Sulphur Springs Project
Venturex Sulphur Springs Pty Ltd
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Sulphur Springs Project Water Management Plan

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Executive Summary

Venturex Sulphur Springs Pty Ltd (Venturex) is developing a copper-zinc mining operation at Sulphur Springs located about 144km to the southeast of Port Hedland, Western Australia. The project is located within the East Pilbara Subarea of the Pilbara Groundwater Area.

The project includes the excavation of oxide and transitional copper and zinc ores from an open pit, and sulphide ore from an underground mine. The ores will be processed using a dense-media sulphide concentrator plant located in a catchment nearby the mine. Tailings from the concentrator plant will be stored in a tailings storage facility (TSF) located in a small catchment upstream of the mine. Waste rock will be stored in a waste rock dump (WRD) located alongside the pit. The mining area will be connected to the plant with an underground drive and portal. Unsealed access roads will be constructed elsewhere between the other project areas. An accommodation camp will be established at a new site located to the north of the project. A new access road to be located alongside Sulphur Springs Creek will link the camp and mine. Access to the project will use the existing road between the Abydos Mine and the Marble Bar Road.

The project is undergoing a front-end engineering design stage whereby necessary dewatering and water management infrastructure will be incorporated into the final designs. These designs will avoid adverse impacts where possible and incorporate engineered structures to mitigate against other potentially significant impacts.

Dewatering will be required to provide dry and safe working conditions in the mine. The dewatering discharge (dewater) will not be discharged but will support ore processing activities. Any short-term excess dewater will be managed within two storage/evaporation ponds. Shortfalls to processing needs will be drawn from groundwater bores located near the mine. Surface water originating from the site will be diverted where possible to avoid disturbing flows downstream and stilled using stormwater basins to manage the turbidity of discharges. Stormwater will only be discharged if it meets acceptable quality criteria.

Objectives and Scope

The primary objective of this WMP is to ensure that potential impacts related to groundwater abstraction and surface water diversion are effectively managed. The approach for dewatering and water management presented in this plan focusses on minimising impacts on the environment.

This document and the supporting technical assessments have been prepared in accordance with:

- the *Pilbara Groundwater Allocation Plan*
- the *Western Australian Water in Mining Guideline*
- the conditions of Operational Policy 5.08 – *Use of Operating Strategies in the Water Licensing Process*

This WMP addresses the following:

- Identification of risks to the environment and existing water users.
- Identification of and balancing the water requirements for the project.
- Water management measures for activities including dewatering, stormwater, and TSF operation.
- Monitoring procedures, standards and reporting requirements.
- It also incorporates the findings from recent assessments of potential environmental impacts from changes to groundwater and surface water and are extensively referenced throughout this document.

Risks to Groundwater and Surface Water

The current proposal presents a potential groundwater risk profile in relation to:

- excavation of an open pit and underground mine
- the TSF in the same catchment to the mine
- mine waste being stored in a permanent facility.

Potential changes to the hydrological processes as a result of the above infrastructure have been considered in detail in terms of their potential to impact groundwater levels, flow and quality during the operational and closure phases in recent technical reports on surface water, groundwater and the site's water balance.

Open Pit Domain

The open pit will capture a small amount of rainfall runoff that would otherwise flow to Sulphur Springs Creek. Diversion of surface water from a small sub-catchment immediately around the pit, and from the WRD will be required to minimise risks associated with water collecting in the pit sump, particularly after the underground mining has commenced. The diverted water from the WRD will need to be managed to minimise the amount of sediment stormwater may carry with it down Sulphur Springs Creek.

Drawdown from mine dewatering could potentially extend downstream along Sulphur Springs Creek where the water table is shallow. As a result, natural discharges of acidic groundwater to Sulphur Springs Creek will cease. Spring flows of low-quality water to Sulphur Springs Creek within the mine area are not expected to return after the project site has been closed.

After closure, the pit will continue to lower the water table in the local catchment and capture surface water flows within the abandonment bund and the nearby crests of the WRD and main TSF embankment. The lake in the final void is expected to remain a terminal sink for local surface water flows and seepage from the TSF and WRD.

Ore Processing Domain

A small proportion of the local catchment surface water will be retained from runoff that occurs in the processing area. This water may contain elevated concentrations of solutes that could harm the environment if it discharges to either Sulphur Springs or Minnieritchie creeks.

TSF Domain

The TSF will capture all surface water that falls into the catchment upstream of the embankment. Compared to baseline conditions, there will be a small reduction in the volumes of runoff that will report to Sulphur Springs Creek, but this is unlikely to be significant. The TSF is planned to be unlined but include underdrains to enhance the capture of seepage from the tailings and minimise hydraulic mounding of the water table within the TSF (PSC5) catchment.

After closure, the TSF landform will be reshaped to direct surface flows to the south, discharging into Minnieritchie Creek and Six Mile Creek catchments. The cover will also manage infiltration to create a geochemically stable environment for the tailings.

Seepage from the TSF will migrate down to the water table, then down the TSF catchment towards the mine. During operations, seepage will be intercepted by the underdrains, seepage recovery bores, and, if required, dedicated drains within the mine. After closure, seepage will collect in the terminal sink and pit lake and not discharge to Sulphur Springs Creek and its riverine environment.

Other Areas

The access road to the site will be used to transport raw materials to the project and the final products out to market. Although it is highly unlikely, spillage of these materials along the access road may lead to contamination of water in Sulphur Springs Creek.

Drawdown from abstraction of groundwater from supply bores may locally reduce the amount of groundwater that normally discharges to the creek lines, particularly if abstraction is undertaken near GDEs. This aspect is already being managed successfully by Atlas around the access road water supply bores.

Management Measures and Contingencies

In line with established principles for managing water in the Pilbara, minimising and managing risks to the water environment will be achieved by:

- dewatering only as much as is required to achieve safe and dry working conditions, and directing the dewater to the ore processing plant and/or water storage/evaporation ponds where it will be managed by the project and not discharged to the environment
- identifying and considering the opportunistic use of surface water captured within the disturbed footprint as a project resource where its use can also minimise the potential impacts downstream
- maintaining a site water balance and make effective use of monitoring data to optimise future water uses across the site
- undertaking the monitoring programme to detect changes to groundwater and surface water levels and quality and abstraction rates to optimise the use of groundwater as a valuable resource in the projects water balance
- closely managing site activities to minimise the risk of unplanned discharges of hydrocarbons or processing-related chemicals
- managing stormwater within the processing and mine areas to minimise the risks of an unplanned release for rainfall events up to 1 in 100-year ARI
- regularly reviewing the monitoring data to identify whether any triggers have been reached, or trends indicate there may be an unplanned response
- preparing annual reports to demonstrate compliance in line with the current DWER guidelines
- installing and maintaining volumetric flow meters in line with *Measuring the Taking of Water*
- developing and maintaining site-specific contingency measures to minimise environmental harm where there is an elevated risk such as seepage downstream of the water storage ponds
- preparing, implementing and maintaining an emergency response plan prior to the commencement of construction and throughout the operational phase in line with WQPN 10 following the principles of: spill *Prevention, Preparedness, Response and Recovery*.
- maintaining compliance with this water management plan.

Water Monitoring Programme

This WMP incorporates an integrated surface water and groundwater monitoring programme to meet the following objectives:

- Confirm how the aquifer responds to abstraction to refine the understanding of hydraulic interconnections and catchment recharge rates.
- Confirm the hydraulic properties of the Creek Fault and the presence of a critical stage-height of the pit lake for seepage containment.
- Determine the aquifer response to water supply abstraction to forecast operational risks to the projects water supply.
- Confirm surface water diversion structures, stilling basins and site water ponds remain effective controls to minimise environmental impacts.
- Confirm the levels and quality of groundwater in natural discharge zones to provide a pre-emptive tool for minimising surface water impacts.
- Confirm the rate of infiltration downstream of the WRD in the Six Mile Creek Catchment is not excessive, and that the quality of discharging water remains compatible with background levels.
- Refine the links between groundwater and surface water by monitoring the local climate.

To achieve this, Venturex will undertake the commitments detailed in the table below.

Summary of Commitments

Environmental Impact/ Issue	Management Commitment
Administration	• The Mine Manager is the responsible person to ensure all aspects of the WMP are undertaken. • Every year, an Annual Monitoring Review (AMR) will be prepared. • This WMP will be reviewed annually following preparation of the AMR.
Groundwater	• Dewatering will be undertaken to minimise abstractions while maintaining a dry and safe working environment in the mine. • Abstraction of groundwater for project make-up supplies from other sources will occur in a way that minimises environmental impacts. • The TSF will have an underdrainage system to intercept seepage and minimise water table mounding. • Seepage-related contingency measures will be initiated if the monitoring results indicate surface water quality triggers have been breached. • PAF materials will be safely stored either in the open pit below the final lake level, or in purpose-designed cells within the WRD to limit the ingress of oxygen and water and generation of acidic discharges to the water table. The PAF cells have been designed to be in the WRD so any seepage that does penetrate the cover will report to the open mine void. Only NAF materials will be placed in the parts of the WRD that extend into the Six Mile Creek catchment. • Before construction commences, obtain a Licence to Take Water for mine dewatering and water supply abstraction.
Surface Water	• Identify opportunities for harvesting surface water within the disturbed footprint to minimise groundwater abstraction and reduce the likelihood of discharges during an extreme event. • Engineer surface water diversion structures, stilling basins and site water ponds to minimise safety-related risks to site workers and minimise changes to downstream environments from areas that may develop low quality runoff. • Sediment basins will be installed at the base of the WRD in each catchment and downstream on Sulphur Springs Creek. In general, the ponds will be designed to hold runoff for a long enough period to reduce the sediment loads. Pond SED1 will contain mine site runoff and spill over into SED2 which is for ensuring the water quality is compatible with background conditions. Water in these ponds that is not suitable for discharge will either evaporate or be pumped back and mixed with the site's water supply system. • The haul roads will be kept clear of any material spillages from haul trucks to avoid contaminating water in the downstream sediment ponds. • The site water ponds will be designed to hold runoff from a 1 in 100-year ARI. The water storage ponds will be managed to store excess mine water and provide a water source for the mine. The water levels in the ponds will be maintained as low as possible to minimise the potential for overflow. The ponds will include an engineered spill point to ensure they are not damaged from overflow during an extreme rainfall event. • After closure, runoff from the TSF will be directed to the Minnieritchie Creek and Six Mile Creek catchment to minimise risks to safety and geotechnical stability. • Before construction commences, obtain a Bed and Banks Permit for proposed infrastructure along Sulphur Springs Creek.

Summary of Commitments (cont.)

Environmental Impact/ Issue	Management Commitment
Unplanned Spills and Emergency Response Plan (ERP)	• Venturex will provide spill response equipment at the site. • All chemicals and fuel storages will be stored within approved bunded areas • All site personnel will receive training on managing spills and the ERP • Regular housekeeping and inspections of potentially contaminating substances. • Venturex will closely manage site activities to minimise the risk of unplanned discharges of hydrocarbons or processing-related chemicals • An Emergency Response Plan will be prepared, approved by DWER and implemented before construction to manage contamination and spills. • All spills will be immediately contained, cleaned up and reported internally.
Monitoring	• Maintain a site water balance to make effective use of monitoring data to optimise future water uses across the site. • Implement the monitoring programme to detect changes to groundwater and surface water levels, quality and abstraction rates to optimise the use of groundwater as a valuable resource in the projects water balance. • Undertake regular reviews of the monitoring data to identify whether any triggers have been reached, or trends indicate there may be an unplanned response. • All abstraction will be metered in accordance with DWER guidelines. • All flow meters will be registered and maintained in accordance with DWER requirements • Monitor the levels and quality of water in the site water ponds to ensure they remain effective barriers to off-site discharges up to a 1 in 100-year ARI event, and remain intact to minimise the release of site water during an extreme event. • Undertake regular inspections and reviews of the TSF to ensure geotechnical integrity of the embankment. • Undertake regular reviews of the health of the downstream riverine environment in conjunction with groundwater and surface water monitoring. • Monitor the levels and quality of stilling basins to ensure discharged stormwater does not affect the downstream environment. • Monitor the quality of groundwater sourced for potable uses in line with appropriate drinking water guidelines in line with Department of Health requirements.

Summary of Commitments (cont.)

Environmental Impact/ Issue	Management Commitment
Contingencies	• Failure of any flow meter – repair or replace faulty flow meters in line with manufacturer's specifications. • Damage to monitoring bores or sites – repair or replace the bore or site infrastructure to re-establish the monitoring capability. • Shortfall in project water demands from mine dewatering – equip and abstract the shortfall from existing water supply bores. • Excess in dewatering volumes over and above the projects water needs – review the site water balance to confirm the excess volumes, and that they remain within the design tolerance of the water storage ponds to manage the excess. • Shortfall in project water demands from mine dewatering and existing water supply bores – drill for and install additional bores at sites identified previously. • If drawdown from the mine extends out of the Sulphur Springs Creek mine catchment – investigate the cause and assess the implications of continued drawdown on any sensitive receptors. • If a baseline trigger is reached, a Level 1 response will be implemented. • If an environmental impact is likely, a Level 2 response will be implemented. • If an unplanned leak or spill is detected, a Level 3 response will be implemented.
Closure	During the operational phase, closure planning will focus on: • The WRD and TSF landform designs to minimise erosion and sediment loads with runoff, so site discharges will not cause unacceptable impacts to the surrounding environment. Sediment control will be included in the infrastructure designs during the closure phase. • Rehabilitation trials will be undertaken on the WRD and TSF to finalise landform and cover designs and finalise closure criteria. • Refine designs for runoff from catchments above the final void to ensure the pit lake remains a terminal sink. • The presence and properties of the Creek Fault downstream of the pit to refine constraints associated with a suitable pit lake level that maintains a terminal sink. • Whether solute accumulation in the TSF is likely to adversely affect the quality of water in the pit lake after closure.

1.0 Introduction

1.1 Background

Venturex Sulphur Springs Pty Ltd (Venturex) is developing a copper-zinc mining operation at Sulphur Springs, located about 144km to the southeast of Port Hedland, Western Australia (**Figure 1**). The project is located within the East Pilbara Subarea of the Pilbara Groundwater Area.

The project includes the excavation of oxide and transitional copper and zinc ores from an open pit, and sulphide ore from an underground mine (**Figure 2**). The ores will be processed using a dense-media sulphide concentrator plant located in a catchment nearby the mine. Tailings from the concentrator plant will be stored in a tailings storage facility (TSF) located in a small catchment upstream of the mine. Waste rock will be stored in a waste rock dump (WRD) located alongside the pit. The mining area will be connected to the plant with haul roads and an underground drive and portal. Unsealed access roads will be constructed elsewhere between the other project areas. An accommodation camp will be established at a new site located to the north of the project. A new access road to be located alongside Sulphur Springs Creek will link the camp and mine. Access to the project will use the existing road between the Abydos Mine and the Marble Bar Road.

