gsm	Sensitivity S1-2
Curraghinalt_WB_Oct_2020_Monthly_FINAL_S1-3.gsm	Sensitivity S1-3
Curraghinalt_WB_Oct_2020_Monthly_FINAL_S1-4.gsm	Sensitivity S1-4
Curraghinalt_WB_Oct_2020_Monthly_FINAL_S1-5.gsm	Sensitivity S1-5
Curraghinalt_WB_Oct_2020_Daily_S1-6.gsm	Sensitivity S1-6
Curraghinalt_WB_Oct_2020_Daily_S1-7.gsm	Sensitivity S1-7
Curraghinalt_WB_Oct_2020_Monthly_FINAL_S2-1.gsm	Sensitivity S2-1
Curraghinalt_WB_Oct_2020_Monthly_FINAL_S3-1.gsm	Sensitivity S3-1
Curraghinalt_WB_Oct_2020_Monthly_FINAL_S3-2.gsm	Sensitivity S3-2
Curraghinalt_WB_Oct_2020_Monthly_FINAL_S3-3.gsm	Sensitivity S3-3
Curraghinalt_WB_Oct_2020_Monthly_FINAL_S3-4.gsm	Sensitivity S3-4
Curraghinalt_WB_Oct_2020_Monthly_FINAL_S4-1.gsm	Sensitivity S4-1
Curraghinalt_WB_Oct_2020_Monthly_FINAL_S4-2.gsm	Sensitivity S4-2
Curraghinalt_WB_Oct_2020_Monthly_FINAL_S5-1.gsm	Sensitivity S5-1
Curraghinalt_WB_Oct_2020_Monthly_FINAL_S5-2.gsm	Sensitivity S5-2
Catchment For Model - Monthly Evap - Present Day	Australian Water Balance Model (AWBM) (for estimating mine site runoff)

The following spreadsheet calculations supporting the water balance modelling were also provided to Golder:

- “Pollanroe and Owenreagh Flows Sent to Golders.xlsx”<sup>4</sup>

Surface water quantity modelling during mine closure consisted of calculations which were undertaken for average and low flow conditions in the receiving watercourses. These calculations are reported in the “Surface Water Impact Assessment for the Curraghinalt Gold Project, County Tyrone, Northern Ireland”<sup>5</sup> report. The review of these calculations is discussed in “Dalradian Proposed Curraghinalt Project Surface Water Quality

<sup>4</sup> Kaya Consultants Ltd. n.d. Pollanroe and Owenreagh Flows sent to Golders.xlsx.

<sup>5</sup> SRK Consulting. 2020. Surface Water Impact Assessment for the Curraghinalt Gold Project, County Tyrone, Northern Ireland. October 2020

Review”<sup>6</sup>, alongside the review of the modelling undertaken to support the assessment of potential impacts to surface water quality.

### 3.0 MODELLING OBJECTIVES

Water balance modelling was undertaken to support mine planning and design, and to assess the possible impacts on downstream watercourses during operations. The specific objectives of the modelling were to:

- Calculate operational water levels/volumes in the water management ponds;
- Calculate the water treatment rates required to maintain water levels in the ponds at appropriate operational water levels, as required for flood water management;
- Assess whether there is sufficient water within the treated water volume and intercepted clean water volume to provide make-up for the process;
- Provide flow estimates for discharges from the mine; and
- Provide inputs to geochemical models.

## 4.0 REVIEW COMMENTS

### 4.1 Modelling Software

Modelling of the mine water balance during operations was undertaken in GoldSim™, a Monte Carlo simulation software designed to support decision-making and risk analysis by simulating future performance while representing the uncertainty and risks inherent in engineering, science, and business systems.

#### ***Golder comment***

GoldSim™ is a standard tool used within the mining industry for water balance modelling. The software allows for the creation of flexible, graphically transparent models capable of the probabilistic simulation of hydrological and mine operating inputs. It is used at mine sites worldwide by the largest mining companies and leading consulting firms for strategic planning, optimisation of operations, risk analyses, and environmental impact assessments.

**Conclusion:** GoldSim™ is considered suitable for the outlined model purpose and objectives (Section 3.0).

### 4.2 Model Scenarios

GoldSim™ modelling was undertaken for the operational phase of the mine and included a Base Case scenario and 16 sensitivity runs to assess responses to changes in selected model inputs, mine operating parameters, and flow routing. In addition to the 16 sensitivity runs presented to Golder (listed in Table 1 and Table 6 through Table 9), an additional sensitivity run (model not provided to Golder) was carried out, the details of which are provided in Section 4.8.

#### ***Golder comment***

Golder has reviewed the submitted model files as well as the supporting reports and, based on this review, the model scenarios (base case and sensitivity runs) which have been undertaken are considered to be appropriate.

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<sup>6</sup> Golder Associates. 2020. Dalradian Proposed Curraghinalt Project Surface Water Quality Review. Document No. 19127735-614-01\_E.

GoldSim™ modelling was not undertaken for mine closure. However, spreadsheet calculations to assess the possible impacts to downstream watercourses during mine closure were undertaken which included estimates of various flows, e.g. site runoff, basal drain and seepage flows from the Dry Stack Facility (DSF), and flows in the Pollanroe and Owenreagh Rivers. Review of these calculations are discussed in a separate technical memorandum, “Dalradian Proposed Curraghinalt Gold Mine Project Surface Water Quality Review”<sup>7</sup>.

**Conclusion:** The model scenarios (base case and sensitivity runs) which have been undertaken are considered to be appropriate.

### 4.3 Conceptual Models

Conceptual models (block flow diagrams) for operating conditions in Years 6, 12 and 20 of the Life-of-Mine (LoM) are presented in “Curraghinalt Gold Mine Project- Site Water Balance - 2020 Update”<sup>8</sup>. The conceptual models consider the following:

- Mine facilities (Underground Mine, Processing Plant, and DSF);
- Proposed water storage ponds (Clean Water Pond, West Water Pond, East Water Ponds);
- Water Treatment Plant; and
- Receiving watercourses (Pollanroe Burn).

Water balance inputs, transfers, and outputs are provided in Table 2 and include water in the ore, mine dewatering flows, precipitation on the DSF and water storage ponds, and runoff from natural and disturbed (developed) catchments.

**Table 2: Flows in the Conceptual Models**

Water Balance Inputs	Water Balance Outputs	Flow Transfers between Facilities
Water in the ore	Water in the concentrate	Water in the tailings
Mine dewatering flows	Water in the paste to underground	DSF seepage
Precipitation on the DSF	Evaporation from the water ponds	Pumped water from the West and East Water Ponds to the Treatment Plant
Runoff from natural and disturbed catchments	Spray water	Recycled water from the Clean Water Pond to the Process Plant Site
Direct rainfall on the water ponds	Evaporator losses	
Sewage	Water treatment plant releases	
	Overflow from the Clean Water Pond	

<sup>7</sup> Golder Associates. 2020. Dalradian Proposed Curraghinalt Project Surface Water Quality Review. Document No. 19127735-614-01\_E.

