APPENDIX N: ST IVES GOLD MINE WATER BALANCE FRAMEWORK - B2018 PROJECT (STANTEC)

11 January 2018

Gold Fields Australia

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AUSTRALIA

Attention: **Alex Langley**

Environmental Advisor

Dear Alex and Elina

St Ives Gold Mine Site Water Balance Framework

Introduction

St Ives Gold Mining Company Pty Limited (SIGMC) currently operates the St Ives Gold Mine (the Site) at Lake Lefroy, located approximately 20 kilometres (km) south-east of Kambalda. The Site involves both open cut and underground gold mining activities on Lake Lefroy-surface and adjacent land.

SIGMC requires an additional expansion of the current area of disturbance approved under Ministerial Statement 879, which covers the current lake-based mining operations only. The revised proposal is for development of new lake-based and land-based gold mining areas for a ten-year period (i.e. 2019 to 2028), referred to as the Beyond 2018 (B2018) Project.

This water balance framework was developed as an initial step in understanding the B2018 Project water balance, dewatering discharge volumes, key operational water use and movement of water between operational facilities and discharge to Lake Lefroy. The primary purpose of the water balance framework is to identify the key factors impacting the site-wide water balance; as such, the focus is on high volume water use / movement aspects.

Background

Based on the current understanding of the site water management and apart from climatic impacts (rainfall, runoff and evaporation), mine dewatering discharge is the single largest water movement aspect. Lake Lefroy is the key receptor of the dewatering discharge and has the largest storage capacity across the Site. The focus of the water balance framework with respect to the B2018 Project operating environment is therefore Lake Lefroy and key factors impacting Lake Lefroy water balance.

The proposed water balance framework aims to identify principal water balance components in terms of volumes moved, generated or lost. This version does not aim at detailed water balance understanding or specification of "smaller" ticket items at an individual site level such as individual open pit setup which may consist of a number of sub-items, examples of which would include pumping infrastructure, settling dams, turkey's nests etc.

The conceptual site-wide water balance framework would eventually include inputs from engineering disciplines from across the entire SIGMC owned tenements, including ore processing, mining groundwater management, tailings management and operations. A list of the water related infrastructure at the Site is contained in the Appendix.

Expectations of robust results from a water balance model rely on accurate conceptual understanding of key water balance components (model framework) and on high quality data from water managing and operating activities. At this stage it is recognised that there are data and linkage gaps that need to be clarified and quantified in order to reduce uncertainties associated with water balance.

The ultimate water balance model for the Site would include development of a Goldsim model with steady state/transient considerations and deterministic vs stochastic treatment of uncertainty and future predictions. This work provides an initial framework for development of such a tool, with indicative quantities assigned to individual water balance components as currently understood from water monitoring. A detailed water balance model for the Lefroy Mill and the Heap Leach Facility has previously been developed using Goldsim but is not discussed in this study.

A number of mining operations at the Site rely on groundwater dewatering. Water produced through dewatering is typically discharge into Lake Lefroy through a system of infiltration turkey's nests.

The Site also operates a processing plant and tailings storage facilities. Excess water is produced through mine dewatering, however, the water is hypersaline and the requirements of the processing plant are met by production of less saline groundwater from a remote borefield (Mt Morgan Borefield).

Lake Lefroy

The water balance at the Site is dynamic with discharge to Lake Lefroy occurring from a variety of discharge locations depending on the current active mining areas. In addition, climatic factors (rainfall, surface water inflows and evaporation obtained from Bureau of Meteorology) are critical to Lake Lefroy water balance.

A summary of historic monthly rainfall and pan evaporation for the Kalgoorlie-Boulder Airport weather station is shown in Table 1.

Lake Lefroy has a surface area of 544 km², and with evaporation an order of magnitude higher than rainfall, Lake Lefroy tends to dry out on an annual basis in areas that are not subject to dewatering discharge.