The project is undergoing a detailed design stage whereby necessary dewatering and water management infrastructure will be incorporated into the final designs. These designs will avoid adverse impacts where possible and incorporate engineered structures to mitigate against other potentially significant impacts.

Dewatering will be required to provide dry and safe working conditions in the mine. The mine dewatering discharge (dewater) will be retained to support ore processing activities. Any short-term excess dewater will be managed within water storage ponds. Shortfalls to processing needs will be drawn from the water storage ponds and/or groundwater bores located near the mine. Surface water originating from the site will be diverted where possible to avoid disturbing flows downstream and stilled using stormwater basins to manage the turbidity of discharges. Stormwater will only be discharged if it is not required by the project and meets acceptable quality criteria.

Venturex holds tenure over the project footprint with the tenements and Licence to Take Water shown on **Figure 2** and listed in **Table 1**.

Table 1 Venturex Groundwater-related Tenure at Sulphur Springs

<table>
<tr><th>Tenement</th><th colspan="2">Lease coverage / Licence to Take Water</th></tr>
<tr><td>M45/494, M45/653 and M45/1001</td><td colspan="2">Sulphur Springs mine area covered by GWL165207(5) for 150,000kL/year for dust suppression, camp site and mineral exploration purposes.</td></tr>
<tr><td rowspan="3">L45/166 & 189</td><td>Bore PAN60</td><td rowspan="4">Abydos Access Link Road East (including GWL176408(4) that also includes bores currently used by Atlas Iron Ltd for the Abydos Mine site).</td></tr>
<tr><td>Bore SSWB36</td></tr>
<tr><td>Bore SSWB38</td></tr>
<tr><td>L45/179 & 189</td><td>Bore SSWB40</td></tr>
</table>

The existing Licence to Take Water (LTW) GWL165207(4) (**Appendix A**) on M45/494, M45/653 and M45/1001 provides for a small annual allocation to abstract groundwater for dust suppression for mining purposes, camp site purposes and mineral exploration activities. It requires that all abstractions are measured using an approved meter installed in accordance with current guidelines and is valid until 30 April 2028. Atlas Iron Ltd (Atlas) hold GWL176408(4) for supplying water for various mine-related purposes from L45/189 and is valid until 29 July 2025. The Operating Plan referred to on the licence conditions specifies that of the combined allocation of 1,198,368kL/year, 315,000kL/year is allocated to the four Venturex-owned bores listed in **Table 1**. Legal access by Atlas is allowed under an agreement with Venturex dated 6 May 2013.

This Water Management Plan (WMP) replaces the previous plan (URS, 2013a).

1.2 Objectives

The primary objective of this WMP is to ensure that potential impacts related to groundwater abstraction and surface water diversion are effectively managed. The approach for dewatering and water management presented in this plan focusses on minimising impacts on the environment.

This document and the supporting technical assessments (AECOM, 2020a, 2020b, and 2020c) have been prepared in accordance with:

- the Pilbara Groundwater Allocation Plan (DoW, 2013d)
- the Western Australian Water in Mining Guideline (DoW, 2013a)
- the conditions of Operational Policy 5.08 – Use of Operating Strategies in the Water Licensing Process (DoW, 2009).

1.3 Water Management Plan Scope

This WMP addresses the following:

- Identification of risks to the environment and existing water users.
- Identification of and balancing the water requirements for the project.
- Water management measures for activities including dewatering, stormwater, water storage pond, and TSF operation.
- Monitoring procedures, standards and reporting requirements.
- It also incorporates the findings from recent assessments (AECOM, 2020a, 2020b and 2020c) of potential environmental impacts from changes to groundwater and surface water and are extensively referenced throughout this document.

This plan will be revised prior to the commencement of dewatering and construction activities when additional detailed designs information will be available.

2.0 Physical Environment

2.1 Climate

Climate is relevant to the project as surface water is a primary mechanism for balancing the regions water quality across the hydrological year (October to September). Groundwater is also very important as it supports the environment during the dry season following recharge during the wet season. The site's climate controls groundwater recharge via infiltration, and discharge through evaporation, when the water table is close to the surface. Typically, groundwater receives recharge from events that deliver 50mm, or a series of events more than 20 to 30mm of rainfall. A detailed account of the interaction of climate and groundwater at the project is provided in AECOM (2020a).

Surface water flows are dependent on the intensity, duration and frequency of rainfall events. In this environment it can also be dependent on the type of event: local thunderstorm or region-wide tropical cyclone or rain-bearing depression. A detailed account of the interaction of climate and surface water at the project is provided in AECOM (2020b)

Rainfall and Evaporation

The Sulphur Springs Project site experiences an arid to subtropical climate with rainfall averaging around 390mm per annum, typically falling as a result of tropical cyclones and local thunderstorms occurring between the months of December and March. Climate conditions are expected to be generally similar to the nearby township of Marble Bar, where mean annual rainfall is 392.3mm (**Table** 2). Given that afternoon thunderstorms tend to be localised, rainfall patterns can vary over distances of tens of kilometres. Frontal systems or cyclonic events tend to result in rainfalls that are similar over a larger area. Cyclonic rainfall in the past five to six years has resulted in a 14% higher annual mean for the site (based on readings at the nearby Abydos Mine) of 448mm.

The evaporation pattern is expected to be like the nearby township of Marble Bar, where mean annual evaporation is approximately 3,300mm (BoM, 2018). The mean monthly pan evaporation ranges from 160mm in the winter up to 400mm in the summer.

Table 2 Monthly Rainfall and Evaporation at Sulphur Springs Project Site

Month	Monthly Rainfall (mm)		Marble Bar Evaporation (mm)
	Marble Bar*	Abydos Mine Site**	
Jan	107.7	147.5	350
Feb	77.9	41.6	280
Mar	76.1	59.9	290
Apr	21.9	30.1	250
May	13.2	34.9	200
June	24.2	32.3	170
Jul	16.7	36.4	170
Aug	0.5	0.0	200
Sep	4.1	0.0	260
Oct	3.5	1.1	350
Nov	9	6.9	380
Dec	32.4	56.6	400
Annual	**392.3**	**447.5**	**3,300**

* - Data for 2000-2018 period from Marble Bar Station No. 004106 (BoM, 2018)
** - Data for 2012-2018 period from Abydos Mine Site (Atlas Iron, 2018)

Extreme Cyclonic Rainfall Events

The Pilbara coast experiences a high frequency of cyclones. Between 1969 and 2016 there have been 17 cyclones with gale-force winds that have passed within 100km of the project site. On average this equates to about one every 2.4 years. Cyclone tracks derived from the Bureau of Meteorology website (BoM, 2017) are presented in **Plate 1**.

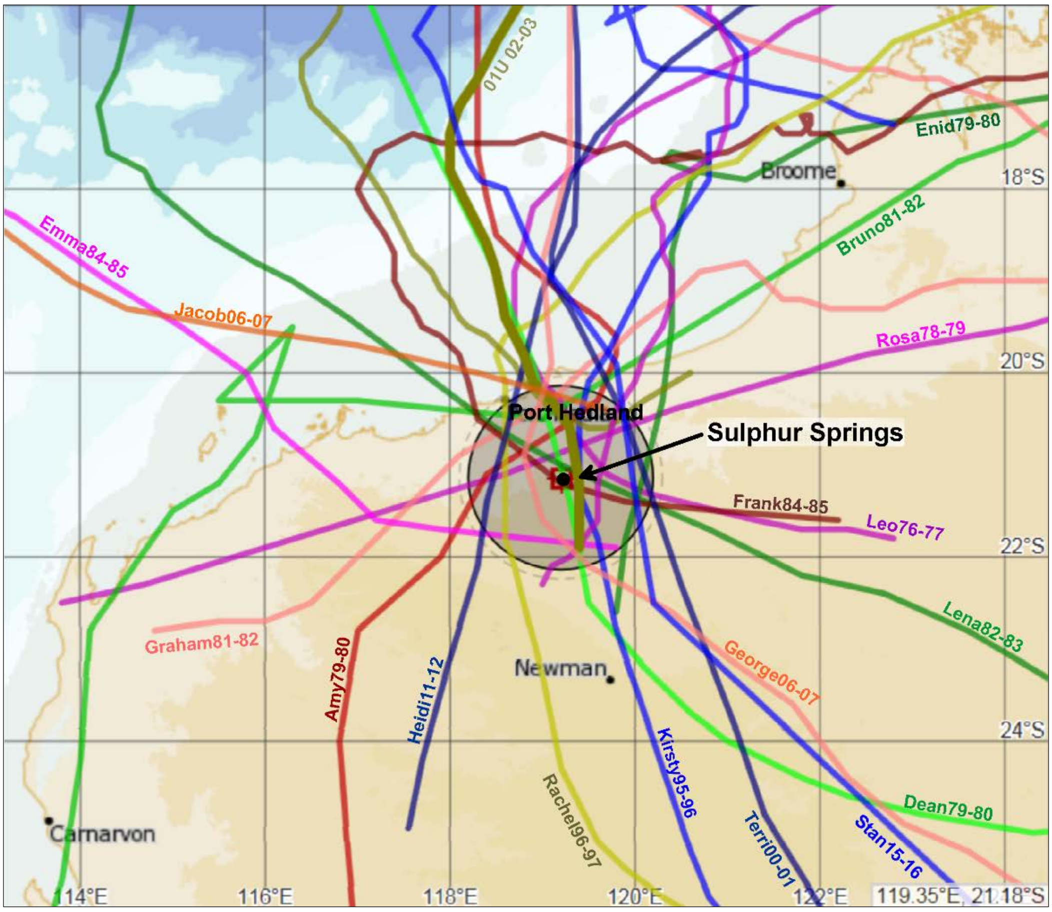

Plate 1 **Cyclone Tracks Within 100km of Sulphur Springs (1969-2016)**

2.2 Topography and Hydrology

The topography at Sulphur Springs is typical of the northern Pilbara, with rocky hills, small gorges, mostly seasonal watercourses and gravelly loam on the valley floors. The project area is characterised by steep, undulating and dissected ranges, forming a low range topography.

The regional topography ranges from around 175mAHD to the north alluvial flats and low hills, to around 350mAHD to the proposed mine area. Prominent topographic features are typically associated with the geological contacts, unconformities and structures in the De Grey Group and the George Creek Group sediments and volcanics. Differential weathering of outcrops of the George Creek Group shale, siltstone, chert and basalt has also resulted in a dissected north-south trending sequence of valleys and ridges.

The hill slopes, flats and poorly defined creeks are typically covered by several species of Spinifex grasses and sparsely vegetated with native species of shrubs and bushes such as *Eucalyptus leucophloia*. The larger creeks and rivers are characterised by *Eucalyptus camaldulenis* and species of melaleucas.

The site is upstream of the proclaimed water reserve (a Priority 1 Public Drinking Water Source Area) located on the lower reaches of the De Grey River. The proposed open pit and TSF is 105km upstream via Sulphur Springs Creek and the East Strelley River (**Figure 3**).

The mine area is located on a major catchment divide and drained by well-defined water courses (creek lines). The water courses draining catchments in the western portion of the mine area drain in a north-westerly direction, and are tributaries of the Sulphur Springs Creek, which drains into the East Strelley River. The water courses in the eastern portion of the mine area (eastern part of the proposed process area) drain in an easterly direction to Minnieritchie Creek, which drains into the Shaw River. The southern portion of the proposed WRD area has water courses that drain south into Six Mile Creek. The mine area catchments are shown on **Figure 4**.

2.3 Geology

Zinc/copper mineralisation at the Sulphur Springs site is within a volcanogenic massive sulphide deposit located in the central eastern terrain of the Archaean Pilbara Craton. The Pilbara Craton is an early Archaean granite–greenstone complex, unconformably overlain by the late Archaean to Proterozoic volcanic–sedimentary succession of the Hamersley Basin. The project area lies mainly within the north–north-easterly trending tectonostratigraphic domain referred to as the Lalla Rookh – Western Shaw Structural Corridor (LWSC). In summary, the LWSC comprises of the following litho-tectonic subdivisions:

- De Grey Group – including the Lalla Rookh sandstone-conglomerate, sandstone, and shale unconformably overly the rocks of the George Creek Group. The De Grey Group sandstones and conglomerates reach a maximum thickness of 3,000m.
- George Creek Group – characterised by banded ironstone formation (BIF), basalt, chert, interbedded sandstone (Paddy Market Formation), shale and felsic volcanics conformably overlies the Sulphur Springs Group.
- Sulphur Springs Group – This group is characterized as a sequence of differentiated volcanic rocks including basalt, dacite, rhyolite (Kangaroo Caves Formation), interbedded sandstone, chert, breccia, and volcaniclastics.
- Warrawoona Group – dominated by mafic volcanic rocks (Apex basalts), volcanogenic sedimentary rocks, chert, carbonate and BIF. The group lies to the north of the study area, extending to a thickness of 6.7km and fault-contacted against the De Grey Group and unconformably underlying the Strelley Pool Chert.
- Granitoid rocks – plutonic and gneissic units underlying the LWSC and represent structural domes of a continuous mid-crustal layer. The units are in contact with the overlying greenstone complex.

At a local scale, the geology is very complex and includes several faults and shears that have dislocated the stratigraphic succession. Three fault-like structures, known as the Main Fault, Gorge Fault and Creek Fault transect the geology within the mine area. The distribution of these geological units and structures and correlation with the proposed infrastructure is shown on **Figure 5** across the proposed project area (based on earlier, pre-2007 mapping), and **Figure 6** across the mine site domain (based on more recent mapping).