<sup>8</sup> Kaya Consulting Ltd. 2020. Curraghinalt Gold Mine Project – Site Water Balance – 2020 Update. October 2020

**Golder comment**

Based on the available information, the conceptual models represent all key infrastructure and flows on site and the physical environment to an adequate resolution.

Golder notes that it would be helpful if a legend item was included which clearly identified that net rainfall on the ponds in Figures 14, 15 and 16 in “Curraghinalt Gold Mine Project - Site Water Balance - 2020 Update”<sup>9</sup>. However, the omission of this legend item does not affect the outcomes of the water balance review.

**Conclusion:** The conceptual models represent all key infrastructure and flows on site and the physical environment to an adequate resolution. Whereas some additional clarity could be added to in terms of reporting the conceptual models, this does not affect the outcomes of the water balance review.

**4.4 Model Simulation Settings**

For impact assessments during operations, the GoldSim water balance model was run with boundary conditions and timesteps as outlined in Table 3.

**Table 3: GoldSim model Boundary Conditions and Timesteps**

Model Parameters	Model Input
Start Date	January 1, 2022
End Date	January 1, 2042
Simulation Timestep	2-day
Number of Realizations	100

**Golder comment**

The water balance is run over the planned duration of the mining operations, and the model start and end dates are acceptable. The use of a 2-day simulation timestep is convenient for the purposes of extracting and viewing results. However, it should be noted that all timeseries were inputted on a monthly basis, and the resolution of the outputs is driven by the monthly resolution of the inputs. The monthly resolution of inputs is deemed appropriate for assessing most flow impacts within the Pollanroe Burn and Owenreagh River, with the exception of reductions in daily flows per Water Framework Directive (Classification, Priority Substances and Shellfish Waters) Regulations (Northern Ireland) 2015 (Sections 4.5 and 4.11.1).

As discussed further in Section 4.8, Golder notes that the model is run on the calendar, as opposed to the hydrologic year (starting at the end of the summer). However, it was noted in the “Curraghinalt Gold Mine Project - Site Water Balance - 2020 Update”<sup>9</sup> that an assessment of the implications of running the model on the calendar (as opposed to the hydrologic) year was carried out, and the differences in model predictions between the two approaches ranged from 0 to 2%. On this basis, Golder deems that the approach of running the model on the calendar year basis is adequate.

The model set-up of 100 realizations is deemed appropriate as it allows the model to cycle through all possible combinations of the annual historical datasets (further details on the representation of hydrology within the water balance presented in Section 4.6.1). Golder notes that 54 years of hydrologic data are cycled within the model for each model simulation. As mentioned further in Section 4.6.1, the 54 years of historical rainfall data include

<sup>9</sup> Kaya Consulting Ltd. 2020.Curraghinalt Gold Mine Project – Site Water Balance – 2020 Update. October 2020

a 1-in-80 wet year. Given the 20-year mine life, Golder considers the cycling of the 54 years of rainfall/runoff data adequate for assessing risk regarding water operations at the mine and has calculated a 22% risk of occurrence of the 1-in-80 wet year occurring at least once during the life of the mine.

**Conclusions:** The water balance is run over the planned duration of the mining operations; the model start and end dates are acceptable. The use of a 2-day simulation timestep is convenient for the purposes of extracting and viewing results. The model set-up of 100 realizations is deemed appropriate as it allows the model to cycle through all possible combinations of the annual historical datasets. Given the 20-year mine life, Golder considers the cycling of the 54 years of rainfall/runoff data adequate for assessing risk regarding water operations at the mine.

#### 4.5 Key Model Inputs and Assumptions

Key model inputs consisted of the following:

- Monthly timeseries of historical precipitation and evaporation for Lough Fea climate station;
- Monthly timeseries of future climate precipitation and evaporation for Representative Concentration Pathway (RCP) 4.5 (further described in Table 5);
- Monthly timeseries of historical and future runoff (natural and disturbed catchments);
- Monthly timeseries of runoff and seepage from active and reclaimed areas on the DSF;
- Clean Water, East and West Pond surface areas and capacities; and
- East and West Pond buffer volumes.

The key assumptions underpinning the model inputs are:

- Representation of the climate with data from the Lough Fea station is appropriate;
- Future climate at the mine will follow RCP 4.5 predictions;
- Runoff from natural catchments calculated using the AWBM adequately represent runoff from the mine site areas;
- Runoff from disturbed mine areas is 20% greater than runoff from natural catchments;
- Runoff and seepage rates from active and reclaimed areas of the DSF calculated using the Surface Water Accounting Model (SWAc) adequately represent flows from the DSF; and
- Pond freeboards are adequate.

#### ***Golder comment***

Golder’s comments on the inputs and assumptions listed above are presented in Table 4 and Table 5, respectively.

**Table 4: Golder Comments on Key Model Inputs**

Key Input	Golder Comment
Monthly timeseries of historical and future climate precipitation and evaporation, monthly timeseries of runoff from natural and disturbed	Golder has assessed the suitability of the monthly timeseries against the modelling objectives (Section 3.0) and excepting the objective to

Key Input	Golder Comment
<p>catchments, and monthly timeseries of runoff and seepage from active and reclaimed areas on the DSF</p>	<p>assess discharges from the mine, considers that a monthly input time series is appropriate for these objectives.</p> <p>The modelling objective to assess discharges from the mine is relevant to the assessment of compensation flow requirements in Pollanroe Burn and Owenreagh River. The relevant river flow standards and objectives against which these requirements can be assessed are defined under the Water Framework Directive (Classification, Priority Substances and Shellfish Waters) Regulations (Northern Ireland) 2015<sup>10</sup>. These river flow standards consider permitted daily abstraction rates as a percentage of natural mean daily flows.</p> <p>The results of the water balance show that the flow in the Pollanroe Burn will, on a monthly and annual basis, be augmented during low and average flow conditions, notably through (i) the dewatering of the underground mine (after treatment) and (ii) through natural groundwater inflows to the Under Drain which discharges to the Pollanroe Burn. However, the water balance does not account for daily variations. In the event that compensation flows are required to meet the requirements of the Water Framework Directive (Classification, Priority Substances and Shellfish Waters) Regulations (Northern Ireland) 2015, groundwater can continue to be pumped from the underground workings at rates that will allow these river flow standards to be met<sup>11</sup>. Golder notes that while a further assessment of the mine discharges which takes daily inputs into account would be helpful, it is not expected to change the overall results from the water balance.</p>
<p>East and West Pond buffer volumes, surface areas, and capacities</p>	<p>The buffer volumes were based on the required flood storage for the 1-in-1000 year, 24-hour event; the input of a buffer volume to store runoff from an extreme storm is considered appropriate. However, the calculations were carried out externally to GoldSim™ and Golder has not reviewed these calculations. Note that the Clean Water Pond is not intended for flood storage and so no buffer volumes were considered within the water balance.</p> <p>The surface areas and capacities of the ponds were provided to the authors of the water balance; Golder cannot assess the suitability or correctness of these inputs.</p>

<sup>10</sup> Water Framework Directive (Classification, Priority Substances and Shellfish Waters) Regulations (Northern Ireland) 2015