Table 1: Average monthly rainfall and evaporation

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Rainfall (mm)	25.8	30.5	26.0	20.8	25.9	27.7	24.8	21.2	14.4	15.4	18.4	16.0
Evaporation (mm)	388	305	267	174	112	78	87	118	174	260	309	372

Lake Lefroy Water Balance (2016/2017 Snapshot)

Historical dewatering rates are available from monitoring reports. SIGMC also commissioned development of site-wide numerical groundwater flow model which was used to derive estimates of dewatering rates for the B2018 Project operation period.

The annual mine water discharge (historical and future), catchment runoff and direct rainfall input to Lake Lefroy along with an estimate of the potential lake evaporation are shown in Figure 1 and Figure 2. The long-term climatic average has been used for the rainfall and runoff in the Beyond 2018 scenario. The dewatering estimates into the future are subject to further modelling refinement, however Figure 1 and Figure 2 indicate that mine dewatering volumes are a relatively minor input to Lake Lefroy's overall water balance and modelling indicates that this will remain the same in the future.

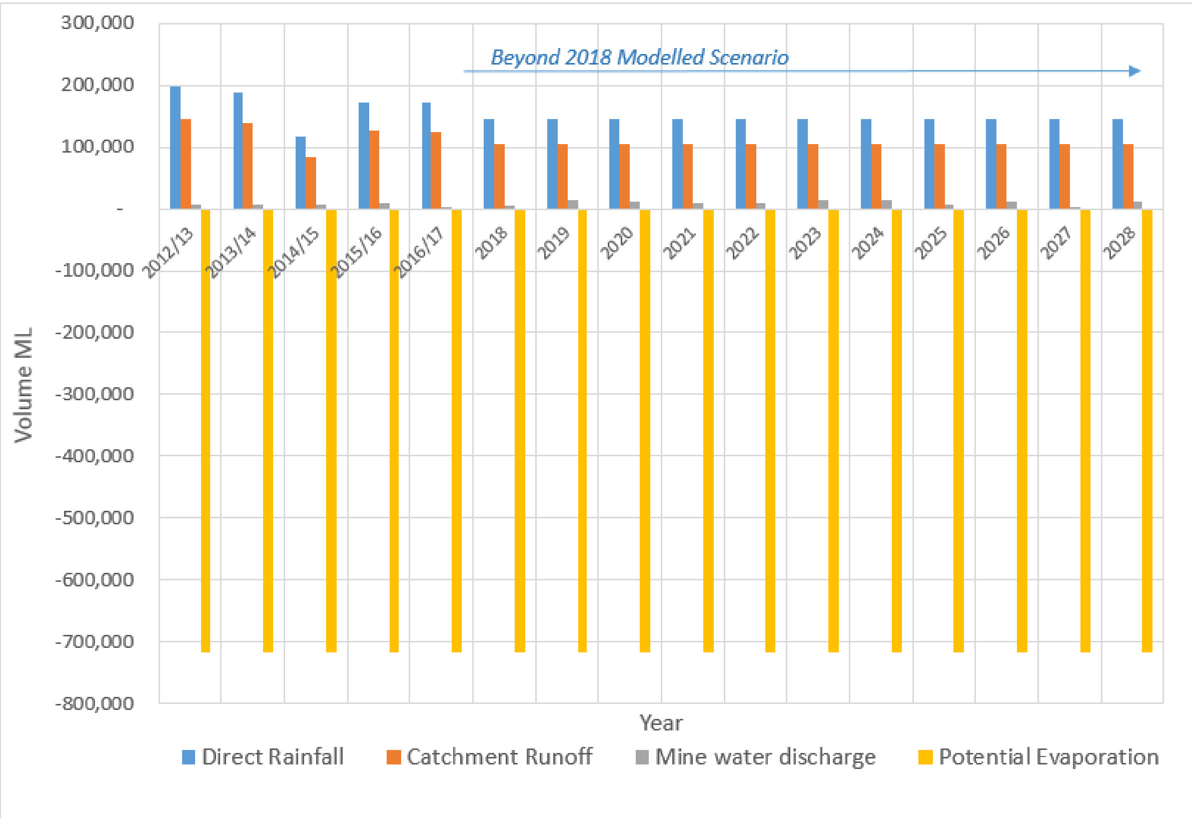


Figure 1: Lake Lefroy key water balance components

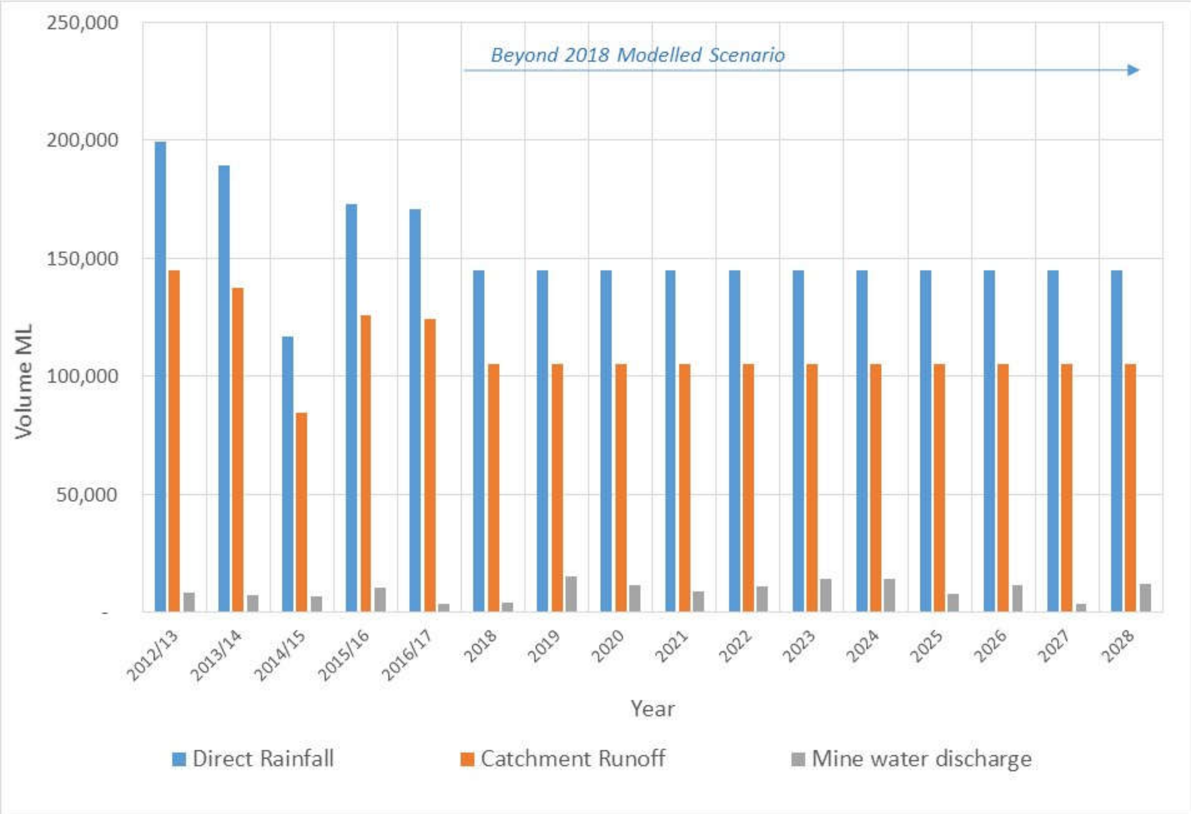


Figure 2: Lake Lefroy key water balance components

The site-wide water balance consists of the following major components:

- Water supply borefield (Mt Morgan)
- Open pits (dewatering and transfers)
- Underground workings (dewatering)
- Dewater discharge locations on Lake Lefroy (discharging water from dewatering)
- Processing facilities, including tailing storage facilities (paddock and in-pit)
- Heap leach operation
- Minor components (accommodation and offices), site drainage and stormwater systems

The water supply borefield sources water for the processing plant at rate of approximately 2 GL/yr.