2.4 Hydrogeology

The groundwater and surface water flow systems in the Sulphur Springs Project area are complex, variable and linked. There are strong correlations with topography, geology and structure in the groundwater and interconnected surface water flow systems. The mine area topography, surface water drainage, catchment areas and inferred groundwater level contours are shown on **Figure 5** and **Figure 6.** Hydrogeological features include:

- Recharge occurs in upland areas. Groundwater discharges occur in valley-floor domains and associated watercourses – including pools and springs. The rate of recharge has been estimated to be about 1.7% of the mean rainfall in part of the mine area (URS, 2013b). Rates of between 0.4% and 4% have been estimated in similar catchments elsewhere in the Pilbara (Cook *et. al*. 2017).
- Groundwater flow direction and water table gradients broadly reflect the local topography.
- The occurrence of pools on valley floors indicates that these settings reflect the shallow depth to the water table, and that the local aquifer systems are seasonally full. Shallow water table zones during the dry season in the Pilbara Region are commonly associated with potential groundwater dependent ecosystems (GDEs).
- The distribution of stratigraphic units influences the groundwater and surface water flow systems. Geological structures such as faults and thrusts influence the groundwater flow and surface water discharge systems. Many watercourses are interpreted to be aligned with zones of structural weakness in the bedrock.
- Groundwater flow is predominantly linked to fractures within the bedrock. In fractured rock aquifers there is some uncertainty regarding continuity of the groundwater flow paths, effective transmissivity of the flow-control structures and volumes of groundwater in storage.
- The local geology and structural setting have the potential to compartmentalise the fractured rock aquifer systems and associated groundwater flow. Occurrences of strongly compartmentalised groundwater flow systems may substantially influence aquifer-system limits, drawdowns extents, and local volumes of stored groundwater in that is connected to the mine.
- Most of the known fractured-rock aquifer systems are aligned with valley-floor watercourses and associated shallow water table settings. Mapping undertaken in 2007 and 2013 examined the presence of GDEs within the project area (Venturex, 2013). It was determined from this mapping that GDEs were probably present along most of Sulphur Springs Creek, and a low-lying section of Minnieritchie Creek to the southeast of the proposed southern evaporation pond.
- Groundwater levels fluctuate in response to seasonal rainfall patterns. Monitoring over the past ten years indicates the water table fluctuates seasonally by up to 5m.
- Water quality in the project area varies widely. Within the proposed open pit footprint, solution cavities have formed through extensive oxidation of sulphide materials, which has resulted in groundwater that is of low pH, relatively high salinity, and elevated concentrations of sulphate and metals/metalloids including aluminium, cadmium, copper, iron, manganese, nickel and zinc. Outside of the mineralised zone, surface water and groundwater are typically of near-neutral pH, low salinity and low concentrations of metals. Seasonal variability in concentrations and alkalinity are the result of evapo-concentration of natural solutes and biological activity within dry season pools.

2.5 Existing Land Use

The project areas lie predominantly on vacant crown land with only the northern portion of the sites access track and mine village located on pastoral leases as shown on **Figure 2**.

Access to Sulphur Springs is via an existing haul road constructed by Atlas Iron for the Abydos Iron Ore project located approximately 10km north-west of the Sulphur Springs deposit.

The existing access road (currently operated by Atlas Iron Pty Ltd) is maintained using groundwater from bores located along its length, including four bores owned by Venturex.

2.6 Existing Groundwater Use

2.6.1 Surface Water Abstraction

As the project falls mainly in vacant crown land (**Figure 2**), there are no known users of surface water in any of three catchments near the project site. The northern end of the project site traverse's parts of the Strelley and Panorama pastoral stations.

There are ephemeral pools along the proposed access road on Sulphur Springs Creek on the Panorama Pastoral Station that may be frequented by wandering stock in the dry season. Ephemeral pools are also present along the upper reaches of Sulphur Springs and Minnieritchie creeks within the vacant crown land area. The dependency by wandering cattle on the Sulphur Springs Creek pools is unknown.

2.6.2 Groundwater Abstraction

Venturex holds Licence to Take Water No. GWL165207(5) that permits the abstraction of 150,000kL/year from three mining leases at Sulphur Springs (**Appendix A**). This licence permits the groundwater to be used for dust suppression for mining purposes, general camp site purposes, and mineral exploration activities.

The nearest groundwater user to Sulphur Springs (that are not part of the Venturex operations) is Atlas Iron Ltd. (Atlas) who has five water bores to dewater the mine, and supply groundwater for the Abydos Iron Ore Mine. These bores are located between 8km and 11km west of Sulphur Springs in a tributary of Six Mile Creek. Under a joint Water Management Plan between the two companies, Atlas also operates four bores (PAN60, SSWB36, SSWB38 and SSWB40 – **Figure 2**) that are owned by Venturex for maintaining the Abydos Mine access road.

Atlas currently abstracts up to 1,198,368kL/year under LTW No. GWL176408(3) with 883,368kL/year from the Atlas bores and 315,000kL/year from the Venturex bores. Monitoring by Atlas (Atlas Iron, 2017) indicates the water table naturally fluctuates over a large range and that drawdown-related changes to the water table can be managed by changing the pumping rates and durations. Venturex will operate the same bores to perform the same function as Atlas. Abstraction under these conditions has been sustainable and drawdown-related impacts are known to be localised

2.6.3 Ecological Dependency

The presence of GDEs within, or near the project footprint was reviewed in 2007 and 2018 (Mattiske, 2007 and 2018). GDE presence was identified by the indicator species *Eucalyptus victrix* and the associated vegetation strata. Six of the seven sites had no surface water present during the field surveys. The study reviewed publicly-available data, and results from previous Sulphur Springs assessments between 2001 and 2017. The review identified seven sites that were deemed to have a moderate likelihood of a GDE presence (**Plate 2**).

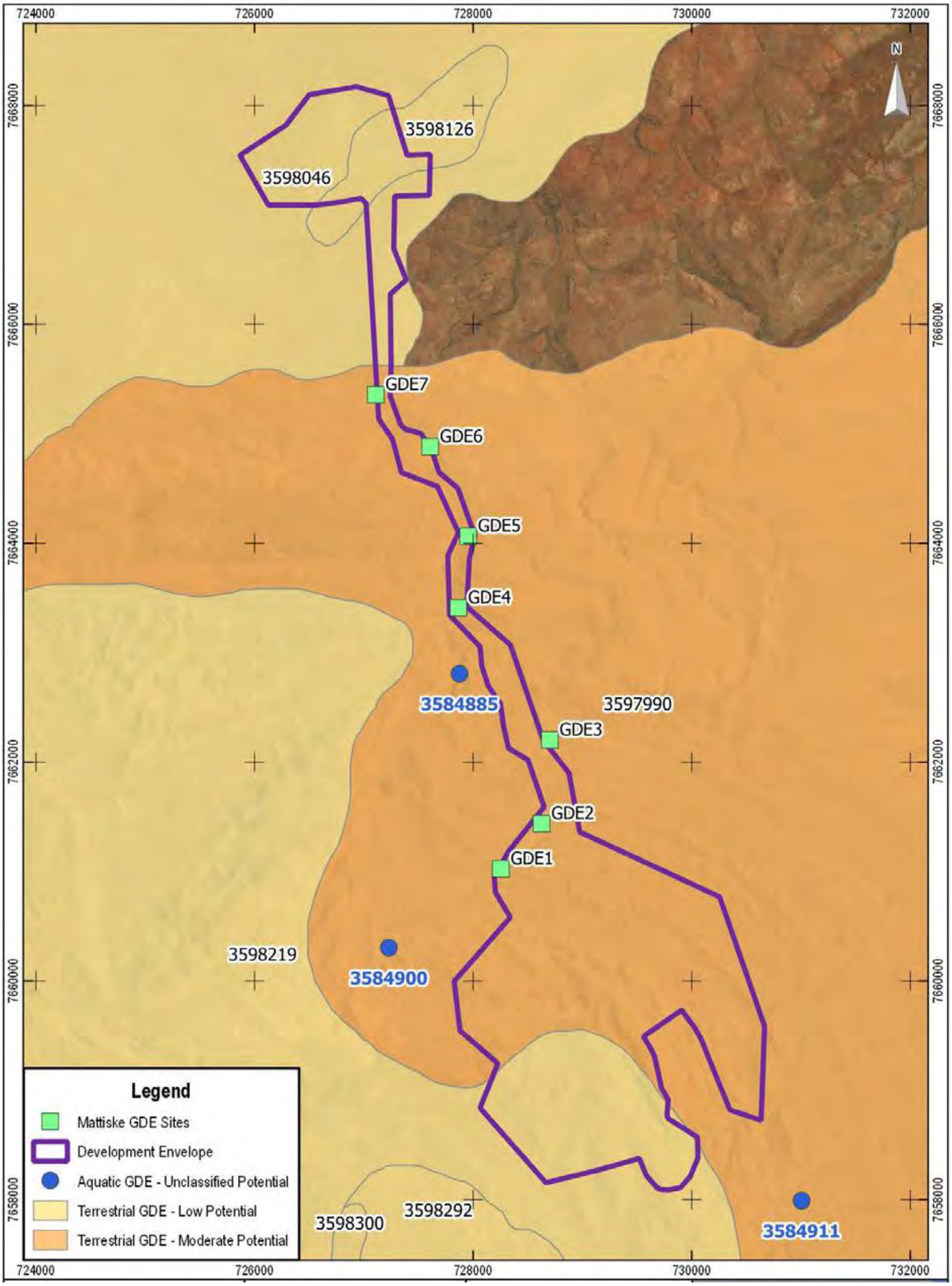

Plate 2 Potential Groundwater Dependent Ecosystems (after Mattiske, 2018)

3.0 Administrative Requirements

This WMP incorporates the following administrative requirements:

1. The person responsible for implementing the plan will be:

Position:	Sulphur Springs Mine Manager
Contact Details:	Level 2/91 Havelock St.
	West Perth, W.A., 6005
	PO Box 585, West Perth, W.A., 6872
	Phone: 6389 7400

2. The water year, for reporting purposes, is defined as: 1 January to 31 December.
3. Venturex will comply with the reporting requirements outlined in Section 3.1.
4. Venturex will comply with management measures outlined in Section 6.

3.1 Reporting Requirements

Reporting requirements for the WMP will be:

- Once groundwater abstraction for construction commences, an annual monitoring review (AMR) will be prepared and submitted to the Department Water and Environmental Regulation (DWER) by 31 March each year. This review will include a full assessment of all available water monitoring data and of predictions that have been used to define future outcomes and water management triggers.
- This WMP will be reviewed every year and recommendations for changes will be included in the AMR for that year. This will include an update of any changes to the water management measurements, protocols and monitoring / reporting frequencies.
- Reports will be submitted to the DWER in electronic format.

3.2 Relevant Regulation, Policies and Guidelines

The site is located within:

- the fractured rock aquifer domain defined in the *Pilbara Groundwater Allocation Plan* (DoW, 2013d)
- the catchment of the De Grey Alluvial Aquifer that is used for the Port Hedland Regional Water Supply Scheme
- the proclaimed Pilbara Surface Water Area *Rights in Water and Irrigation Act 1914*.

Water resource objectives for the De Grey Alluvial Aquifer include:

- Prevent saltwater intrusion into the aquifer caused by abstraction.
- Maintain water quality for the most beneficial use (potable water supply).
- Maintain groundwater and pool levels within a target range to maintain aquatic habitat and riparian vegetation dependent on groundwater and protect values as listed in the Directory of Important Wetlands in Australia.

Although it is unlikely that the project will affect this resource, it is recognised that it is in the headwaters of the catchment supporting surface water flows to the scheme area.

Relevant policies and guidelines that are applicable to groundwater aspects at the Sulphur Springs project include:

Western Australian Government

- Rights in Water and Irrigation Act 1914
- Rights in Water and Irrigation Act (Approved Meters) Order 2009

Department of Water and Environmental Regulation

- Hydrogeological Reporting Associated with a Groundwater Well Licence. Operational Policy No. 5.12, November 2009 (DoW, 2009)
- Stormwater management at industrial sites (DoW, 2010)
- West Australian Water in Mining Guideline (DoW, 2013a)
- Liners for containing pollutants, using synthetic membranes. (DoW, 2013b)
- Liners for containing pollutants, using engineered soils. (DoW, 2013c)
- Pilbara Water Allocation Plan (DoW, 2013d)
- Information the Department of Water requires to assess a proposed development or activity (DoW, 2016).

Water Quality

- Guidelines for Fresh and Marine Water Quality (ANZECC & ARMCANZ, 2000)
- Australian Drinking Water Guidelines (NHMRC & NRMMC, 2011)

Other

- Minimum Construction Requirements for Water Bores in Australia (NUDLC, 2012)

4.0 Proposed Activities and Potential Risks

The proposed Sulphur Springs project presents a potential groundwater risk profile in relation to:

- excavation of an open pit and underground mine
- mine waste being stored in a permanent facility
- establishment of an access road along Sulphur Springs Creek.

Potential changes to the hydrological processes as a result of the above infrastructure have been considered in detail in terms of their potential to impact groundwater levels, flow and quality during the operational and closure phases in recent technical reports on surface water, groundwater and the site's water balance (AECOM, 2020a, 2020b and 2020c).

4.1 Project Description

The Sulphur Springs Project has undergone several changes in ownership and development concepts since an initial feasibility study was conducted in 2002. The main changes have been associated with mining methods and tailings disposal, with open pit only, underground only, dry stacked tails and valley filled tailings options being historically considered. An underground-only plan with dry stacked tails project design was approved by DMIRS via mining proposal in 2014, however, no work under this approval has commenced. The current project proposal involves a combined open pit and underground mining method and valley fill TSF.

The proposed project footprint is shown on **Figure 2** and summarised in **Table 3**.

Table 3 Summary of the Proposed Project

Proposed Project
Up to 1.5Mtpa*, 28.9ha open pit and underground mine
Up to 1.5Mtpa, 60.4ha processing plant and associated infrastructure
A 42ha 'valley fill' TSF
One 79.6ha permanent waste rock dump
Miscellaneous supporting elements including mine village, access roads and mine services infrastructure
*Mtpa – Million tonnes per annum. Source: MBS, 2016

4.1.1 Mine Dewatering

The open pit is proposed to be developed to access oxide ore materials above the eastern and western zones in two stages. It will also provide access to a suitable site to establish ventilation shafts. The current pit design will result in an excavation that will be about 735m x 520m and extend below the surface at about 1,252mRL (252mAHD) to between 1,100 and 1,190mRL (100 to 190mAHD – **Figure 4**). For the underground workings, a portal will be established near the processing plant that will enter the resource area from the northeast.

The pit is planned to be dewatered by floor sumps and bores intersecting the cavernous and permeable materials within and adjacent to the ore zones and fault structures that occur within the pit's footprint. The pit void will be excavated to an elevation that is below the baseline water table and will therefore, partially re-fill after the cessation of mining and the associated dewatering.

4.1.2 Tailings Storage Facility

Operational Phase

The concept-level design of the TSF (Knight Piesold, 2020) involves a valley-fill structure, within the upper reaches of the Sulphur Springs Creek catchment, located to the south of the mine (**Figure 2** and **Figure 4**). The TSF site is proposed to occupy a north-facing valley with the main embankment with a crest starting at 1,320.6mRL (320.6mAHD). The TSF will recover water from decant structures that will operate in sequence as the pond is maintained away from the embankments by the deposited tailings. Over a period of ten years (ten stages), the embankment will be enlarged to reach a final height of 1,360.5mRL (360.5mAHD) using the downstream lift approach. During the latter half of the facilities life, additional saddle embankments will be required at four locations to contain the tailings and decant pond within the valley.