<sup>11</sup> SRK Consulting. 2020. Surface Water Impact Assessment for the Curraghinalt Gold Project, County Tyrone, Northern Ireland. October 2020

**Table 5: Golder Comments on Key Assumptions**

Key Assumption	Golder Comment
Representation of the local climate with data from the Lough Fea station is appropriate.	This assumption is reasonable based on the limitations of available climate data. “Curraghinalt Gold Mine Project- Site Water Balance - 2020 Update” <sup>12</sup> indicates that Lough Fea is the closest station and has a comparable elevation to the mine site. Golder estimates the station is located approximately 18.5 km east of the mine site and has an elevation of 225 m AMSL.
Future climate at the mine will follow RCP 4.5 predictions	<p>IPCC’s ‘Climate Change 2014: Synthesis Report’<sup>13</sup> adopts four possible future climate change scenarios called ‘Representative Concentration Pathways’ or RCPs. These are RCP 2.6, RCP 4.5, RCP 6.0 and RCP 8.5. Each scenario describes a different climate future depending on greenhouses gas emissions and land use. The likelihood of RCP 2.6 and RCP 8.5 is considered low.</p> <p>The RCP 4.5 climate predictions are considered to be a medium stabilization pathway<sup>14</sup>. Golder deems this to be a reasonable approach for the Base Case and all the sensitivity runs bar one. A sensitivity run was undertaken considering RCP 8.5 which is discussed further in Section 4.8.</p>
Runoff from natural catchments calculated using the AWBM adequately represent runoff from the mine site areas	<p>Runoff from natural catchments was calculated using the AWBM<sup>15</sup>. Calculations were undertaken separately from the site-wide water balance, and outputs from this model were used as inputs to the site-wide water balance. The results from the AWBM were calibrated, through visual comparison, to flow duration curves from four local monitoring locations. No validation of the AWBM runoff values was carried out.</p> <p>The modelled normalized flow-duration curves show a good visual match to the observed flow-duration curves for the small catchments on the site. However, Golder notes that the modelled flow duration curve under-predicts low flows and over-predicts high flows. Further discussion on the implications (if any) of this would be useful. However, Golder notes that sensitivity analyses (S1-1 and S1-2) were carried out to address uncertainties in runoff. As such, while a discussion on implications would be useful, Golder considers that uncertainty in runoff inputs has been sufficiently addressed.</p> <p>Given the limited site-specific data available (between 2 and 6 years of daily data), Golder considers the lack of a validation exercise</p>

<sup>12</sup> Kaya Consulting Ltd. 2020. Curraghinalt Gold Mine Project – Site Water Balance – 2020 Update. October 2020

<sup>13</sup> IPCC. 2014. Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. IPCC, Geneva, Switzerland, 151 pp.

<sup>14</sup> Department for Environmental, Food and Rural Affairs (DEFRA). 2018. UKCP18 Guidance: Representative Concentration Pathways. Obtained from <https://www.metoffice.gov.uk/binaries/content/assets/metofficegovuk/pdf/research/ukcp/ukcp18-guidance---representative-concentration-pathways.pdf>

<sup>15</sup> Broughton, W. 2004. The Australian Water Balance Model. Environmental Modelling and Software. Volume 19, Issue 10, Pages 943 – 956.

Key Assumption	Golder Comment
	<p>reasonable. Due to the lack of validation, the fit of the modelled catchment results to the observed local site catchment runoff should be quantified using an appropriate goodness-of-fit approach. Overall, however, Golder deems the calibration of the flow duration curves through visual comparison to be adequate.</p>
<p>Runoff from disturbed catchments is 20% greater than runoff from natural catchments</p>	<p>Disturbed catchments will include unpaved roads, hard standing areas and roofs<sup>16</sup>. A runoff rate (percentage of rainfall occurring as runoff) for disturbed catchments would lie between the rate of 65% for natural catchments and 90% from hardstanding areas during storm events. The report goes on to state that the representation of runoff from disturbed areas through a 20% increase of natural runoff provides a balanced rate within the above-mentioned range of 80%.</p> <p>Golder considers this approach reasonable given the above logic and due to the monthly resolution of the model.</p> <p>Golder also notes that results from Sensitivity Run S1-1 (runoff increased by 20%, monthly rainfall data resolution) and Sensitivity Run S1-7 (runoff increased by 20%, daily rainfall data resolution) do not indicate any infringement on the freeboard requirements in the storage ponds.</p>
<p>Runoff and seepage rates from active and reclaimed areas of the DSF calculated using the SWAc adequately represent flows from the DSF</p>	<p>Runoff and infiltration rates for the DSF were input to the water balance model based on calculations by SRK.</p> <p>Golder considers this approach reasonable, based on a general understanding of SWAc modelling. Golder has not reviewed the SWAc model used specifically for the assessment of the DSF flows. As stated in the “Curraghinalt Gold Mine Project - Site Water Balance - 2020 Update”<sup>Error! Bookmark not defined.</sup> the hydrological inputs to this model are the same as that for the water balance.</p>
<p>Pond freeboards are adequate</p>	<p>The East and West ponds will be operated so that there is sufficient freeboard in the ponds to accommodate a 24-hour, 1 in 1,000 year storm event<sup>16</sup>. These calculations were carried out externally to GoldSim and Golder has not reviewed these calculations. However, selection of the 24-hour, 1 in 1,000-year storm is reasonable; the probability of this storm event occurring at least once during the 20 years of mining operations is 2%.</p>

<sup>16</sup> Kaya Consulting Ltd. 2020.Curraghinalt Gold Mine Project – Site Water Balance – 2020 Update. October 2020

**Conclusion:** Golder identified that monthly timeseries inputs are not appropriate for assessing compliance with daily river flow standards in Water Framework Directive (Classification, Priority Substances and Shellfish Waters) Regulations (Northern Ireland) 2015. However, further assessment of the mine discharges which takes daily inputs into account, while being helpful, is not expected to change the overall results from the water balance, which indicates monthly and annual flows in the Pollanroe Burn are augmented during low and average flow conditions. Golder also identified that the modelled flow duration curve for natural catchments under-predicts low flows and over-predicts high flows. While further discussion on the implications (if any) of this would be useful, Golder considers the representation of runoff within the model to be adequate given that sensitivity analyses were carried out to address uncertainties in runoff rates. Therefore, Golder considers that the inputs and assumptions of the water balance are appropriate and does not consider that any further assessment is required at this planning stage.

## 4.6 Model Logic and Calculations

### 4.6.1 Hydrology

A “stochastic” approach to rainfall, runoff and evaporation modelling was presented in “Curraghinalt Gold Mine Project - Site Water Balance - 2020 Update”<sup>17</sup>. This approach consisted of the shifting of historical annual timeseries, in randomized order, based on Monte Carlo seeding. The annual historical datasets were shifted starting in January of each year.