Dewatering of open pits (currently 7 in operation) and underground workings (currently 4) takes place via in-pit sumps and underground pumping infrastructure – bore dewatering is generally not used on the Site. The total dewatering volumes ranged between 6.5 to 10.5 GL/yr over the last five years. Groundwater modelling was used to prepare estimates of dewatering for B2018 Project operational period.

A schematic of Lake Lefroy water balance for 2016/17 is shown in Figure 3. This is intended as a broad overview of water movement at the Site to the major receptor, Lake Lefroy, and therefore excludes, as outlined above, movement of smaller water volumes (including the reticulated potable water supply) and closed-loop operational water movement (Lefroy Mill and Heap Leach facility).

A snapshot of a potential 2019 scenario is shown in Figure 4. Dewatering estimates have been generated from groundwater modelling and a range of climate scenarios have been generated using historical data.

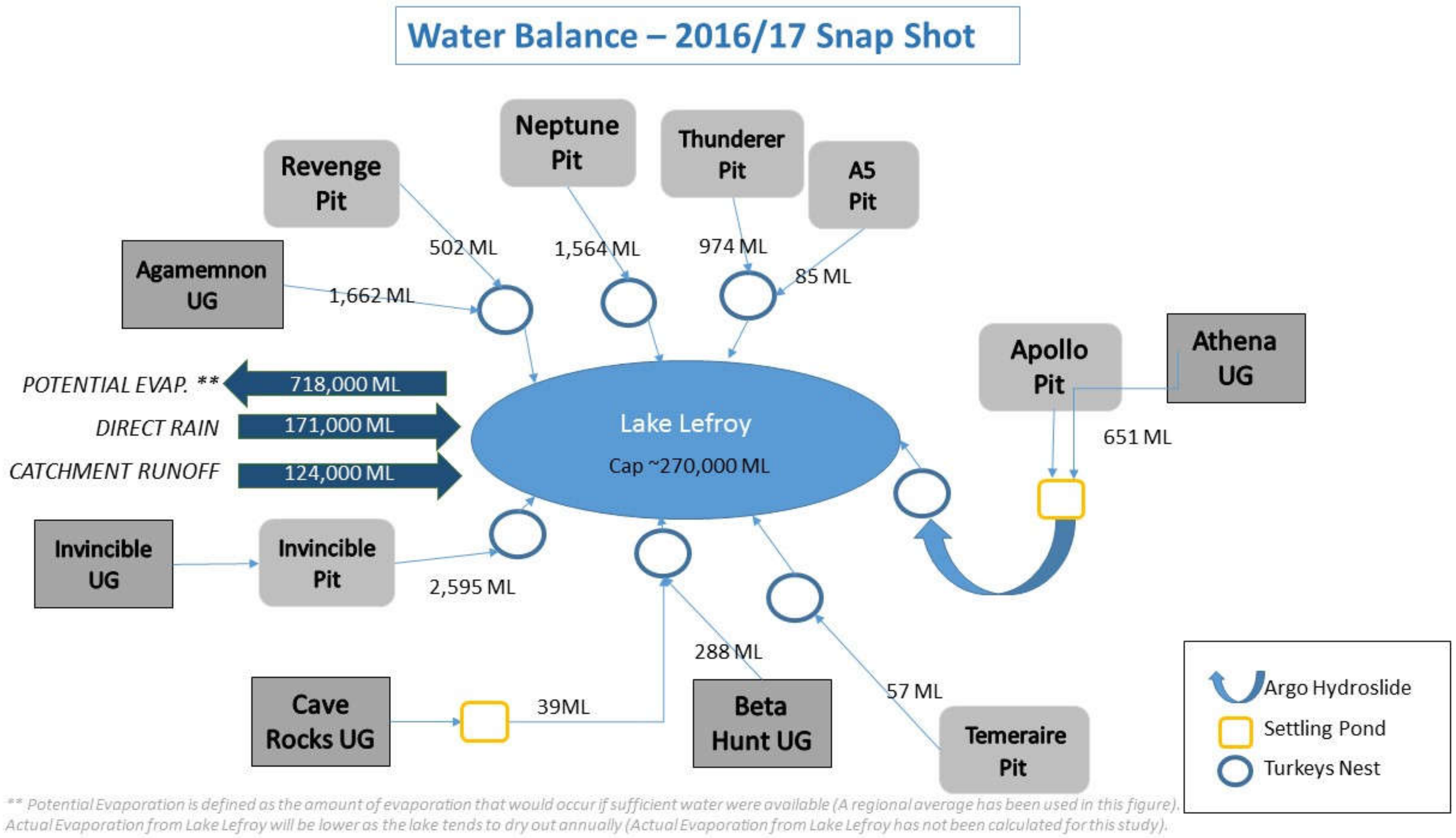
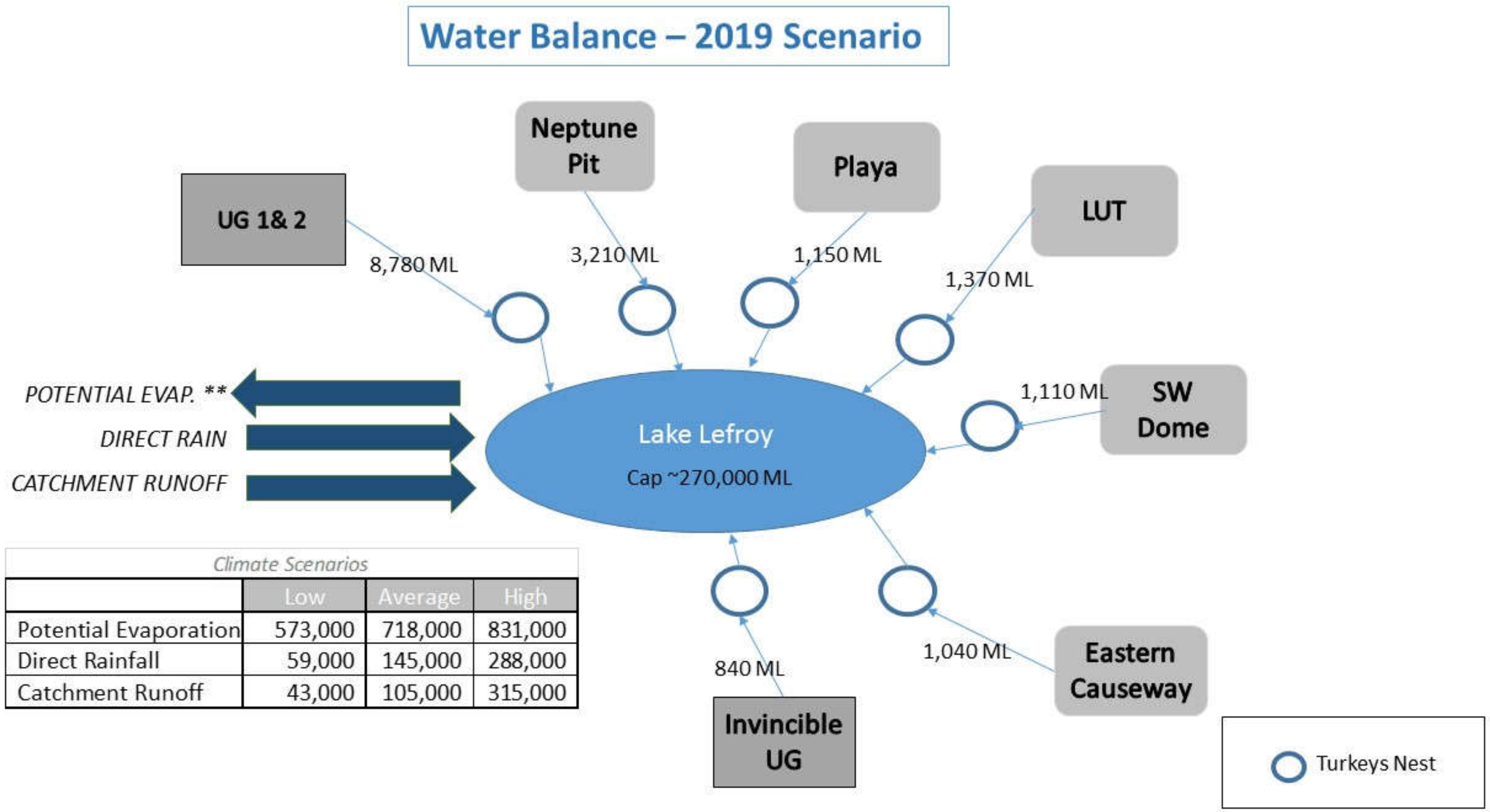