The tailings materials will be enriched in metals/metalloids and have been classified as potential acid forming (PAF) by previous geochemical assessments (URS, 2007c and 2007d; GCA, 2012b). To minimise potential impacts to the receiving environment, an underdrainage system running along the spine of the valley will be placed across the basin to control hydraulic loads on the water table. The collector drain will be fed by finger drains placed across the floor. The collected seepage will be pumped from a sump placed at the upstream toe of the main embankment. Bores will be installed on around the TSF to monitor the groundwater and be sized to allow them to be converted to seepage recovery bores if required.

Once operational, tailings will be deposited to the TSF using spigots which will be placed to form a decant pond that will remain away from the embankments. Decant structures will recover the water where it will be treated (pH adjusted and heavy metal removal) prior to being reused in the process.

Closure Phase

The proposed closure concept for the TSF includes a water shedding surface that is erosion resistant (Knight Piesold, 2020). This concept was originally developed by O'Kane Consultants (2017). The current conceptual design includes a composite cover based on a combined water shedding and store and release cover that incorporates a drainage layer over compacted soils liner formed on the tailings surface. To operate under gravity, the surface of the tailings will need to be shaped at closure to avoid the accumulation of water in the cover. Surface water runoff from the cover will be directed to tributaries of Minnieritchie and Six Mile creeks.

4.1.3 Mine Waste Rock Dump

The mine wastes will consist of material classified as non-acid forming (NAF) and potential acid forming (PAF). The PAF materials, and to a lesser extent the NAF materials, are enriched in metals/metalloids (URS, 2007a and 2007b; GCA, 2012a). Venturex is planning to store waste rock materials from the open pit in a permanent waste rock dump (WRD) structure with an area of 79.6ha located to the southwest of the pit as shown on **Figure 2** and **Figure 4**. The permanent WRD is to be located mostly within the surface water catchment of the pit void but will extend into the adjoining Six Mile Creek catchment to the south.

To minimise the volume of PAF materials stored in the WRD, some of these materials will be returned underground. Material from the underground mine will be placed in the pit void below the predicted lake level. The PAF materials are estimated to represent less than 19% of the materials to be placed within the permanent WRD and are to be encapsulated in engineered cells within the NAF material (MBS, 2016). The PAF cells will be located within the pit void catchment so that any seepage from these cells after closure will report to the open pit void. Surface water runoff from the WRD is to be diverted by stormwater infrastructure designed to a 1 in 100-year storm event capacity (AECOM, 2019b).

At closure, the WRD will be modified to be a long-term stable landform, having an engineered cover to minimise ingress of air and water into the encapsulated PAF cells and associated AMD generation. The surface area of the WRD will be modified to minimize the surface water runoff draining into the pit by shaping the post-closure surface area of the WRD area to drain away from the pit into the Six Mile Creek (SMC) catchment. The proposed final landform of the WRD in the catchment area of the pit will be modified such that 31ha of the WRD area in the pit catchment will drain into the SMC catchment. (**Figure 4**)

4.1.4 Project Water Supply

Groundwater from mine dewatering will be the primary source of water for the project, particularly in the first several years (AECOM, 2019a and 2019c). Water demands by the project are expected to include the needs identified in **Table 4**.

Table 4 **Estimated Project Water Supply Demands**

Water Use	Demand (kL/day)	Quality	Source
Construction Phase			
Site Office	50	Potable	Bore SSWB6
Construction and Dust Suppression	800	Fresh	Bores SSTP01, SSTP03, SSWB12 and SSWB20
Total	**900**		
Operations			
Processing	1,600	Fresh	Mine Dewatering (bores and sumps)
Underground Mine Development	400	Fresh	Mine Dewatering (bores and sumps)
Accommodation Camp	50	Potable	Potable Bore
Access Road Maintenance (not part of this assessment)	1,000*	Fresh	Bores SSWB36, SSWB38, SSWB40 and PAN60
Site Dust Suppression	600	Fresh	Bores SSTP01, SSTP03, SSWB12 and SSWB20
Total	**3,650**		
* - This is the same volume currently licensed from these existing bores by the Abydos Mine for the access road.			

Water to support construction activities will be drawn from existing groundwater bores located near the mine site (**Table 5**). The dewatering water is expected to be of variable quality, but generally of low pH, and containing elevated concentrations of other solutes. Once treated, this water will be suitable for ore processing and dust suppression within and near the mine.

Dust suppression supplies for the access road will be drawn from the existing supply using bores along the route that are owned by Venturex and currently operated by Atlas Iron.

Potable water will be drawn from existing bores that are not affected by mineralisation in the mine area. The bores selected for this purpose will be tested to confirm their suitability, or to identify treatment processes, if required.

Table 5 Details of Known Groundwater Sources

Source	Location (MGA z50)		Depth (m)	Yield (kL/d)	Aquifer Interval (mbgl)	Groundwater Quality	
	Easting	Northing				Salinity (mg/L)	pH
SSDW001	728984.6	7659778.4	158	2,160	86-87	1,010	3.0
SSTP01	730538.1	7658858.4	107	430	43-46, 82-83	770	N.D.
SSTP03	727181.3	7660438.9	84	430	21-41, 70-72	900	7.1
SSWB06	730258.3	7659432.4	96	520	48-51	684	7.4
SSWB12	730527.6	7659573.7	36	345	N.D.	798	7.1
SSWB20	728773.0	7659513.0	120	345	20, 57	375	7.1
SSWB36	727194.2	7666655.2	75	475*	37-42, 51-53	438	7.1
SSWB38	727116.5	7665891.7	72	140*	52-54	874	7.0
SSWB40	727494.8	7664982.8	48	390*	37-39, 43-45	608	7.0
PAN60	731899.0	7666332.0	102	170	50-72	134	7.0
* - Rates as per Abydos Link Road Water Supply Scheme (Atlas Iron, 2017)							

4.2 Potential Risks

Recent assessments into the surface water and groundwater flow systems (AECOM, 2020a, 2020b, and 2020c) concluded that the project activities have the potential to adversely affect surface water and groundwater in different ways in each project area. The following is a summary of potential risks.

4.2.1 Open Pit Domain

The open pit will capture a relatively small amount of surface water runoff that would otherwise contribute to stream flow to Sulphur Springs Creek. Diversion of surface water from the sub-catchment containing the WRD will be required to minimise risks associated with water collecting in the pit sump, particularly after the underground mining has commenced. The diverted water from the will be managed to minimise the amount of sediment stormwater may carry with it down Sulphur Springs Creek.

Drawdown from mine dewatering could potentially extend downstream along Sulphur Springs Creek where the water table is shallow. As a result, natural discharges of acidic groundwater to Sulphur Springs Creek will cease. Spring flows of low-quality water to Sulphur Springs Creek within the mine area are not expected to return after the project site has been closed.

After closure, surface water runoff from the catchment area upstream of the pit will be managed such that the pit remains a hydraulic sink and will continue to lower the groundwater table in the local catchment. The pit lake water is expected to eventually to be of low quality.

4.2.2 Ore Processing Domain

A small proportion of the local catchments surface water will be retained from runoff that occurs in the processing area. This water may contain elevated concentrations of solutes that could harm the environment if it discharges to either Sulphur Springs or Minnieritchie creeks.

4.2.3 TSF Domain

The TSF will capture all surface water that falls into the catchment upstream of the embankment. The TSF will include an underdrain to collect seepage and minimise hydraulic mounding on the water table during the operational phase. Seepage is expected to remain within the TSF catchment and migrate towards the mine. Additional seepage interception will be undertaken, if required, using low-yielding recovery bores and/or drains within the mine.

After closure, the TSF landform will be reshaped to divert surface water away from the final void and discharge to the Minnieritchie Creek and Six Mile Creek catchments. Residual seepage is expected to migrate towards the mine and be captured within the terminal sink formed by the pit lake.

Seepage is not expected to migrate to the adjacent catchments or Sulphur Springs Creek downstream of the pit.

4.2.4 Other Areas

The access road to the site will be used to transport raw materials to the project and the final products out to market. Although it is highly unlikely, spillage of these materials along the access road may lead to contamination of water in Sulphur Springs Creek.

The access road and sediment ponds near the mine will change alter the bed and banks of Sulphur Springs Creek. The road and ponds will be designed to minimise adverse impacts to the creek hydrology and ecology.

Drawdown from abstraction of groundwater from supply bores may locally reduce the amount of groundwater that normally discharges to the creek lines, particularly if abstraction is undertaken near GDEs. This aspect is already being managed successfully by Atlas around the access road water supply bores.

5.0 Summary of Impact Assessments

The following is a summary of recent impact assessments undertaken on surface water, groundwater and the site's water balance (AECOM, 2020a, 2020b and 2020c). The sites referred to in these assessments are shown on **Figure 7**.

5.1 Operational Phase

5.1.1 Surface Water Flow

Minnieritchie Creek Catchment

The baseline hydrology of Minnieritchie Creek includes the following characteristics:

- The project footprint in the Minnieritchie Creek catchment (measured at the first Pool at site MRC2) covers an area of 42ha for the process plant and southern evaporation pond. This represents 6% of the total catchment area of 650ha at MRC2 and 4% of the total catchment area of 1,054ha at MRC4.
- Consequently, the runoff at MRC2 is expected to be 94% of baseline and further downstream at MRC4 96% of baseline.
- At MRC2 the operational runoff is about 7 times greater than the runoff generated from the remainder of the subcatchment in which the process plant is located. At MRC4 the runoff is about 11 times greater.
- With the highly variable rainfall in any given year and the rapid catchment response, the stream flows at MRC2 and MRC4 typically will last only several days after the rainfall event generating the stream flow.
- The simulated peak flow rates vary greatly, and the catchment has a fast response to a rainfall event. Stream flows reduce significantly within a short period of time after the event. Base flows are mainly due to groundwater inflow into the creek line.
- The baseline riverine environment is apparently able to adapt to large variability, mostly short duration stream flow event s along most of the creek lines

The proposed project is predicted to cause a negligible change in the naturally highly variable stream flow along MRC downstream of the project site. This change is due to a reduction in runoff volumes contributing to the stream flow downstream caused by the capture of storm water runoff from the Process Area. This reduction will progressively diminish further along stream as stream flows from tributaries unaffected by the project make up an increasingly greater portion of the stream flow in MRC.

The reduction in stream flow volumes and corresponding peak discharge rates may lead to conditions with marginally less sediment transport and marginally higher risk of sediment deposition.

Sulphur Springs Catchment

The baseline hydrology of Sulphur Springs Creek includes the following characteristics:

- The project footprint in the Sulphur Springs Creek East catchment (measured at the first confluence at site SSC13) covers an area of 157ha including 129ha for the mine, TSF and WRD, and 28ha from the processing plant site. This represents 58% of the total catchment area of 271ha at SSC13. At the start of Sulphur Springs Creek, at site SSC14, just downstream of the confluence of SSC East (271ha) and SSC West (556ha) branches represent a combined 827ha, of which the project footprint is 165ha (20%).
- The catchment area upstream and including the proposed pit is about 155.9ha, comprised of three sub-catchments: the WRD catchment (58.5ha), the TSF catchment (PSC5 – 54.6ha) and two undisturbed catchments (PSC4 – 10.9ha and PSC6 – 3.0ha) and the Pit (28.9ha). Runoff in the TSF and pit will be captured and combined with the mine water system. Runoff from the WRD area would need to be diverted around the pit to prevent flooding following rainfall events.

- The pit (28.9ha), the TSF (42ha) and WRD (58.5ha) areas represent 11%, 16% and 22% of the SSC East catchment at SSC13 (271ha), and 3%, 5% and 7% of the SSC East and SSC West catchments at SSC14 (827ha).
- Peak flow rates from these catchments will vary greatly. The catchments have a relatively fast response to rainfall events, and stream flows are expected to reduce significantly within a short period of time after the event. Base flows are mainly due to groundwater inflow into the creek line.

Because the footprint is small in relation to the catchments around it, the project is predicted to cause only a minor change to a flow system that is naturally highly variable stream.

During the operational phase, there is predicted to be a flow reduction of about 46% just downstream of the confluence of SSC East Plant and Pit (SSC13) with the change diminishing progressively downstream to an indistinguishable 4% at the proposed Accommodation Village at the start of SSC Access Road. Changes in stream flow volumes and corresponding peak discharge rates are expected to cause slight but largely indistinguishable modifications of the sediment regime in SSC.

Six Mile Creek Catchment

The baseline hydrology of Six Mile Creek includes the following characteristics:

- The 47ha WRD footprint is present in three small sub-catchments in the upper-most reaches of Six Mile Creek. The WRD footprint is about 14% of the catchment at the first significant confluence 2km downstream (328ha).
- Given the WRDs location at the top of the regional divide, runoff response times are very fast, but local volumes and flow durations are expected to be small.

The project is expected to cause a negligible change in the naturally highly variable stream flows along SMC downstream of the project site. With the construction of sediment basins at the WRD toe in each sub-catchment, peak flow rates expected to remain similar to baseline conditions. It is expected that the proposed project will have a negligible impact on the sediment regime in SMC.

5.1.2 Surface Water Quality

Minnieritchie Creek Catchment

The baseline quality of surface water in the Minnieritchie Creek Catchment:

- has a circum-neutral pH between 7.1 and 7.7 (both at MRC2)
- is fresh to brackish salinity – 516mg/L TDS (MRC2) to 1,080mg/L TDS (MRC5)
- is high in alkalinity – 523mg/L to 572mg/L (as $CaCO_3$)
- is characterised by low sulphate to chloride ratios – 0.1 to 0.2
- has generally low concentrations of trace metals / metalloids and nutrients
- has occasional detections of nickel (0.002 to 0.004mg/L) during the dry season
- has a major ion composition reflecting a generally magnesium-bicarbonate water type

The quality of surface water in the Minnieritchie Creek catchment is similar to other nearby unmineralised catchments. The quality fluctuates seasonally depending on rainfall and the concentrations of solutes that accumulate from groundwater discharge dispersed by runoff.

Surface water in this catchment is circum-neutral, fresh, has low concentrations of metals / metalloids and nutrients, and has a high alkalinity. The major ion chemistry is dominated by magnesium-bicarbonate because of geochemical reactions within the catchment, particularly where the baseflow is derived from groundwater that has recharged an aquifer comprising mafic rock types.