#### ***Golder comment***

The time-shifting approach to hydrologic inputs applied to the model allowed for a range of climate conditions to be considered. The historical climate time series input to the model(s) represents a range of climate conditions ranging from the 1-in-80 wet year to 1-in-200 dry year<sup>17</sup>. As discussed further in Section 4.6.2, adjustments were made to the historical datasets to incorporate climate change effects. The impact of these climate change adjustments to the return periods represented within the model is not reported. However, Golder deems the time-shifting approach to hydrologic model inputs adequate based on the 20-year life of the mine and estimates a 22% risk of occurrence of the 1-in-80 wet year occurring at least once during the life of the mine, and a 10% risk of occurrence of the 1-in-200 dry year occurring at least once during the life of the mine.

The shift is based on a calendar year (starting at the beginning of January), rather than a hydrologic year (starting at the end of the dry season). However, an additional assessment was carried out to assess the implications of aligning the shift with the hydrologic year and, based on the results, there was no significant difference in the model results between the two approaches.

**Conclusion:** Golder considers that the approach to modelling hydrologic inputs (i.e., time-shifting at the start of a calendar year) is appropriate and does not consider that any further assessment is required.

### 4.6.2 Climate Change

Golder noted that climate change was incorporated based on linear interpolation between historical climate data for 2020 and climate predictions for benchmark years 2040 and 2060. Golder also notes that the monthly rainfall for 2040 and 2060 benchmark years were calculated based on an average of the monthly anomalies of the previous and subsequent 5 years of data. The averaging of these years was undertaken to extract key climate trends and remove interannual variations deemed to reflect variabilities in the modelling.

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<sup>17</sup> Kaya Consulting Ltd. 2020.Curraghinalt Gold Mine Project – Site Water Balance – 2020 Update. October 2020

### ***Golder comment***

There is currently no standard industry practice or regulatory guidance on incorporating climate change predictions into mine water balance models. However, the linear interpolation of monthly rainfall and evaporation between historical data for 2020 and climate change benchmark years 2040 and 2060 is considered reasonable for the purposes of mine planning.

Golder has not reviewed the raw climate prediction data, and so cannot speak to the validity of calculating 2040 and 2060 benchmark rainfall by averaging the previous and subsequent years.

**Conclusion:** Golder notes that there is no standard industry practice or regulatory guidance on incorporating climate change predictions into mine water balance models. However, the linear interpolation of monthly rainfall and evaporation is considered appropriate. Golder has not reviewed the raw climate prediction data and cannot speak to the validity of averaging rainfall for years previous and subsequent to 2040 and 2060.

### **4.6.3 Flow Rates**

As mentioned in Section 4.5, runoff rates from natural catchments were estimated using the AWBM, whereas runoff and seepage flow rates from the DSF were calculated using the SWAc. These timeseries, which were derived separately from the site-wide water balance, were input directly into the model. The runoff rates from disturbed areas were based on the application of a 20% increase to the runoff rates from natural catchments.

The model logic also considered transfers between the site facilities as well as discharges to the environment (as outlined in Table 2).

### ***Golder comment***

The logic and calculations with regard to flow rates in the water balance model have been reviewed and are deemed correct. Given that the model inputs and assumptions are considered reasonable (Section 4.5), the flow rates calculated in the model are acceptable.

**Conclusion:** Golder considers that the approach taken to determine flow rates is appropriate and does not consider that any further assessment is required.

### **4.6.4 Water Storage and Spill Assessment**

The East and West Ponds will be operated so that there is sufficient freeboard in the ponds to accommodate a 24-hour, 1 in 1,000 year storm event<sup>18</sup>. The flood storage requirements were assessed outside of Goldsim™ and Golder has not reviewed these calculations. To determine whether freeboard is maintained within the ponds, the available flood storage capacities in the ponds in the water balance must be manually compared to the flood storage requirements. There is no inherent logic within the model which alerts the user as to whether or not the storage requirements are compromised during model runs; this needs to be assessed through the inspection of the model outputs.

### ***Golder comment***

Golder has reviewed the approach for assessing the likelihood of spills from the East and West Ponds and can confirm it is acceptable and sufficient for the purposes of mine planning.

**Conclusion:** The approach taken to assess the likelihood of spills is sound and sufficient for the purposes of mine planning. Golder does not consider that further assessment is required at this planning stage.

<sup>18</sup> Kaya Consulting Ltd. 2020. Curraghinalt Gold Mine Project – Site Water Balance – 2020 Update. October 2020

## 4.7 Uncertainty in Model Inputs and Outputs

The following sources of uncertainty are associated with key model inputs<sup>19</sup>:

- Rainfall and approach to modelling climate variability;
- Flood storage assumptions;

The following sources of uncertainty are associated with key model outputs<sup>19</sup>:

- Water Treatment Capacity;
- Clean Water Pond Design and Risk of Water Shortages;
- Compensation Flow; and
- Engineering Designs.

### ***Golder Comment***

Golder considers that all sources of uncertainty have been captured in the list above. The sources of uncertainty listed for the model inputs have been addressed through sensitivity analysis assessments (Section 4.8), as well as the application of a stochastic approach to modelling climate (Section 4.6.1).

Two sources of uncertainty listed for the model outputs, (i) Water Treatment Capacity and (ii) Clean Water Pond Design and Risk of Water Shortages, have also been addressed through sensitivity analysis assessments (Section 4.8).

The possibility exists that a higher compensation flow may be required by regulators through the permitting process; however, as increased monthly and annual flows are provided to the Pollanroe Burn, there is confidence that increased demands for compensation flows could be met<sup>19</sup>. Golder notes that no sensitivity analysis assessment has been carried out to assess to what extent increased compensation flow demands could be provided from the Clean Water Pond. However, the exclusion of this assessment does not affect the validity of the results from the Base Case.

Regarding uncertainty relating to engineering designs, the designs of engineered structures were provided to the authors of the water balance by others, and so the authors were reliant on information provided to them regarding sizing and operation of these structures<sup>19</sup>. Golder has not reviewed these engineering designs as part of the water balance review.

**Conclusion:** All identified sources of uncertainty in model inputs and outputs have been addressed adequately through sensitivity analysis assessments. Golder notes that no sensitivity analysis assessment has been carried out to assess to what extent, increased compensation flow demands (if required) could be provided from the Clean Water Pond. However, the exclusion of this assessment does not affect the validity of the results from the Base Case. Golder does not consider that further assessment is required at this planning stage.

## 4.8 Sensitivity Analysis of Model Inputs

The “Curraghinalt Gold Mine Project - Site Water Balance - 2020 Update” reports the results and conclusions of a series of sensitivity analyses carried out on certain hydrologic inputs and other key inputs, process water demands and changes in mine infrastructure, water management options, and conservative model runs using GoldSim™. The models used to carry out these sensitivity analyses are presented in Table 1. An additional sensitivity run (model not provided to Golder) was carried out to assess the implications of aligning the shift of

<sup>19</sup> Kaya Consulting Ltd. 2020.Curraghinalt Gold Mine Project – Site Water Balance – 2020 Update. October 2020

the annual historical climate datasets with the hydrologic year, as opposed to the calendar year. Based on reporting in the “Curraghinalt Gold Mine Project- Site Water Balance - 2020 Update”<sup>20</sup> the differences in model predictions between the two approaches ranged from 0 to 2%.