Figure 3: Lake Lefroy key water balance components (2016/17 Snap Shot)



Climate Scenarios

	Low	Average	High
Potential Evaporation	573,000	718,000	831,000
Direct Rainfall	59,000	145,000	288,000
Catchment Runoff	43,000	105,000	315,000

*** Potential Evaporation is defined as the amount of evaporation that would occur if sufficient water were available (Regional values have been used in this figure). Actual Evaporation from Lake Lefroy will generally be lower as available water is limited and the lake tends to dry out.*

Figure 4: Lake Lefroy key water balance components (2019 Scenario)

The "snap shot" shown in Figure 3 includes current dewatering discharge, and estimates of annual average rainfall, surface water runoff into Lake Lefroy and potential evaporation. A factor of 0.5 has been applied to the regional potential pan evaporation (Bureau of Meteorology estimate) to account for the effect of the lake surface (compared to pan evaporation) and the high salinity in the lake. It should be noted that the potential evaporation is based on the full lake surface area; however, actual evaporation losses will depend on the area of Lake Lefroy that is inundated following rainfall and surface water inflows, or dewatering discharge.

Estimates of the B2018 Project dewatering discharge volumes are shown in Figure 4. Actual volumes are likely to be different, based on individual pit characteristics. It is however clear that climatic factors of rainfall, runoff and potential evaporation are orders of magnitude larger than the dewatering discharge volumes expected under B2018 development conditions.

Way Forward – Recommendations

The following actions are recommended to aid in further development of a site-wide water balance:

- Complete inventory of water balance components.
- Include inventories of minor components where needed (e.g. processing plant, TSFs, heap leach).
- Collate quantities associated with water balance components and assign their uncertainty levels.
- Update the water demand from the processing facilities into the future.
- Incorporate findings on seepage rates and water movements from ongoing and future studies (including TSF investigations).
- Refine water balance estimates (dynamic) from TSFs and the heap leach to allow for efficient management of water levels around TSF(s) and the heap leach.
- Develop the first version of a site wide water balance in Goldsim.
- Incorporate salinity estimates in to the site water balance
- Include expected variability of all inputs over the B2018 Project operational period to allow for sensitivity and uncertainty analysis and for design of potential mitigation measures.
- Design water management actions based on Goldsim modelling.
- Evaluate dewatering management using Goldsim to minimise environmental impacts of on-going discharge into Lake Lefroy.

Yours sincerely

Johan van Rensburg

Stantec Australia Pty Ltd

Reviewed By: ________________________________

Copy to: Elina Vuorenmaa, Talis

Appendix

An inventory of the surface water and groundwater infrastructure at St Ives Gold Mine is contained in the following tables.