The key potential surface water quality risk in this catchment is potential seepage from the southern water storage pond. The pond is planned to be lined so seepage is expected to be minimal. Should the quality of groundwater or surface water downstream deteriorate more than 20% of baseline, seepage recovery may be required.

Sulphur Springs Catchment

Baseline surface water quality parameters for several metals along the groundwater discharge zone within the mine site exceed the freshwater ecosystem guidelines (ANZECC & ARMCANZ, 2000). Baseline data upstream of the mineralised zone also have concentrations above these guidelines for copper, nickel and zinc. Downstream of the mineralised project area, at SSC14, the concentrations of all metals are below the generic guideline trigger values.

Key findings in terms of baseline surface water quality along Sulphur Springs Creek include:

- Compared to other catchments in the region, surface water discharging from the mine area has distinctly lower pH and alkalinity, and higher salinity, dissolved metals/metalloids and ionic proportions of sulphate. Evaporation of this water has left distinctly sulphurous residues along the creek bed.
- The catchment surrounding the mine evidently has low levels of mineralisation since surface water entering the proposed pit area has lower alkalinity and traces of several metals including: copper, nickel and zinc.
- Surface water along Sulphur Springs Creek retains a hydrochemical signature from the mineralised groundwater discharges in the mine site. The ionic proportions of sulphate (dominant in the mine site) are rapidly reduced once it is mixed with water from the western arm of Sulphur Springs Creek where is becomes increasingly bicarbonate-dominant.

As described in a recent groundwater assessment (AECOM, 2020a), acidic discharges along Sulphur Springs Creek will cease once mine dewatering lowers the water table below the creek bed. As a result, the quality of surface water along Sulphur Springs Creek, downstream of the mine is expected to slowly revert to a magnesium-bicarbonate type water. This change is not expected to significantly alter the alkalinity or hydrochemistry of metals / metalloids, but it will reduce the overall sulphate loadings. Eventually, once residual sulphate loadings within the catchment have been dispersed, surface water is expected to trend towards the bicarbonate-dominant water type observed in other catchments.

The key risk with surface water in Sulphur Springs Creek quality from the WRD will be turbidity and sediment in runoff. Sediment will be managed by using silt traps located at the base of the WRD, and on Sulphur Springs Creek downstream of the haul road. Any minor spillage associated with ore haulage from the mine to the processing plant will be contained on the haul road. Runoff from this area will be contained in the first pond (SED1 – **Figure 8**). The quality of water in this pond will be monitored to determine whether it should be pumped back into the mine water system or allowed to evaporate in-situ. Any overflow from this pond will be temporarily stored in the second pond (SED2) to ensure the quality of discharged water is comparable to background conditions.

The key to minimising operational impacts to surface water downstream of the ore processing area will be to:

- maintain the site to minimise the amount of potentially contaminating residues that could be mobilised by runoff
- maintain the water level in the stormwater ponds as low as possible – preferably empty prior to the wet season and forecasted extreme events
- install and maintain an engineered overflow area to preserve the integrity of the stormwater ponds even during an extreme event.

Six Mile Creek Catchment

The baseline quality of surface water in the Six Mile Creek Catchment has been defined at one natural spring (SMC1) as being:

- weakly alkaline pH between 8.0 and 8.4
- fresh salinity – 256 to 333mg/L TDS
- high in alkalinity – 523mg/L to 572mg/L (as $CaCO_3$)
- characterised by low sulphate to chloride ratios – 0.1 to 0.2

- generally low concentrations of trace metals / metalloids and nutrients
- occasional detections of copper (0.001 to 0.004mg/L)
- a major ion composition reflecting a generally magnesium-bicarbonate water type
- the major ion water quality is similar to surface water and groundwater in other unmineralised catchments such as Minnieritchie Creek
- hydrochemically very similar to site MRC2 and MRC4 on Minnieritchie Creek which is also unaffected by mineralisation.

Operational components that could affect surface water quality on Six Mile Creek include the waste rock dump. Compared to baseline conditions, the WRD has the potential to release higher concentrations of sediment in runoff. The NAF materials planned to be stored are not expected to release significant quantities of dissolved solutes.

Sediment will be managed by using settlement basins located at the base of the WRD (**Figure 8**). If the sediment basins are maintained, the stormwater discharge to the local tributaries should remain within the prevailing background levels.

5.1.3 Groundwater Levels and Flow

Sulphur Springs Mine Domain

Dewatering for the proposed mine will commence with bores before the pit reaches the water table and with in-pit sumps when the floor reaches the water table in the fractured and cavernous bedrock. The predicted annual rate of dewatering under the proposed mine plan is expected to range between about 764 and 3,795kL/day, or 5.9GL total over the 11-year construction and mining period. After the open pit is complete, the focus of dewatering will shift to sumps, in-pit bores and/or drain holes located underground.

With the commencement of dewatering, it is expected that the acidic natural groundwater discharges down Sulphur Springs Creek will cease as the water table is lowered below the creek bed. Abstraction may also result in changes to groundwater levels in adjacent catchments. As indicated by the baseline data, the Main Fault may provide such a pathway for inter-catchment flow from the north.

Initially, drawdown will propagate along the permeable faults as groundwater drains from local fractures and the weathered interval where they are saturated. Eventually, drawdown could propagate out to the catchment boundary and beyond, where permeable structures allow it. The rate of propagation will depend on the permeability and extent of the interconnected fracture network, and volume of water held in storage nearby. Within the bounds of uncertainty, it is expected that over the 11-year mine life that detectable drawdown (+/-0.5m) will extend down Sulphur Springs Creek by between 780 and 1,100m. Other than the existing acidic groundwater exposures in the mine area, there are no other known groundwater discharge zones that will be affected by dewatering.

Proposed TSF Domain

The TSF is proposed to be in the same groundwater flow system as the mine (**Figure 4**). The TSF has the potential to alter the groundwater levels beneath the structure and discharge rates to the mine. During operations, the drawdown cone is predicted to extend beneath the north-western end of the TSF. The TSF has been designed with an underdrainage network to enhance seepage recovery and control the phreatic surface in the weathered bedrock aquifer.

Groundwater conditions in the proposed TSF valley (PSC5) have been characterised by groundwater monitoring at the mine and in the WRD catchment nearby. Groundwater is recharged by rainfall infiltration during the wet season, and subsequently flows to low-lying areas of the catchment, eventually reaching the mine area where it currently discharges to surface water flow along Sulphur Springs Creek.

Seepage from the TSF is predicted to remain within the PSC5 catchment and migrate towards the mine. During operations, seepage into the mine will be minimised by intercepting it with an underdrainage network and recovery bores. Residual seepage will be captured in drains in the pit and/or underground mine. Recovered seepage will be returned to the TSF or recycled for ore processing.

Seepage flow outside the PSC5 catchment is only possible under extreme circumstances and towards the end of the operations period. For this to occur, the decant pond needs to be at an elevation above the fresh bedrock interface under the surrounding ridgeline saddles and located for an extended period close to the edges of the tailings footprint. Even under these conditions, seepage at very low rates will be constrained to creek lines in the adjacent catchments. This seepage will mix with native groundwater and disperse into seasonal surface water flows.

Proposed WRD Domain

The proposed waste rock dump (WRD) will result in a permanent structure containing non-acid-forming (NAF) and potentially acid-forming (PAF) materials (MBS, 2016). The PAF materials will be encapsulated by low-permeability materials including oxidised rock (that is clayey and silty), and inert chert and siltstones from the hanging wall. Any seepage from these cells will be captured by the open pit. A temporary stockpile of NAF material at the TSF will also be formed during operations to provide material for future embankment lifts and other necessary earthworks.

It is common for WRDs to increase the rate of groundwater recharge (due to higher infiltration rates and short-term post-event storage within the structure) and cause the water table to mound slightly. The monitoring data indicate the local baseline recharge rates are relatively high and that recharged groundwater flows quickly downslope. Due to its proximity to the open pit and the predicted dewatering cone of depression, this additional recharge is unlikely to result in a significant change to the water table. Given this, the main body of the WRD is not expected to have any impact on the groundwater system outside of the mine site.

A portion of the WRD (comprising NAF materials) will extend into the Six Mile Creek catchment. Even if the drawdown cone does not extend this far south, changes to the water table in that catchment are likely to be small and localised. The increase in recharge storage may result in a small increase in the rate and duration of post rainfall event discharges from the existing spring at SMC1.

5.1.4 Groundwater Quality

Sulphur Springs Mine Domain

There are many groundwater bores and old mineral holes located across the project area (AECOM, 2020a). Sampling these bores indicates the following in terms of baseline groundwater quality:

- It is circum-neutral in pH except for locations within Sulphur Springs Creek valley where pH ranged from 3.8 to 5.7.
- It is relatively low in salinity except for groundwater from bores located within Sulphur Springs catchment where the water table is close to the surface. Higher salinities are the result of evapotranspiration along active discharge zones and chemical weathering at locations situated within the mineralised zone.
- It is elevated in sulphate and metals/metalloids including cadmium, copper, nickel and zinc, with the highest concentrations observed in the low pH groundwater zone in Sulphur Springs Creek valley, because of long-term groundwater interaction with the mineralisation.

Groundwater within the mineralised zone is known to discharge into Sulphur Springs Creek, primarily because of secondary permeability that has developed through long-term geochemical reactions within the fractured and mineralised rock. As a result, groundwater at the mine site exhibits a unique chemical signature compared to groundwater elsewhere in the broader catchment.

Baseline monitoring (AECOM, 2020a, 2020b) indicates groundwater from the mine site discharges along a 450 to 500m stretch of Sulphur Springs Creek downstream of the centre of the proposed pit that will be incorporated into the proposed haul road. This discharge is expected to cease once groundwater levels are lowered by dewatering. As a result, surface water captured in the planned sediment control structures further downstream is not expected to be influenced by acidic groundwater discharges. There are no pools or other groundwater expressions downstream of this discharge zone until after the confluence with Sulphur Springs (West) Creek at site SSC14 (**Figure 4**).

Proposed TSF Domain

The TSF will be in a sub-catchment of the mine, from which, groundwater flows to Sulphur Springs Creek. Baseline monitoring indicates groundwater from the TSF catchment discharges along a stretch of Sulphur Springs Creek within the proposed mine footprint.

Groundwater emanating from the TSF catchment may have a different hydrochemical signature compared to baseline. Solutes from the tailings will flow to the mine void where it will be captured and recycled in the raw water supply during operations or captured in a terminal sink in the mine void after closure.

During operations, the additional solutes from the relatively small volume of tailings seepage will be dispersed into the mine water system. If seepage passes through the ridgeline saddles, the volume of seepage (about 6kL/d) towards the end of operations is not expected to significantly change the quality of surface water discharging to Minnieritchie or Six Mile creeks.

Proposed WRD

The WRD will contain materials classified as PAF, which will be encapsulated within NAF material in engineered cells to minimise ingress of water and subsequent oxidation of the sulphide minerals known to be present (URS, 2007a and 2007b; GCA, 2012a). The encapsulation cells will be constructed to remain above the water table and potential infiltration flowpaths along the base of the structure. The encapsulation structures will also be designed to minimise the interaction with incidental rainfall infiltration. Any seepage that does pass through the cells will be captured by the post-closure drawdown capture zone that is predicted to surround the final void.

5.2 Closure Phase

5.2.1 Surface Water Flow

Minnieritchie Creek Catchment

After closure, surface water flows from the processing plant area will be returned to Minnieritchie Creek. Surface water flows from part of the TSF (about 21ha) will be directed to an adjacent tributary of Minnieritchie Creek.

Surface water flows to Minnieritchie Creek after closure are expected to remain similar to existing conditions. The additional runoff from the TSF is expected to be insignificant to the naturally highly variable flows at MRC2 (3%) or MRC4 (2%).

Sulphur Springs Catchment

After closure, surface water flows from the processing plant area will be returned to Sulphur Springs Creek. Runoff from the TSF (42ha) will be directed to the Minnieritchie Creek and Six Mile Creek catchments, decreasing flows slightly in Sulphur Springs Creek.

After closure, the pit will form a lake and terminal hydraulic sink. Consequently, the runoff from the pit catchment area (155.9ha) will no longer contribute to streamflow downstream of the pit.

The net change to flows down Sulphur Springs Creek, at the confluence of the east and west branches (site SSC14) is expected to be a reduction of 19% and a reduction of 5% further downstream at the site of the Accommodation Village at which point this change is expected to be indistinguishable from baseline flows.

Six Mile Creek Catchment

After closure, the WRD is planned to extend into the Six Mile Creek catchment by about 47ha. The proposed modification of the surface area of the WRD in the Sulphur Springs catchment will result in an additional area of 28.7ha draining surface water runoff into the Six Mile Creek catchment. This may result in a small increase in surface water flows in most upper portion of this catchment.

In addition, part of the TSF area (21ha) is planned to drain into the Six Mile Creek catchment. This may result in a small increase in surface water flows in most upper portion of this catchment.

The combined change to flows in Six Mile Creek due to additional runoff from the WRD and TSF areas is an additional 15% of baseline in the upper reaches, reducing to an increase of 4% further along at the pool in Six Mile Creek (Location ID 5).

There may be a small and highly localised change in the peak flow rates due to a difference in the highly variable runoff characteristics compared to the undisturbed catchment, but this is not expected to alter the hydrology of Six Mile Creek in any meaningful way.

5.2.2 Surface Water Quality

Minnieritchie Creek Catchment

The processing plant area incorporating the southern water storage pond in Minnieritchie Creek catchment will be rehabilitated using benign materials. It is assumed that runoff from the contributing part of the TSF landform will also be benign. As a result, the quality of runoff is expected to be similar to the prevailing background conditions.

Sulphur Springs Catchment

After closure, it is expected that the WRD, TSF, processing plant area and interconnecting haul roads will be rehabilitated, and that this will involve the removal or burial of any potentially contaminating substances. The quality of runoff from these areas will effectively return to a stable and non-polluting condition. Rehabilitation of the haul road that will be built upon the existing groundwater discharge zone will require careful attention to limit the solute loadings that surface water will mobilise once it is rehabilitated.

Given that groundwater including seepage from the TSF will be captured by the pit lake and it will no longer discharge to Sulphur Springs Creek, the downstream surface water quality is expected to slowly transition from a sulphate-dominant chemistry into a bicarbonate-dominant chemistry. The speed of this transition will need to be determined once the final closure design has been established, but it is not expected that this change will result in an adverse impact.

It is anticipated that during the closure phase, attention will need to be given to managing sediment and turbidity downstream of the project site, particularly once the sediment-control basins and access roads are decommissioned. A sediment control basin may need to remain for the duration of the closure phase to manage the quality of discharges as the final landform stabilises.