**Golder Comment**

Golder has reviewed the inputs and outputs to these models, as well as the results and conclusions presented in Section 7 of the “Curraghinalt Gold Mine Project - Site Water Balance - 2020 Update”<sup>20</sup>. The sensitivity analyses carried out adequately represent credible “worst-case” scenarios.

Golder’s comments regarding each of the sensitivity analysis assessments are presented in Table 6, Table 7, Table 8 and Table 9.

**Table 6: Sensitivity Analysis Parameters – Hydrologic Inputs and Other Key Inputs**

Model Description	Sensitivity Parameter	Golder Comment
Base Case	None	Base Case considered climate change under RCP 4.5 conditions. Golder consider this appropriate.
Sensitivity S1-1	Runoff + 20%	As the Base Case model already simulates a wet year (1-in-80 year wet), Golder considers this increase to the runoff flow rates (natural and disturbed catchments) to be appropriate for assessing uncertainty due to rainfall and runoff characteristics.
Sensitivity S1-2	Runoff – 20%	As the Base Case model already simulates a dry year (1-in-200 year dry), Golder considers this decrease to the runoff flow rates (natural and disturbed catchments) to be appropriate for assessing uncertainty due to rainfall and runoff characteristics.
Sensitivity S1-3	Underground inflow + 20%	Golder considers this increase to the underground inflow to be appropriate for assessing uncertainty in groundwater inflows. The assessment of the underground inflow rates was carried out separately as part of the “Dalradian Proposed Curraghinalt Project Groundwater Modelling Review” <sup>21</sup> .
Sensitivity S1-4	Underground inflow – 40%	Golder considers this decrease to the underground inflow rates to be appropriate for assessing uncertainty in groundwater inflows. The assessment of the underground inflow rates was carried out separately as part of the “Dalradian Proposed Curraghinalt Project Groundwater Modelling Review” <sup>21</sup> .
Sensitivity S1-5	Climate Change at RCP 8.5	As demonstrated in Table 8 of the “Curraghinalt Gold Mine Project - Site Water Balance - 2020 Update” <sup>22</sup> , summer months are projected to experience less rainfall while winter months are

<sup>20</sup> SRK Consulting. 2020. Surface Water Impact Assessment for the Curraghinalt Gold Project, County Tyrone, Northern Ireland. October 2020.

<sup>21</sup> Golder Associates Ltd. 2020. Dalradian Proposed Curraghinalt Project Groundwater Modelling Review. Document No. 19127735.611.01.E

<sup>22</sup> Kaya Consulting Ltd. 2020. Curraghinalt Gold Mine Project – Site Water Balance – 2020 Update. October 2020

Model Description	Sensitivity Parameter	Golder Comment
		<p>projected to experience more rainfall. The report presents, qualitatively, that the model does not predict any shortages in the drier summer months, and that increased treatment rates are needed in the winter months. However, the modelling shows that the available storage capacity in the East and West Ponds never falls below the flood storage requirements<sup>22</sup>.</p> <p>Upon review of the RCP 8.5 climate inputs, Golder has noted the following:</p> <ul style="list-style-type: none"> <li>■ Rainfall: No climate change adjustments were made to the rainfall inputs to represent the RCP 8.5 scenario.</li> <li>■ Evaporation: No climate change adjustments were made to evaporation inputs to represent the RCP 8.5 scenario.</li> </ul> <p>These rainfall and evaporation inputs only affect the ponds in the model and do not impact runoff and seepage rates. The pond areas are small and so the exclusion of climate updates to these inputs will not substantially affect the model results.</p> <p>Golder considers the RCP 8.5 climate scenario to be appropriate for assessing uncertainty in climate change predictions.</p>
Sensitivity S1-6	Daily hydrological timestep	<p>Upon review of the sensitivity analysis model, Golder has noted that runoff values were input on a daily basis; however, rainfall and evaporation values were input on a monthly basis.</p> <p>The rainfall and evaporation inputs only affect small pond surface areas and so the monthly resolutions of these inputs will not substantially affect the model results.</p> <p>Golder considers a daily hydrological timestep to be adequate for assessing uncertainties in the climate inputs.</p>
Sensitivity S1-7	Daily hydrological timestep in addition to increase in runoff by 20%	<p>Upon review of the sensitivity analysis model, Golder has noted that runoff values were input on a daily basis. However, rainfall and evaporation values were input on a monthly basis.</p> <p>The rainfall and evaporation inputs only affect small pond surface areas and so the monthly resolutions of these inputs will not substantially affect the model results.</p> <p>Golder considers the combination of a daily hydrological timestep and increased runoff to be adequate for assessing the robustness of the model regarding the required flood storage in the East and West Ponds, as well as the maximum required treatment rate.</p>

Model Description	Sensitivity Parameter	Golder Comment
		Golder notes that the Clean Water Pond receives diverted water from north of the proposed infrastructure site. Water will be stored for additional make-up to the processing plant, and to provide compensation flow to the Pollanroe Burn. The pond will have a spillway to allow free overflow to the Pollanroe Burn during extreme storm events.

Sensitivity analysis assessments were carried out on process water demands and changes in mine infrastructure. The parameters adjusted, as well as Golder’s comments, are shown in Table 7.

**Table 7: Sensitivity Analysis Parameters - Process Water Demands and Changes in Mine Infrastructure**

Model Description	Sensitivity Parameter	Golder Comment
Sensitivity S2-1	Fresh Water Requirement increased by 100%	Golder considers this increase to the fresh-water requirements to be an appropriate upper range for assessing uncertainty in this process water demand.
Sensitivity S3-1	Maximum Treatment Rate decreased by 50%	Golder considers this reduction in the maximum treatment rate to be an appropriate upper range for assessing uncertainty in freshwater requirements.  Under this sensitivity analysis scenario, there is some encroachment on the flood storage requirements in the pond (freeboard) <sup>23</sup> . However, Golder has reviewed the model and no spill is reported from the pond.
Sensitivity S3-2	Maximum Treatment Rate increased by 50%	Golder considers this increase in the maximum treatment rate to be an appropriate lower range for assessing uncertainty in freshwater requirements.
Sensitivity S3-3	Increased Loss to Evaporator in the RO Treatment Plant (increased from 0.5% to 2.5%)	No justification has been provided as to the range of values considered and Golder cannot provide comment. However, Golder notes that these flows constitute a minor component of the overall flows in the water balance and impacts of changes to these flows are anticipated to be negligible.
Sensitivity S3-4	Additional storage requirements in the East	Golder considers this increase to the flood storage requirements in the East and West Ponds to be an

<sup>23</sup> Kaya Consulting Ltd. 2020.Curraghinalt Gold Mine Project – Site Water Balance – 2020 Update. October 2020

Model Description	Sensitivity Parameter	Golder Comment
	and West Ponds (storage requirement increased by 50%)	appropriate upper range for assessing uncertainty in hydrology inputs and freeboard requirements.

Sensitivity analysis assessments were carried out on water management options. The adjusted model logic, as well as Golder’s comments, are shown in Table 8.