Table 2: Water related infrastructure – Southern

Infrastructure Type	Element
Water Containment Infrastructure	Apollo-Argo-Athena Washdown Evaporation Pond
	Argo Hydroslide and Dam
	Argo Hydroslide Discharge Turkey's Nest
	Argo Minewater Dam
	Argo Underground Water Supply Tanks and Overflow Dam
	Athena Paste Plant Ponds
	Athena Process Ponds
	Athena ROM Pad Drains
	Clifton Open Pit Tank
	Ives Reward Diversion Drains
	Junction Flood Bund
	Junction main Paste Plant Dam
	Junction Paste Plant Turkey's Nest
	Junction Sewerage Ponds
	Junction Washdown Bay Ponds
	Lake Finn Evaporation Pond
	Lake Finn Evaporation Pond Spill Collection Sumps
	Old Mill Access Road Sumps
	Old Mill Haulage Yard Drainage Dam
	Old Mill Haulage Yard Wash Bay Ponds
	Old Mill Process Water Dam
	Old Mill Surface Water Collection Dam
	Old Mill Turkey's Nest
	Old Mill Turkey's Nest North
	Roadside Sediment Collection Ponds
	St Ives Potable Water Pipelines
Groundwater Infrastructure	Argo Dewatering Pipelines to Hydroslide
	Athena Argo Diana Dewatering and Feed Line to Athena Paste Plant
	Junction Dewatering Lines to Lake Lefroy and Lake Finn
	Mount Morgan Borefield and Pipeline to Lefroy Mill
	Southern Project Area Dewatering Bores
	Southern Project Area monitoring Bores

Table 3: Water related infrastructure – Central

Infrastructure Type	Element
Water Containment Infrastructure	Belleisle Paste Plant Settlement Ponds
	Belleisle Turkey's Nest
	Britannia Footwall Turkey's Nest
	Foster Office Water Tank
	Heap Leach to Pinnace Open Pit Drain
	Heap Leach Facility Wet Plant and Ponds
	Lefroy Pastoral Dam
	Lefroy Process Water Ponds
	Lefroy Processing Plant Water Collection Dam
	Lefroy Surface Water Collection Dam
	Lefroy Wash Bay Evaporation Pond
	Leviathan Diversion Drains
	Mars Turkey's Nest
	Neptune Turkey's Nest
	Revenge Turkey's Nest
	Roadside Sediment Collection Ponds
	St Ives Potable Water Pipelines
	Thunderer Turkey's Nest
	TSF 4 Diversion Drains
	TSF 4 Return Water Dam
	TSF 4 Turkeys Nest
	Victory Dam
Groundwater Infrastructure	Africa Dewatering Pipelines
	Belleisle Dewatering from Mars Open Pit to Lake Lefroy
	Central Project Area Dewatering Bores
	Central Project Area Monitoring Bores
	Foster Dewatering Line to Lake Lefroy

Table 4: Water related infrastructure – Northern

Infrastructure Type	Element
Water Containment Infrastructure	Cave Rocks Flood Mitigation Drain
	Cave Rocks Haul Road Turkey's Nest
	Cave Rocks Settling Ponds
	Cave Rocks Sewage Treatment Plant and Sediment Collection Pond
	Cave Rocks Turkey's Nest Lake Lefroy
	Gatehouse Wash Bay Pond and Associated Infrastructure
	Moorebar Dam
	Moorebar Dam to Lefroy Processing Plant Process Pond Pipeline via KNO Tank
	Roadside Sediment Collection Ponds
	Santa Ana-Bahama Dewatering Turkey's Nest
	Santa Ana-Invincible Dewatering Turkey's Nest
	Silver Lake Laboratory Sewerage Ponds
	St Ives Potable Water Pipelines
Groundwater Infrastructure	Bahama Dewatering Pipeline and Discharge Point
	Cave Rocks Dewatering Pipeline
	Formidable to Intrepide Dewatering Line
	Northern Project Area Dewatering Bores
	Northern Project Area Monitoring Bores