Six Mile Creek Catchment

After closure, it is expected that the WRD and TSF will be rehabilitated and that the resulting structures will be stable and not release sediment or solutes in a manner that will lead to long-term or unacceptable impacts. Rehabilitation trials will probably be necessary to determine the final design characteristics to achieve this objective.

5.2.3 Groundwater Levels and Flow

Sulphur Springs Mine Domain

Once mining is completed, the mine void will slowly fill with groundwater, TSF seepage and runoff from rainfall entering the pit footprint. The rate of flooding will slow once the water level reaches the pit floor where the void volume per metre rise will increase significantly, and evaporation from the pit lake will begin to take effect. Due to evaporation, the resultant pit lake is predicted to rise and stabilise between about 217 and 221mAHD, or 24 to 28m below the lower-most section of the final pit crest (AECOM, 2020c).

The pit lake level will fluctuate with the rates of groundwater and rainfall inflow and evaporation outflow. These fluctuations will have seasonal and event-driven frequencies. An assessment of these scenarios is included in a recent water balance study (AECOM, 2020c). That study concluded that with the addition of runoff from the residual catchment i.e. runoff from the pit and inward facing pats of the TSF and WRD, the level is expected to remain below the inferred seepage threshold at 235mAHD and the pit rim at 245mAHD. Under these conditions, the pit is expected to become a persistent hydraulic sink.

One aspect that will require further consideration during operational phase will be the potential influence of the Creek Fault on the post-closure groundwater capture zone. Although it is expected this structure will extend the drawdown capture zone when the pit lake levels remain low, the critical pit lake elevation above which an outward-facing gradient may develop along this structure needs to be confirmed. This aspect may influence how post-closure surface water inputs to the pit lake are managed.

Proposed TSF Domain

After closure, the drawdown cone around the mine void is predicted to extend under the entire TSF. Seepage from the TSF after closure is expected to remain within the PSC5 catchment and migrate towards the mine void. Seepage flow outside the PSC5 catchment is not expected to occur after closure because the phreatic surface will recover, and groundwater will return to topographically-driven flow. Residual seepage will only migrate towards the open pit void where it will be captured in a terminal sink.

Proposed WRD Domain

After closure, the WRD will be reshaped and capped to achieve a stable landform (MBS, 2016), and minimise water ingress to the encapsulated PAF cells. While the rate of infiltration through the WRD has not yet been defined, the change in the rate of recharge to the water table will be insignificant in the broader context given the open pit will maintain a hydraulic sink and capture any recharge beneath the WRD footprint. Changes to recharge rates for the parts of the WRD that are in the Six Mile Creek catchment are expected to be insignificant, but there may be minor discharges of groundwater at the toe for a period following heavy rainfall.

5.2.4 Groundwater Quality

Sulphur Spring Catchment

Water in the void is expected to become increasingly saline and contain higher concentrations of most solutes due to evaporation (AECOM, 2020c). Recent predictions suggest the salinity will slowly increase from about 450mg/L to between about 10,000mg/L and 14,000mg/L 300 years after closure depending on the concentrations in the seepage from the TSF. Similarly, the concentrations of the key solutes are expected to increase to about: 0.03mg/L (copper), 0.56 to 1.0mg/L (nickel), 0.25 to 0.87mg/L (selenium) and 18.5 to 21.7mg/L (zinc) after a similar period. The actual concentrations of TDS and these solutes will vary depending on the rate of oxidation of the tailings during and after the drain-down phase, and PAF materials in the walls during the flooding stage, hydrochemical solubility limits (MBS, 2019b) and the degree of mixing that takes place between deep groundwater in the underground void and water in the pit lake.

However, because the pit lake level is expected to remain between about 24 to 28m below the surrounding ground level and current water table), ongoing discharges down Sulphur Springs Creek are not expected to be re-established (AECOM, 2020a and 2020c). The post-closure pit lake is expected to maintain a hydraulic sink within the local water table. Because of the strong hydraulic effect, solutes within the mine void are unlikely to migrate a significant distance from the void footprint.

Proposed WRD

The WRD after closure will be engineered to achieve a stable landform (MBS, 2016) and minimise water ingress to the encapsulated PAF cells. This will minimise long-term influences on groundwater quality. As with the operational phase, any seepage from these cells is expected to be captured by the pit lake.

5.3 Impact Summary

Based on the assessments undertaken, potential impacts have been identified for most of the project domains during operations, and some of them after closure. A summary of these issues is provided in **Table 6** (for operations) and **Table 7** (for closure). Qualitative rankings of the potential extent, severity and significance of uncertainties are also provided for context.

Table 6 Summary of Potential Issues During the Operational Phase

Domain	Description	Relative Risk from Proposed Project (H/M/L)		
		Extent	Severity	Uncertainty
Open Pit	The open pit will slightly reduce the volume of runoff to Sulphur Springs Creek.	L	L	L
	Drawdown from dewatering will lower the water table along part of Sulphur Springs Creek where GDEs may be present.	L	M	L
Processing	There will be a small reduction in the volumes of surface water flowing to Sulphur Springs and Minnieritchie creeks because it will be captured as dirty water in the processing area.	L	L	L
	Potentially contaminated water in the site water ponds may spill to local creeks during an extreme event.	L	M	M
TSF	Seepage from the TSF will discharge to the dewatered mine.	L	L	M
WRD	There is a potential that runoff containing elevated sediment loads may be released to Sulphur Springs and/or Six Mile creeks.	L	M	L
Access Road	Spillage on the haul and access roads may affect the quality of local surface water.	L	L	L
	Diversions, culverts and runoff from the road may alter the hydrology of Sulphur Springs Creek	M	L	L
Water Supply	Water supply abstractions from bores will locally lower the water table and reduce base flows to nearby creeks.	L	L	L
Relative Risk Scale Description	**Low** – Effects are localised within one sub-catchment and likely to result in no (or insignificant) impact.			L
	Medium – Effects may cross a catchment boundary or involve multiple sub-catchments and are likely to result in an impact that requires monitoring to mitigate impacts after closure.			M
	High – Effects broad and across multiple catchments and are likely to result in an impact that requires significant mitigation during operations and close monitoring (+/- triggers).			H

Table 7 Summary of Key Potential Issues After Closure

Domain	Description	Relative Risk from Proposed Project (H/M/L)		
		Extent	Severity	Uncertainty
Open Pit	The open pit will continue to slightly reduce the volume of runoff to Sulphur Springs Creek.	L	L	L
	The water balance of the pit lake will remain negative, thus creating a terminal sink that will prevent lake water from overtopping and flowing down Sulphur Springs Creek.	L	L	L
	Residual drawdown from the pit lake will form a terminal hydraulic sink that will continue to lower the water table along part of Sulphur Springs Creek where GDEs may be present.	L	L	L
	The pit lake water will slowly become saline, may become acidic, and evolve with elevated concentrations of solutes including trace metals.	L	M	L
TSF	Seepage from the TSF will migrate to the lake within the final mine void and be captured within the terminal sink it forms.	L	L	L
	Runoff from the final landform will be directed to Minnieritchie Creek and Six Mile Creek catchments. The net change to both catchments is expected to be negligible	L	L	L
WRD	If the final landform is unstable, there is a potential that runoff containing elevated sediment loads may be released to Sulphur Springs and/or Six Mile creeks.	L	M	L
	PAF material stored in the WRD may release solutes to the water table but will be captured by the residual cone of depression surrounding the pit lake.	L	L	L
Relative Risk Scale Description	**Low** – Effects are localised within one sub-catchment and likely to result in no (or insignificant) impact.			L
	Medium – Effects may cross a catchment boundary or involve multiple sub-catchments and are likely to result in an impact that requires monitoring during the operational phase to mitigate impacts after closure.			M
	High – Effects broad and across multiple catchments and are likely to result in an impact that may require significant mitigation during operations and close monitoring (+/- triggers) to achieve closure criteria.			H

6.0 Management Measures and Contingencies

6.1 Objectives

In line with established principles for managing water in the Pilbara (DoW, 2013a, 2013d), minimising and managing risks to the water environment will be achieved by:

- dewatering only as much as is required to achieve safe and dry working conditions, and directing the dewater to the ore processing plant and/or water storage/evaporation ponds where it will be managed by the project and not discharged to the environment
- identifying and considering the opportunistic use of surface water captured within the disturbed footprint as a project resource where its use can also minimise the potential impacts downstream
- maintaining a site water balance and make effective use of monitoring data to optimise future water uses across the site
- undertaking the monitoring programme to detect changes to groundwater and surface water levels and quality and abstraction rates to optimise the use of groundwater as a valuable resource in the projects water balance
- closely managing site activities to minimise the risk of unplanned discharges of hydrocarbons or processing-related chemicals
- managing stormwater to minimise the risks of an unplanned release for rainfall events up to 1 in 100-year ARI
- regularly reviewing the monitoring data to identify whether any triggers have been reached, or trends indicate there may be an unplanned response
- preparing annual reports to demonstrate compliance in line with the current DWER guidelines (DoW, 2009d)
- installing and maintaining volumetric flow meters in line with *Measuring the Taking of Water* (DoW, 2016b)
- developing and maintaining site-specific contingency measures to minimise environmental harm where there is an elevated risk such as seepage to Minnieritchie Creek downstream of the TSF
- preparing, implementing and maintaining an emergency response plan prior to the commencement of construction and throughout the operational phase in line with WQPN 10 (DoW, 2006a) following the principles of: spill *Prevention, Preparedness, Response and Recovery*.
- maintaining compliance with this water management plan.

The issues summarised in **Table 6** and **Table 7** will need to be managed to minimise the extent and severity of the projects impacts. The following discussion outlines management measures that will be employed to meet this objective during the operational phase and after closure.

6.2 Water Management During the Operational Phase

6.2.1 Implementation

In line with the issues identified in **Table 6** and the above objectives, potential impacts associated with activities during the operational phase will be managed by:

- continue monitoring surface water and groundwater to refine baseline conditions and support the development of post-closure designs
- engineering surface water diversion structures, stilling basins and site water ponds that will minimise safety-related risks to site workers and minimise changes to downstream environments from areas that may develop low quality runoff
- abstracting only enough groundwater from the mine to meet the operational objectives

- abstracting groundwater for project make-up supplies from other sources in a way that minimises environmental impacts i.e. abstracting water to minimise drawdown impacts on nearby riverine environments (where present)

Site-specific management measures will include:

Mine Area:

- Prepare and implement a dewatering programme that will refine abstractions based on the current mining schedule and prevailing hydrogeological conditions including groundwater levels and trends and recent climatic conditions. The plan should use a dewatering technique that allows the rate, depth and location to be refined based on local conditions to avoid excessive abstraction.
- Monitor groundwater levels across the Sulphur Springs catchment to confirm the extent of drawdown, rates of recharge and impacts on GDEs associated with sensitive undisturbed riverine areas.
- Monitor surface water and groundwater quality across the Sulphur Springs catchment to determine the extent and severity of changes resulting from dewatering and footprint disturbances.
- Monitor the rates and quality of runoff from the WRD to determine the effectiveness of diversion, erosion and sediment control structures.
- Monitor the quality of runoff within the open pit to determine the influence that exposure of mineralised materials in the walls is having on water collecting in the sump.
- Monitor the influence that mine dewatering has along the Creek and Main faults to identify whether there is a critical elevation that the pit lake should remain below after closure, and whether groundwater in adjacent catchments is being affected by dewatering.

Processing Area:

- Undertake regular inspections and reviews of the site water ponds to ensure the integrity of the liners and water transfer pipelines remain effective barriers to seepage.
- Monitor the levels and quality of water in the site water ponds to ensure they remain effective barriers to off-site discharges up to a 1 in 100-year ARI event, and remain intact to minimise the release of site water during an extreme event.
- Install a bore downstream of the site water ponds to monitor for potential impacts on the local groundwater levels and quality.

TSF Area:

- Undertake regular inspections and reviews of the TSF to ensure the integrity of the embankments and seepage collection system.
- Install bores close to, and on the downstream side of the main (northern) and southern embankments, and at discrete locations in saddles along the eastern and western sides to monitor seepage-related changes and assess risks of cross-catchment migration.
- Take regular readings and samples of surface water along Six Mile and Minnieritchie creeks to monitor the quality of surface water.
- Undertake regular reviews of the health of the downstream riverine environments (in conjunction with groundwater and surface water monitoring) to identify unplanned operational impacts, and to support refinement of closure designs and criteria.
- Undertake geochemical sampling to monitor the quality of decant and pore water to identify whether solute accumulation in the TSF is likely to affect the quality of seepage after closure.

WRD Area:

- Install monitoring equipment to measure the levels in the stilling basins to ensure they contain runoff for an adequate period to minimise the release of sediment.
- Install a monitoring bore downstream of the WRD in catchments that don't directly drain to the open pit.
- Sample surface water in the stilling basins and groundwater in downstream monitoring bores to identify any potentially adverse changes to downstream quality.

Project Water Supply:

- Operate non-dewatering water sources in a way to minimise excessive use of these resources.
- Monitor the abstraction, levels and quality of groundwater to determine the best use based on the yield, quality, and potential to impact the environment of each source.
- Closely monitor the quality of groundwater sourced for potable uses in line with appropriate drinking water guidelines (NHMRC & NRMMC, 2011).

6.2.2 Contingencies

Contingency actions will be implemented if the following unplanned events take place:

- Failure of any flow meter – repair or replace faulty flow meters in line with manufacturer's specifications.
- Damage to monitoring bores or sites – repair or replace the bore or site infrastructure to re-establish the monitoring capability.
- Shortfall in project water demands from mine dewatering – equip and abstract the shortfall from existing water supply bores.
- Excess in dewatering volumes over and above the projects water needs – review the site water balance to confirm the excess volumes, and that they are still within the tolerance of the water storage/evaporation ponds to manage the excess. If not, review and if possible, reduce the dewatering rate and/or consider an alternative storage site.
- Shortfall in project water demands from mine dewatering and existing water supply bores – drill for and install additional bores at sites identified previously (URS, 2013b).
- If drawdown from the mine extends out of the Sulphur Springs Creek mine catchment – investigate the cause and assess the implications of continued drawdown on any sensitive receptors.
- If the quality of downstream surface water exceeds the site's trigger, initiate a Level 1 or Level 2 response as defined in Section 6.2.3.
- If a leak or spill of hydrocarbons of other potentially contaminating chemical substance occurs, initiate a Level 3 response and follow the emergency response plan.