**Table 8: Sensitivity Analysis Parameters - Water Management Options**

Model Description	Sensitivity Parameter	Golder Comment
Sensitivity S4-1	Divert Natural Runoff in Western Diversion Channel to Pollanroe	<p>In the Base Case, the West Diversion Channel reports directly to the West Pond. The purpose of this sensitivity assessment was to assess the impact on (i) required treatment rates and (ii) available flood storage in the West Pond, in the event that the operational (or planning) decision is made to re-route the West Diversion channel directly to the Pollanroe Burn. Note that this diversion of the West Diversion Channel to the Pollanroe Burn is considered only as part of the sensitivity analysis.</p> <p>The assessment demonstrates that the proposed water treatment capacity and pond volumes are conservative<sup>23</sup>, as the possibility would exist for this water to discharge directly to the Pollanroe Burn, pending approval by the regulator.</p> <p>Golder considers this assessment adequate for assessing the impact on treatment rates and water flood storage requirements in the event that this approach is considered.</p> <p>However, Golder notes that the increase in Pollanroe Burn flows is not specifically modelled (the diverted flows do not report to any receiving water body within the model), and is not discussed in the provided report. If consideration (as part of future planning processes or operational decision-making) is to be given to diverting this water directly to the Pollanroe Burn, additional effort would be needed to assess the downstream impacts on the Pollanroe Burn.</p>

Model Description	Sensitivity Parameter	Golder Comment
Sensitivity S4-2	Runoff from undeveloped areas of DSF released to Pollanroe	<p>In the Base Case, the runoff from undeveloped areas on the DSF reports directly to the West Pond. The purpose of this sensitivity assessment is similar to S4-1. Like S4-1, the assessment demonstrates that the proposed water treatment capacity and pond volumes are conservative<sup>24</sup>, as the possibility would exist for this water to discharge directly to the Pollanroe Burn. This possibility is only considered as part of the sensitivity analysis.</p> <p>Golder considers this assessment adequate for assessing the impact on treatment rates and water flood storage requirements in the event that this approach is considered.</p> <p>However, Golder notes that the increase in Pollanroe Burn flows is not specifically modelled (the diverted flows do not report to any receiving water body within the model) and is not discussed in the provided report. If consideration (as part of future planning processes or operational decision-making) is to be given to diverting this water directly to the Pollanroe Burn, additional effort would be needed to assess the downstream impacts on the Pollanroe Burn.</p>

Conservative sensitivity analysis runs were carried out, combining changes to multiple model parameters. The parameters adjusted, as well as Golder’s comments, are shown in Table 8.

**Table 9: Sensitivity Analysis Parameters - Conservative Sensitivity Model Runs**

Model Description	Sensitivity Parameter	Golder Comment
Sensitivity S5-1	Conservative Wet Weather Run, with increased runoff rates (+20%) from all surfaces, and increased underground inflows (+20%)	Golder considers these increases in runoff and underground inflows reasonable for assessing a conservative wet weather scenario. The percentage increases are consistent with sensitivity analysis runs S1-1 and S1-3 in Table 6.
Sensitivity S5-2	Conservative Dry Weather Run with increased flood storage requirement (+50%), reduced runoff	Golder considers these changes in the flood storage requirement of the East and West Ponds, runoff rates and fresh water demand appropriate for assessing a conservative dry weather scenario. The percentage

<sup>24</sup> Kaya Consulting Ltd. 2020.Curraghinalt Gold Mine Project – Site Water Balance – 2020 Update. October 2020

Model Description	Sensitivity Parameter	Golder Comment
	rates (-20%) and increased freshwater demand (+100%)	changes are consistent with sensitivity analysis runs S3-4 (Table 7), S1-2 (Table 6), S2-1 (Table 7).

**Conclusion:** Some gaps in the sensitivity analysis assessments were noted in Table 6, Table 7, Table 8 and Table 9 and are summarized as follows:

- Sensitivity Analysis S1-6 (Daily Hydrological Timestep) considers daily runoff and seepage inputs, but monthly rainfall and evaporation inputs.
- Sensitivity Analysis S1-7 (Daily Hydrological Timestep in Addition to Increase in Runoff by 20%) considers daily runoff and seepage inputs, but monthly rainfall and evaporation inputs.
- Justification of the range of values considered in Sensitivity Analysis S3-3 (Increased Loss to Evaporator in the RO Treatment Plant).
- Assessment of the impacts of diverting runoff from undeveloped areas to Pollanroe Burn modelled in Sensitivity Analyses S4-1 (Divert Natural Runoff in Western Diversion Channel to Pollanroe) and S4-2 (Runoff from Undeveloped Areas of DSF Released to Pollanroe), in the event of planning or operational changes.

Although these gaps are noted, Golder does not consider any further assessment is required at this planning stage.

#### 4.9 Key Modelling Conclusions

The key conclusions regarding surface water quantity modelling, as outlined in the “Curraghinalt Gold Mine Project - Site Water Balance - 2020 Update” report <sup>25</sup> are as follows:

- There is a low risk of water shortage at the mine site and a low risk of spillage of untreated mine water;
- The model predicts that the pond water levels can be operated with more than sufficient freeboard above the operational water levels in the East and West Ponds;
- The sensitivity analysis assessments show that the water management plan, proposed water treatment capacity and pond volumes are robust with respect to uncertainties in model inputs; and
- There may be options to reduce flow rates to the water management ponds in the future, but the approach taken is conservative and considers the management of runoff from the full site area.

#### **Golder Comment**

It is Golder’s opinion that the overall conclusions are sound based on the results presented.

**Conclusion:** The key conclusions of the water balance are sound based on the results presented and Golder does not consider that further assessment is required.

<sup>25</sup> Kaya Consulting Ltd. 2020.Curraghinalt Gold Mine Project – Site Water Balance – 2020 Update. October 2020

## 4.10 Key Model Limitations

Golder notes the following key model limitations:

- Absence of site-specific, long-term climate data;
- Lack of site-specific flow data; and
- Extraction of climate change data (precipitation and temperature) from a 25 km<sup>2</sup> grid encompassing the project site.

### ***Golder Comment***

These model limitations have been sufficiently addressed in the modelling approach and through the consideration of sensitivity assessments.

**Conclusion:** The model limitations have been sufficiently considered; Golder does not consider that any further assessment is required.

## 4.11 Compliance with Regulatory Requirements

Golder has assessed the outcomes of the water balance against the following key guidelines and directives:

- Water Framework Directive (Classification, Priority Substances and Shellfish Waters) Regulations (Northern Ireland) 2015;
- Regulation 9 of the “Planning (Management of Waste from Extractive Industries) Regulations (Northern Ireland) 2015”;
- Regulation 10 of the “Planning (Management of Waste from Extractive Industries) Regulations (Northern Ireland) 2015”;
- EC directive 2000/60/EC;
- EC directive 2006/11/EC; and
- EC directive 2006/118/EC.

Upon review of the above-mentioned documents, Golder has considered the compliance of the outcomes of the water balance based on the following key issues: (i) Maintenance of low flows (ii) Reduction of erosion and (iii) Prevention of contamination of receiving water bodies. The following sections discuss the compliance of the outcomes of the water balance in relation to these issues.