6.2.3 Provisional Triggers and Response Actions

Provisional triggers have been developed from the baseline monitoring data (**Table 8**). The purpose of these triggers is to identify whether changes to surface water or groundwater are significantly outside the normal range, thus necessitating a series of actions to investigate the cause to prevent an adverse environmental impact. In addition, reportable triggers have been identified based on guideline values from the Australian Water Quality Guidelines (ANZECC & ARMCANZ, 2000).

The baseline triggers have been selected based on a margin that is 20% beyond the baseline range. Given the low concentrations of some parameters, the triggers have been increased to a reliably detectable value compared to the corresponding limit of reporting. As the provisional triggers are drawn from baseline data, they will be reviewed regularly to ensure they remain relevant as more monitoring data become available.

Table 8 Provisional Water Triggers

SW / GW	Location	Parameter	Baseline Range[5]	Applicable Trigger	
				Baseline Trigger	Guideline Trigger
Surface Water	**Sulphur Springs & Six Mile creeks** SSC14, SSC20, SMC1.	pH	7.3 – 8.4	7.0 – 8.8	-
		DO (mg/L)	2.4 – 7.0	>2.0	-
		TDS (mg/L)	260 – 1,500	<1,800	4,000[1]
		Arsenic (mg/L)	<0.001 – 0.004	<0.005	0.013[2]
		Cadmium (mg/L)	<0.0001 – 0.012	<0.0015	0.0020[2]
		Copper (mg/L)	<0.004	<0.005	0.007 – 0.013[2]
		Nickel (mg/L)	<0.002	<0.003	0.057 – 0.100[2]
		Selenium (mg/L)	<0.012	<0.015	0.011[2]
		Zinc (mg/L)	<0.017	<0.020	0.042 – 0.072[2]
	Minnieritchie Creek MRC2, MRC4	pH	7.1 – 8.4	7.0 – 8.5	-
		DO (mg/L)	4.0 – 10.8	>3.2	-
		TDS (mg/L)	500 – 1,080	<1,300	4,000[1]
		Arsenic (mg/L)	<0.001	<0.002	0.013[2]
		Cadmium (mg/L)	<0.0001	<0.0002	0.0020[2]
		Copper (mg/L)	<0.001	<0.002	0.007 – 0.013[2]
		Nickel (mg/L)	<0.004	<0.005	0.057 – 0.100[2]
		Selenium (mg/L)	<0.01	<0.01	0.011[2]
		Zinc (mg/L)	<0.005	<0.006	0.042 – 0.072[2]
Groundwater	**TSF Area:** TSF1, TSF2, TSF3, TSF4, TSF5, TSF6	pH	7.1 – 7.2	7.0 – 7.3	-
		TDS (mg/L)	480 - 580	<640	4,000[1]
		Arsenic (mg/L)	<0.001	<0.002	0.5[1]
		Cadmium (mg/L)	<0.0002	<0.0003	0.01[1]
		Copper (mg/L)	<0.001	<0.002	1.0[1]
		Nickel (mg/L)	<0.001	<0.002	1.0[1]
		Selenium (mg/L)	<0.01	<0.01	0.02[1]
		Zinc (mg/L)	<0.005	<0.006	20[1]
		SWL (mbrp)	-	+/-20%[4]	-
	Process Area: Kim Bore, PPS1[3]	pH	7.1 -7.4	7.0 -7.5	-
		TDS (mg/L)	680 - 800	<800	4,000[1]
		Arsenic (mg/L)	<0.001	<0.002	0.5[1]
		Cadmium (mg/L)	<0.0002	<0.0003	0.01[1]
		Copper (mg/L)	<0.008	<0.009	1.0[1]
		Nickel (mg/L)	<0.002	<0.003	1.0[1]
		Selenium (mg/L)	<0.01	<0.01	0.02[1]
		Zinc (mg/L)	<0.031	<0.034	20[1]
		SWL (mbrp)	-	+/-20%[4]	-

SW / GW	Location	Parameter	Baseline Range[5]	Applicable Trigger	
				Baseline Trigger	Guideline Trigger
	Six Mile Creek: SSWB21, SSWB25	pH	7.0	6.9 – 7.1	-
		TDS (mg/L)	400 – 1,120	<1,240	4,000[1]
		Arsenic (mg/L)	<0.004	<0.005	0.5[1]
		Cadmium (mg/L)	<0.0001	<0.0002	0.01[1]
		Copper (mg/L)	<0.006	<0.007	1.0[1]
		Nickel (mg/L)	0.010 – 0.023	<0.025	1.0[1]
		Selenium (mg/L)	N.D.	<0.01	0.02[1]
		Zinc (mg/L)	0.019 – 0.025	<0.028	20[1]
		SWL (mbrp)	-	+/-20%[4]	-

Note: A trigger will be exceeded if the result is outside of the specified ranges.
1 – Stock drinking water limits (ANZECC & ARMCANZ, 2000).
2 – 95% protection, HMTV adjusted (ANZECC & ARMCANZ, 2000).
3 – based on water quality results from other bores in the catchment (AECOM, 2018a).
4 – +/-20% from the baseline seasonal range.
5 – Excludes baseline data from bore SSDW001.

A trigger will be exceeded if two successive routine readings are above the baseline trigger or range. If this occurs, the following action plan will be implemented:

Level 1 Response (confirmation and background data review)

- If a baseline trigger is exceeded, re-sample within seven days from receipt of the results to confirm the exceedance.
- Review results against the site's data trends to identify whether it is part of a short-term or long-term change.
- Review background monitoring data to identify whether the change is due to a regional trend i.e. climate-based rather than site-based event.
- If the change is in line with background changes, continue to monitor the change to determine whether a guideline trigger is breached, otherwise, initiate a Level 2 response.
- Report the event in the next annual monitoring report.

Level 2 Response – (impact identification and mitigation)

- If the baseline trigger is reached due to a site-based event, review contributing factors to identify the cause(s).
- Review or establish predictive results to identify impact risks.
- If the change is not expected to result in an impact, continue monitoring and report in the next annual monitoring report.
- If the guideline trigger is breached, re-sample the site within seven days (if this hasn't occurred as part of a Level 1 response) from receipt of the results, review local and background monitoring data, and investigate for evidence of an impact.
- If the change has, or is likely to result in an adverse impact, develop a mitigation plan and seek approval from DWER within six months of becoming aware of the change.
- Implement the approved mitigation plan and continue to monitor to determine effectiveness of the change.

Potential Level 2 response contingency actions include

- Operation of existing or additional recovery bores if cross-catchment seepage is occurring.
- Alkaline pH adjustment of full decant water stream instead of only the volume required for processing.
- Alkaline pH adjustment of tailings via lime addition at the final tailings hopper prior to deposition into TSF.
- Alkaline pH adjustment of tailings via calcined magnesia at the final tailings hopper prior to deposition into TSF.

Level 3 Response – (unplanned leaks, spills and emergency response)

An unplanned event such as a leak or spill will be managed according to the ERP. The ERP will contain details on the type of response, level and timing of internal and external reporting.

An unplanned event is one that involves the release of potentially contaminating substances, either following a sudden occurrence, or slow but undetected release. Control and containment of substances such as hydrocarbons and processing chemicals are governed by various regulations outside the scope of this plan. Identification and reporting of a contamination event are defined in the Contamination Sites Guidelines (DER, 2017).

6.3 Water Management During the Closure Phase

In line with the management objectives and issues identified in **Table 7**, potential impacts associated with activities during the closure phase will be managed by:

- undertaking regular reviews of the monitoring data during the operational phase to identify appropriate closure criteria
- identifying key locations where site-specific closure criteria will apply
- undertaking rehabilitation trials to confirm the most appropriate method of achieving acceptable runoff, streamflow and surface water quality outcomes
- undertaking closure trials at the TSF to demonstrate the final cover design will control seepage to a suitable degree to stabilise the tailings and minimise seepage-related impacts
- engineering permanent surface water diversion structures and stilling basins to meet agreed safety and environmental closure criteria.

Site-specific management measures for closure could include:

Mine Area:

- Refine the pit lake level and quality predictions to redefine closure criteria involving the pit lake and risks associated with any potential release of contaminated water Sulphur Springs Creek along the Creek Fault. The refinements for quality will need to include mass balance accounts of groundwater and surface water inflows and outflows as well as geochemical loadings from exposure mapping.
- Refine designs for permanent surface water diversion away from the pit to maintain an effective hydraulic sink in the final void. The current commitment to divert runoff from the pit catchment focussed on the WRD and TSF sub-catchments will be progressively refined.

TSF Area:

- Review monitoring data during the operational phase including groundwater levels and quality around the TSF. These reviews will refine the characteristics of any post-closure preferential flowpaths, discharge rates and locations, as well as net seasonal influences on the final void pit lake. It will also focus on refining the net percolation rate for the cover design and it influence on stabilising the geochemistry of the tailings.

WRD Area:

- Review monitoring data collected during the operational phase including flow rates, volumes and quality downstream of the WRD. This review will consider the post-closure landform stability and erosion characteristics to inform and refine closure designs with respect to the release of runoff to the environment.

7.0 Water Monitoring Programme

An integrated surface water and groundwater monitoring programme is proposed to meet the following objectives:

- Confirm how the aquifer responds to abstraction to refine the understanding of hydraulic interconnections and catchment recharge rates.
- Confirm the hydraulic properties of the Creek Fault and the presence of a critical stage-height of the pit lake for seepage containment.
- Determine the aquifer response to water supply abstraction to forecast operational risks to the projects water supply.
- Confirm surface water diversion structures, stilling basins and site water ponds remain effective controls to minimise environmental impacts.
- Confirm the levels and quality of groundwater in natural discharge zones to provide a pre-emptive tool for minimising surface water impacts.
- Confirm the rate of infiltration downstream of the WRD in the Six Mile Creek Catchment is not excessive, and that the quality of discharging water remains compatible with background levels.
- Confirm the height and extent of the seepage mound under the TSF and its quality to determine if seepage-related impacts to Minnieritchie Creek or Six Mile Creek is occurring.
- Refine the links between groundwater and surface water by monitoring the local climate.

To achieve the above objectives, a monitoring programme involving abstraction measurements, surface water and groundwater level readings, and sampling at key locations. For the processing and evaporation pond domains, downstream water monitoring will be conducted in-sync with other ecosystem health monitoring. Visual observations, from year to year, along the groundwater discharge zones near the project infrastructure will be undertaken.

Groundwater and surface water monitoring will be undertaken during the pre-operational (construction) phase of the project. It is intended that this monitoring will capture 12 to 18 months (one additional seasonal cycle) of data prior to large-scaled dewatering and TSF operation. The existing environmental dataset will be enhanced with the results of the planned monitoring (pre-operational and operational phases) in order to inform the environmental and post-closure objectives.

It is anticipated that during the operational phase an appropriate monitoring programme for the closure phase will be developed in conjunction with site-specific closure criteria. At this stage, the closure phase monitoring will likely reflect a continuation of the operational monitoring until the agreed closure criteria have been met.

The recommended monitoring programme, spanning the pre-operational and operational phases is detailed in **Table 9**. Locations proposed for monitoring are shown on **Figure 9**.

In addition to the above, annual monitoring reviews will be undertaken in line with the current DWER reporting guidelines to assess compliance with the programme and progress updates on the monitoring objectives.

In addition to the existing monitoring bores and sites, several new sites are recommended to be installed during the construction period to acquire enough baseline data. The sites listed in **Table 10** are aimed at monitoring key locations on the flowpaths between the project and sites of interest. The locations are shown on **Figure 9**.

Table 9 Water Monitoring Programme

Sites	Parameter Type	Parameter to be Measured	Pre-operational Frequency	Operational Frequency
Sulphur Springs Project Site	Climate	Rainfall and evaporation	Hourly (rainfall), daily (evaporation)	
All operating abstraction bores: (SSDW001, SSWB03, SSWB06, SSWB12, SSWB20, SSTP001, SSTP003), Pit sump discharge line, Underground dewatering discharge line, Selected underground groundwater inflow zones.	Abstraction	Groundwater quantity (kL)	Monthly	Monthly
	Levels	Depth below datum / ground (m)	Monthly	Monthly
	Quality (field)	Physicochemical: (pH, EC, temp)	Monthly	Monthly
	Groundwater Quality (Lab)	**Field:** pH, EC, temp **Physicochemical:** pH, EC, TDS, acidity, total alkalinity, hardness **Major Ions:** Na, K, Ca, Mg, HCO_3, CO_3, Cl, SO_4, NO_3 **Minor ions & dissolved trace metals/ metalloids:** Si, Al, As, Cd, Cr (tot), Cu, Fe, Pb, Mn, Ni, Se, Tl, Te and Zn	Annually	Annually
All production bores. Monitoring bores: **Mine** - SSWB66, SSWB67, SSWB68, SSWB69, Unknown, *CF1, CF2, CF3*. **TSF** - *TSF1, TSF2, TSF3, TSF4, TSF5, TSF6.* **Processing** - Kim Bore, *PPS1, NEP1,* SSWB33. **Regional** - SSWB18, SSWB21, SSWB22, SSWB23, SSWB25, SSWB26.	Groundwater Levels	Depth below datum / ground (m)	Monthly	Monthly

Table 9 Water Monitoring Programme (cont.)