### 4.11.1 Maintenance of Low Flows

The EC Directive 2000/60/EC speaks to the need for achieving Good water status in each river basin, whether this be from an ecological, hydrological, or hydrogeological perspective. The “Water Framework Directive (Classification, Priority Substances and Shellfish Waters) Regulations (Northern Ireland) 2015<sup>26</sup> presents standards for water flow and water level in rivers of High, Good, Moderate and Poor status.

As noted in the report “Surface Water Impact Assessment for the Curraghinalt Gold Project, County Tyrone, Northern Ireland”<sup>27</sup>, the Owenkillew and Owenreagh Rivers are considered as salmonoid watercourses of Good Status.

<sup>26</sup> Water Framework Directive (Classification, Priority Substances and Shellfish Waters) Regulations (Northern Ireland) 2015

<sup>27</sup> SRK Consulting. 2020. Surface Water Impact Assessment for the Curraghinalt Gold Project, County Tyrone, Northern Ireland. October 2020.

The Owenreagh River is classed as a Type C2 river under the Water Framework Directive (Classification, Priority Substances and Shellfish Waters) Regulations (Northern Ireland) 2015<sup>26</sup>. As the Pollanroe Burn is a tributary to the Owenreagh River, Golder has applied the river flow standards and objectives of the Owenreagh River to the Pollanroe Burn for the purpose of this review.

Therefore, for both the Pollanroe Burn and Owenreagh River (classified as C2 and of Good status), the permitted reduction in flow (abstraction) per day, as a percentage of the natural mean daily flow, should not exceed<sup>26</sup>:

- 25% at natural mean daily flow exceeding the 60<sup>th</sup> percentile low flow condition;
- 20% at natural mean daily flow exceeding the 70<sup>th</sup> percentile low flow condition;
- 15% at natural mean daily flow exceeding the 95<sup>th</sup> percentile low flow condition; and
- 10% at natural mean daily flow **not** exceeding the 95<sup>th</sup> percentile low flow condition.

According to the “Curraghinalt Gold Mine Project - Site Water Balance - 2020 Update” report<sup>28</sup>, increases in monthly average and low flows are predicted for both the Owenreagh River and Pollanroe Burn.

### **Golder Comment**

The predicted increases in average and low flow conditions for both the Owenreagh River and Pollanroe Burn are based on assessment of monthly climate and hydrology inputs. Flows in these rivers will be augmented through (i) the dewatering of the underground mine (after treatment) and (ii) through natural groundwater inflows to the Under Drain which discharges to the Pollanroe Burn.

However, the water balance does not take account of daily variations. The “Water Framework Directive (Classification, Priority Substances and Shellfish Waters) Regulations (Northern Ireland) 2015” outlines permitted daily abstraction rates as a percentage of natural mean daily flows. In the event that compensation flows are required to meet these river flow standards, discharge from underground workings can continue to be pumped at rates that allow the standards to be met. Further assessment of the mine discharges (taking daily inputs into account), while being helpful, is not expected to change the overall results from the water balance.

**Conclusion:** In the event that compensation flows are required to meet river flow standards, discharge from underground workings can continue to be pumped at rates that allow the standards to be met. Golder notes that a further assessment of the mine discharges which takes daily inputs into account, while being helpful, is not expected to change the overall results from the water balance. Golder does not consider that further assessment is required.

### **4.11.2 Reduction of Erosion**

Regulation 9 of the “Planning (Management of Waste from Extractive Industries) Regulations (Northern Ireland) 2015”<sup>29</sup> speaks to the reduction of erosion, caused by water or wind, as far as it is *technically possible and economically viable*.

The Pollanroe Burn will receive inflows from the proposed infrastructure site (which includes discharge from the Water Treatment Plant and overflow from the Clean Water Pond), the contributing catchment downstream of the proposed infrastructure site, as well as from the East Diversion Ditch. The East Diversion Ditch and the Clean Water Pond receive runoff from catchments which would report to the Pollanroe Burn under baseline (undeveloped site) conditions. Overall, the development of the proposed infrastructure site will increase flows

<sup>28</sup> Kaya Consulting Ltd. 2020. Curraghinalt Gold Mine Project – Site Water Balance – 2020 Update. October 2020

<sup>29</sup> The Planning (Management of Waste from Extractive Industries) Regulations (Northern Ireland) 2015. 2015 No. 85

within the Pollanroe catchment (due to increased runoff rates from disturbed ground etc) under average and low flow conditions<sup>30</sup>. However, under flood flow conditions, the only releases allowed from the site for storm events up to and including the 1-in-2 year up to the 24-hour, 1-in-1000 year event will be discharged from the Water Treatment Plant<sup>30</sup>. As such, flood flows in the Pollanroe Burn are predicted to be lower during operations than under baseline conditions, as flood waters will be stored and managed within the proposed infrastructure site and will be limited by the treatment rates<sup>30</sup>. The maximum treatment rate is 83.3 L/s, which is lower than the baseline 1-in-2 year flood flow of 900 L/s.

For closure, a qualitative assessment of impacts to flows was carried out based on an “areas assessment” of runoff rates from reclaimed areas<sup>30</sup>. There will be a risk of increased surface water runoff from the surface of the DSF. The need for mitigation of these flows as part of the closure planning process was highlighted; however, it was stressed that with mitigation in place, it was expected that flood flows would be maintained at baseline conditions. Overall, the flows reporting to the Pollanroe Burn are expected to be increased or very similar to baseline conditions.

### **Golder Comment**

Given that the discharges to the Pollanroe Burn from the proposed infrastructure site would be controlled and limited to the water treatment rate during flood events (which is lower than the baseline 2-year flood flow of 900 L/s), it is Golder’s opinion that the increase in flows reporting to the Pollanroe Burn is unlikely to increase the risk of accelerated erosion in the channel. It is Golder’s recommendation, however, that during the detailed design stage, hydraulic analysis of the Pollanroe Burn be undertaken to assess the need for any required erosion protection controls within the channel itself. Golder also recommends proper engineering design be applied to the outfall locations at Pollanroe Burn (East Diversion and Water Treatment Plant outfall) during the detailed design stage, to reduce risk of erosion in the channel at these locations.

**Conclusion:** Golder notes that the results conform with Regulation 9 of the “Planning (Management of Waste from Extractive Industries) Regulations (Northern Ireland) 2015; Golder does not consider that further assessment is required.

### **4.11.3 Prevention of Contamination of Receiving Water Bodies**

Both Regulations 9 and 10 of the “Planning (Management of Waste from Extractive Industries) Regulations (Northern Ireland) 2015”<sup>31</sup> require the prevention of contamination of surface water in the short and long-term perspectives. The EC directives 2006/11/EC and 2006/118/EC both refer specifically to pollution through the discharge of specific dangerous substances.

Under climate conditions up to the design event (24-hour, 1-in-1000 year storm), any discharge from the mine will pass through the water treatment plant. However, any flows in excess of design conditions (greater than the 24-hour, 1-in-1000 year event) will be released via pond spillways to the Pollanroe Burn, and will bypass the water treatment plant. The release of flows during a storm event exceeding the design event would therefore potentially cause a risk to water quality in the receiving water body, as these flows will bypass the water treatment plant. The risk of contamination to receiving water bodies in an event in excess of the 24 hour, 1-in-1000 year event was assessed, and during such a large flood event, limited impacts are expected downstream of the ponds due to dilution in the receiving water bodies<sup>32</sup>. Overall, the predicted increases in contaminant concentrations are within the range of values seen in the river under natural conditions, and exceedances of

<sup>30</sup> SRK Consulting. 2020. Surface Water Impact Assessment for the Curraghinalt Gold Project, County Tyrone, Northern Ireland. October 2020

<sup>31</sup> The Planning (Management of Waste from Extractive Industries) Regulations (Northern Ireland) 2015. 2015 No. 85

guideline values are predicted only for those parameters that exceed guidelines under baseline conditions. This is discussed further in the “Dalradian Proposed Curraghinalt Project Surface Water Quality Review”<sup>32</sup>

In accordance with Regulations 9 and 10 of the “Planning (Management of Waste from Extractive Industries) Regulations (Northern Ireland) 2015”, the water balance demonstrates that contaminated water and leachate is collected using surface collection drains and underdrains. This contaminated water and leachate are treated through the water treatment plant, with the exception of seepage through the liner of the DSF to the underdrain reporting directly to the Pollanroe Burn. However, dilution calculations were carried out to assess the impact of the basal seepage on water quality in the Pollanroe Burn at the mouth, and the results of the assessment indicates that predicted concentrations in the Pollanroe Burn are lower than national drinking water standards, apart from specific parameters where average baseline conditions exceed drinking water standards. Golder’s review of water quality impacts (including for events in excess of design conditions) is presented in “Dalradian Proposed Curraghinalt Project Surface Water Quality Review”<sup>32</sup>.

### **Golder Comment**

Golder notes that any contaminated water and leachate will be treated at the water treatment plant, except for seepage through the liner of the DSF to the underdrain reporting directly to the Pollanroe Burn. However, predicted concentrations in the Pollanroe Burn (based on the dilution assessments which include seepage from the DSF) are lower than national drinking water standards, apart from specific parameters where average baseline conditions exceed drinking water standards<sup>33</sup>.

**Conclusion:** Golder notes that the results conform with Regulations 9 and 10 of the “Planning (Management of Waste from Extractive Industries) Regulations (Northern Ireland) 2015”, as well as EC directives 2006/11/EC and 2006/118/EC. Golder does not consider that further assessment is required.

## **5.0 SUITABILITY OF WATER BALANCE MODEL (FIT FOR PURPOSE)**

Golder has completed an independent third-party review of the water balance models used to support assessment of the possible impacts to surface water quantity from the proposed Curraghinalt underground gold mining project. This review has been undertaken with consideration given to the stated purpose of the models (Section 3.0), applicable requirements of the “Water Framework Directive (Classification, Priority Substances and Shellfish Waters) Regulations (Northern Ireland) 2015”, Regulations 9 and 10 of the “Planning (Management of Waste from Extractive Industries) Regulations (Northern Ireland) 2015”, EC Directives 2000/60/EC, 2006/11/EC and 2006/118/EC, and good international industry practice.

### **Golder Comment**

It is Golder’s opinion that the water balance models are fit for purpose based on the following key points:

- Climate and hydrological characteristics and processes have been appropriately represented within the model;
- The logic and calculations within the model are sound;
- The model considers a range of uncertainty in the inputs, through the application of a stochastic approach to modelling hydrological inputs as well as a series of sensitivity analysis assessments;

<sup>32</sup> Golder Associates. 2020. Dalradian Proposed Curraghinalt Project Surface Water Quality Review. Document No. 19127735-614-01\_E.

<sup>33</sup> Golder Associates. 2020. Dalradian Proposed Curraghinalt Project Surface Water Quality Review. Document No. 19127735-614-01\_E

- The model considers adequate freeboard requirements within the water storage ponds, and demonstrates that the ponds can be operated with more storage than actually required to capture the runoff from the 1-in-1000 year event;
- The model addresses the requirements outlined in Regulations 9 and 10 of the “Planning (Management of Waste from Extractive Industries) Regulations (Northern Ireland) 2015”, EC Directives 2000/60/EC, 2006/11/EC and 2006/118/EC. The outcomes of the model are in compliance with the requirements of these documents.

However, the following points have been noted:

- The modelled flow duration curve under-predicts low flows and over-predicts high flows. Further discussion on the implications (if any) of this would be useful. The fit of the modelled catchment results to the observed local site catchment runoff should be quantified using an appropriate goodness-of-fit approach. However, no further assessment is required at this planning stage.
- Climate change was incorporated based on linear interpolation between historical climate data for 2020 and the climate predictions for benchmark years 2040 and 2060. The monthly rainfall for the 2040 and 2060 benchmark years were calculated based on an average of the monthly anomalies of the previous and subsequent 5 years of data. Golder cannot comment on the validity of averaging rainfall years previous and subsequent to the benchmark years.
- Golder notes that no sensitivity analysis assessment has been carried out to assess the range of flows that could be provided from the Clean Water Pond to provide compensation flows (if required) in the Pollanroe Burn and Owenreagh Rivers. No further assessment is required at this planning stage.
- No justification has been provided as to the range of values considered in Sensitivity Analysis S3-3 (Increased Loss to Evaporator in the RO Treatment Plant). No further assessment is required at this planning stage.
- Sensitivity Analyses S1-6 and S1-7 consider daily inputs to the water balance model. However, Golder has noted that rainfall and evaporation values were input on a monthly basis. No further assessment is required at this planning stage.
- Sensitivity Analysis S4-1 considers that natural runoff in the Western Diversion Channel is diverted to the Pollanroe Burn. However, the impacts of this diversion on the Pollanroe Burn are not assessed or discussed. If consideration (as part of future planning processes or operational decision-making) is to be given to diverting this water directly to the Pollanroe Burn, additional assessment would be needed to assess the downstream impacts on the Pollanroe Burn. However, no further assessment is required at this planning stage.
- Sensitivity Analysis S4-2 considers that runoff from undeveloped areas of DSF is released directly to the Pollanroe Burn. However, the impacts of this diversion on the Pollanroe Burn are not assessed or discussed. If consideration (as part of future planning processes or operational decision-making) is to be given to diverting this water directly to the Pollanroe Burn, additional assessment would be needed to assess the downstream impacts on the Pollanroe Burn. However, no further assessment is required at this planning stage.
- Hydraulic analysis of the Pollanroe Burn should be undertaken during the detailed design stage to assess the need for any required erosion protection controls within the channel itself. Proper engineering design

of the outfall locations at Pollanroe Burn (East Diversion and Water Treatment Plant outfall) during the detailed design stage, to reduce risk of erosion in the channel at these locations.

## 6.0 CLOSING REMARKS

We trust the above meets your requirements at this time. Please do not hesitate to contact the undersigned if you require clarification or have any queries.

[REDACTED]  
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