Sites	Parameter Type	Parameter to be Measured	Pre-operational Frequency	Operational Frequency
Mine - SSWB66, SSWB67, SSWB68, SSWB69, Unknown, *CF1, CF2, CF3*. **TSF** -, *TSF1, TSF2, TSF3, TSF4, TSF5, TSF6.* **Processing** - Kim Bore, *PPS1, NEP1,* SSWB33. **Regional** - SSWB18, SSWB21, SSWB22, SSWB23, SSWB25.	Groundwater Quality	**Field:** pH, EC, DO, redox, temp **Physicochemical:** pH, EC, TDS, acidity, total alkalinity, hardness **Major Ions:** Na, K, Ca, Mg, HCO_3, CO_3, Cl, SO_4, NO_3 **Minor ions & dissolved trace metals/ metalloids:** Si, Al, As, Cd, Cr (tot), Cu, Fe, Pb, Mn, Ni, Se, Tl, Te and Zn	Annually Quarterly for TSF and Processing bores (increased to monthly if any triggers are breached)	Annually Quarterly for TSF and Processing bores (increased to monthly if any triggers are breached)
MRC – MRC2. **SSC** – *MS1, MS2, MS3, MS4*, SSC14, SSC20. **SMC** – SMC1.	Surface Water Levels	Depth above the datum (m)	Hourly	Hourly
MRC – MRC2. **SSC** – *MS4*, SSC14. **SMC** – SMC1.	Surface Water Flows	Flow Rate (L/s)	Hourly	Hourly
MRC – MRC2. **SSC** – *MS1, MS2, MS3, MS4*, *TSD*, SSC14, SSC17, SSC20. **SMC** – SMC1. **Background** – *MRC0*, SSC21.	Surface Water Quality	**Field:** pH, EC, DO, redox, temp **Physicochemical:** pH, EC, TDS, acidity, total alkalinity, hardness **Major Ions:** Na, K, Ca, Mg, HCO_3, CO_3, Cl, SO_4, NO_3 **Minor ions & dissolved trace metals/ metalloids:** Si, Al, As, Cd, Cr (tot), Cu, Fe, Pb, Mn, Ni, Se, Tl, Te and Zn **Hydrocarbons:** TPH, BTEX (MS3, MS4, SSC14, and MRC2 only)	Monthly (when water present) Event-based at MRC0 and SSC21.	Quarterly (when water present) Event-based at MRC0 and SSC21.
Note: *Italicised and underlined* site names will be new once the site has been constructed (see **Figure 9**)				

Table 10 Additional Water Monitoring Locations

Catchment	GW / SW	Site Reference	Approximate Location		Purpose
			Easting	Northing	
Sulphur Springs Creek (East)	Surface Water	MS1	729,265	7,659,570	Creek site to monitor inflow rates and quality from upstream of pit.
Sulphur Springs Creek (East)	Surface Water	MS2 (WRD5)	728,805	7,659,540	Creek sites to monitor discharge rates and quality to Sulphur Springs Creek.
Sulphur Springs Creek (East)	Surface Water	MS3 (SED1)	728,715	7,660,620	Creek sites to monitor discharge rates and quality to Sulphur Springs Creek.
Sulphur Springs Creek (East)	Surface Water	MS4 (SED2)	728,365	7,660,860	Creek sites to monitor discharge rates and quality to Sulphur Springs Creek.
Sulphur Springs Creek (East)	Surface Water	TSD	728,215	7,660,420	Surface water site downstream of the topsoil stockpile.
Sulphur Springs Creek (East)	Groundwater	CF1	728,670	7,660,440	Bores to monitor discharge and dewatering impacts along the Creek Fault.
Sulphur Springs Creek (East)	Groundwater	CF2	728,730	7,660,120	Bores to monitor discharge and dewatering impacts along the Creek Fault.
Sulphur Springs Creek (East)	Groundwater	CF3	728,880	7,659,970	Bores to monitor discharge and dewatering impacts along the Creek Fault.
Sulphur Springs Creek (East)	Groundwater	TSF1	730,800	7,659,915	At the toe of the main TSF embankment
Sulphur Springs Creek (East)	Groundwater	TSF2	730,855	7,659,965	In the eastern ridgeline saddle
Sulphur Springs Creek (East)	Groundwater	TSF3	730,750	7,659,865	At the toe of the southern embankment
Sulphur Springs Creek (East)	Groundwater	TSF4	731,190	7,659,865	At the toe of the southern embankment
Sulphur Springs Creek (East)	Groundwater	TSF5	731,415	7,660,150	In two of the western ridgeline saddles
Sulphur Springs Creek (East)	Groundwater	TSF6	729,810	7,660,750	In two of the western ridgeline saddles
Sulphur Springs Creek (East)	Groundwater	NEP1	729,429	7,661,160	Downstream of Northern Evaporation Pond
Minnieritchie Creek	Surface Water	MRC0	731,000	7,659,630	Upstream of the confluence of disturbed and undisturbed sub-catchments of Minnieritchie Creek.
Minnieritchie Creek	Ground water	PPS1	730,540	7,659,620	Downstream of processing plant in Minnieritchie Creek catchment to monitor potential seepage from the SWP.

8.0 Summary of Commitments

Venturex will undertake the commitments detailed in **Table 11**.

Table 11 Summary of Commitments

Environmental Impact/ Issue	Management Commitment
Administration	• The Mine Manager is the responsible person to ensure all aspects of the WMP are undertaken. • Every year, an Annual Monitoring Review (AMR) will be prepared. • This WMP will be reviewed annually following preparation of the AMR.
Groundwater	• Dewatering will be undertaken to minimise abstractions while maintaining a dry and safe working environment in the mine. • Abstraction of groundwater for project make-up supplies from other sources will occur in a way that minimises environmental impacts. • The TSF will have an underdrainage system to intercept seepage and minimise water table mounding. • Seepage-related contingency measures will be initiated if the monitoring results indicate surface water quality triggers have been breached. • PAF materials will be safely stored either in the open pit below the final lake level, or in purpose-designed cells within the WRD to limit the ingress of oxygen and water and generation of acidic discharges to the water table. The PAF cells have been designed to be in the WRD so any seepage that does penetrate the cover will report to the open mine void. Only NAF materials will be placed in the parts of the WRD that extend into the Six Mile Creek catchment. • Before construction commences, obtain a Licence to Take Water for mine dewatering and water supply abstraction.
Surface Water	• Identify opportunities for harvesting surface water within the disturbed footprint to minimise groundwater abstraction and reduce the likelihood of discharges during an extreme event. • Engineer surface water diversion structures, stilling basins and site water ponds to minimise safety-related risks to site workers and minimise changes to downstream environments from areas that may develop low quality runoff. • Sediment basins will be installed at the base of the WRD in each catchment and downstream on Sulphur Springs Creek. In general, the ponds will be designed to hold runoff for a long enough period to reduce the sediment loads. Pond SED1 will contain mine site runoff and spill over into SED2 which is for ensuring the water quality is compatible with background conditions. Water in these ponds that is not suitable for discharge will either evaporate or be pumped back and mixed with the site's water supply system. • The haul roads will be kept clear of any material spillages from haul trucks to avoid contaminating water in the downstream sediment ponds. • The site water ponds will be designed to hold runoff from a 1 in 100-year ARI. The evaporation ponds will be managed to store excess mine water and provide a water source for the mine. The water levels in the ponds will be maintained as low as possible to minimise the potential for overflow. The ponds will include an engineered spill point to ensure they are not damaged from overflow during an extreme rainfall event. • After closure, runoff from the TSF will be directed to the Minnieritchie Creek and Six Mile Creek catchment to minimise risks to safety and geotechnical stability. • Before construction commences, obtain a Bed and Banks Permit for proposed infrastructure along Sulphur Springs Creek.

Table 11 Summary of Commitments (cont.)

Environmental Impact/ Issue	Management Commitment
Unplanned Spills and Emergency Response Plan (ERP)	• Venturex will provide spill response equipment at the site. • All chemicals and fuel storages will be stored within approved bunded areas • All site personnel will receive training on managing spills and the ERP • Regular housekeeping and inspections of potentially contaminating substances. • Venturex will closely manage site activities to minimise the risk of unplanned discharges of hydrocarbons or processing-related chemicals • An Emergency Response Plan will be prepared, approved by DWER and implemented before construction to manage contamination and spills. • All spills will be immediately contained, cleaned up and reported internally.
Monitoring	• Maintain a site water balance to make effective use of monitoring data to optimise future water uses across the site. • Implement the monitoring programme to detect changes to groundwater and surface water levels, quality and abstraction rates to optimise the use of groundwater as a valuable resource in the projects water balance. • Undertake regular reviews of the monitoring data to identify whether any triggers have been reached, or trends indicate there may be an unplanned response. • All abstraction will be metered in accordance with DWER guidelines. • All flow meters will be registered and maintained in accordance with DWER requirements • Monitor the levels and quality of water in the site water ponds to ensure they remain effective barriers to off-site discharges up to a 1 in 100-year ARI event, and remain intact to minimise the release of site water during an extreme event. • Undertake regular inspections and reviews of the TSF to ensure geotechnical integrity of the embankment. • Undertake regular reviews of the health of the downstream riverine environment in conjunction with groundwater and surface water monitoring. • Monitor the levels and quality of stilling basins to ensure discharged stormwater does not affect the downstream environment. • Monitor the quality of groundwater sourced for potable uses in line with appropriate drinking water guidelines in line with Department of Health requirements.

Table 11 Summary of Commitments (cont.)

Environmental Impact/ Issue	Management Commitment
Contingencies	• Failure of any flow meter – repair or replace faulty flow meters in line with manufacturer's specifications. • Damage to monitoring bores or sites – repair or replace the bore or site infrastructure to re-establish the monitoring capability. • Shortfall in project water demands from mine dewatering – equip and abstract the shortfall from existing water supply bores. • Excess in dewatering volumes over and above the projects water needs – review the site water balance to confirm the excess volumes, and that they are still within the design tolerance of the evaporation ponds to manage the excess. • Shortfall in project water demands from mine dewatering and existing water supply bores – drill for and install additional bores at sites identified previously. • If drawdown from the mine extends out of the Sulphur Springs Creek mine catchment – investigate the cause and assess the implications of continued drawdown on any sensitive receptors. • If a baseline trigger is reached, a Level 1 response will be implemented. • If an environmental impact is likely, a Level 2 response will be implemented. • If an unplanned leak or spill is detected, a Level 3 response will be implemented.
Closure	During the operational phase, closure planning will focus on: • The WRD and TSF landform designs to minimise erosion and sediment loads with runoff, so site discharges will not cause unacceptable impacts to the surrounding environment. Sediment control will be included in the infrastructure designs during the closure phase. • Rehabilitation trials will be undertaken on the WRD and TSF to finalise landform and cover designs and finalise closure criteria. • Refine designs for runoff from catchments above the final void to ensure the pit lake remains a terminal sink. • The presence and properties of the Creek Fault downstream of the pit to refine constraints associated with a suitable pit lake level that maintains a terminal sink. • Whether solute accumulation in the TSF is likely to adversely affect the quality of water in the pit lake after closure.

9.0 References

AECOM, 2019a. Sulphur Springs Hydrogeological Assessment. Unpublished report to Venturex Sulphur Springs Pty Ltd. Document Ref: 60447561_ENV_RPT_005.0

AECOM, 2019b. Sulphur Springs Surface Water Assessment. Unpublished report to Venturex Sulphur Springs Pty Ltd. Document Ref: 60447561_ENV_RPT_006.0

AECOM, 2019c. Sulphur Springs Water Balance Assessment. Unpublished report to Venturex Sulphur Springs Pty Ltd. Document Ref: 60447561_ENV_RPT_007.0

ANZECC & ARMCANZ, (2000). Australian and New Zealand Environmental and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand (ANZECC and ARMCANZ).2000, National Water Quality Management Strategy: Australian and New Zealand Guidelines for Freshwater and Marine Water Quality, Australian Water Association, Canberra.

Atlas Iron, 2017. Atlas Abydos Link Road East - Annual Water Report 2016/2017. Unpublished report by Atlas Iron Pty Ltd, Section 4, Revision 2, dated 25 August 2017.

BoM, 2017. Southern Hemisphere Tropical Cyclone Data Portal. Published online by the Bureau of Meteorology at: http://www.bom.gov.au/cyclone/history/tracks/index.shtml. Accessed: 9 October 2017

BoM, 2018. Climate data sourced from the Bureau of Meteorology website at: http://www.bom.gov.au/climate/data/. Access on 16 April 2018.

Cook et. al. 2017. Groundwater age, mixing and flow rates in the vicinity of large open pit mines, Pilbara Region, North-western Australia. Published in the Hydrogeology Journal, Vol 25, No. 1, February 2017.

DER, 2017. Identification, reporting and classification of contaminated sites in Western Australia. Contaminated Sites Guidelines. Published by the Western Australian Department of Environment Regulation, June 2017.

DoW, 2009. Hydrogeological Reporting Associated with a Groundwater Well Licence. Operational Policy No. 5.12, November 2009.

DoW, 2010. Stormwater management at industrial sites. Water quality protection note 52, May 2010.

DoW, 2013a. West Australian Water in Mining Guideline. Water Licensing Delivery Series, Report No. 12, May 2013.

DoW, 2013b. Liners for containing pollutants, using synthetic membranes. Water quality protection note 26, August 2013.

DoW, 2013c. Liners for containing pollutants, using engineered soils. Water quality protection note 27, August 2013.

DoW, 2013d. Pilbara Water Allocation Plan. Department of Water, Water resource allocation and planning report series Report no 55, October 2013.

DoW, 2016. Information the Department of Water requires to assess a proposed development or activity. Water quality protection note no. 18, January 2016.

GCA, 2012a. Pilbara Copper-Zinc Project: Geochemical Characterisation of Mine-Waste Samples (Sulphur Springs Deposit) – Implications for Mine-Waste Management. Graeme Campbell & Associates Pty Ltd, report dated 29/11/2012

GCA, 2012b. Pilbara Copper-Zinc Project: Geochemical Characterisation of Process-Tailings-Slurry Samples (Sulphur Springs and Mons Cupri Deposits) – Implications for Process-Tailings Management. Graeme Campbell & Associates Pty Ltd, report dated 29/11/2012

Knight Piesold, 2016. Tailings Storage Facility and Heap Leach Pad Preliminary Design. Unpublished report to Venturex dated 31 October 2016. Report Ref. PE801-00300_02.

Knight Piesold, 2018. Tailings Management and Heap Leach Facility Preliminary Design. Unpublished draft report prepared for Venturex Resources Lt. Document Ref: PE801-00300/05, Rev A, May 2018.

Mattiske (2007) A review of the Flora and Vegetation and an Assessment of Groundwater Dependent Ecosystems in the Panorama Project Survey Area. Prepared for URS Australia Pty Ltd, September 2007.

Mattiske (2018) A review of the Flora and Vegetation – Sulphur Springs Zinc Copper Project. Prepared for Venturex Resources Ltd, March 2018.

MBS, 2016. Sulphur Springs Zinc-Copper Project EPA Referral Supporting Document. Unpublished report prepared for Venturex Resources Ltd dated 9 December 2016.

MBS, 2019a. ERD: Tailings Geochemistry. Unpublished memorandum prepared for Venturex Resources Ltd, dated 9 June 2019.

MBS, 2019b. Pit Lake Water Quality – Pit Overflow Source Concentrations. Unpublished memorandum prepared for AECOM Australia Pty Ltd, dated 10 June 2019.

NUDLC, 2012. Minimum Construction Requirements for Water Bores in Australia. Published by the National Uniform Drillers Licensing Committee, Third Edition, 2012. ISBN 978-0-646-56917-8.

NHMRC & NRMMC, 2011. Australian Drinking Water Guidelines Paper 6 National Water Quality Management Strategy. National Health and Medical Research Council, National Resource Management Ministerial Council, Commonwealth of Australia, Canberra. Version 3.1 updated March 2015.

O'Kane, 2017. Sulphur Springs Conceptual TSF Cover Design. Draft memorandum to Venturex Resources Ltd, dated 8 May 2017. Document reference: 1031/01.

O'Kane, 2019. Sulphur Springs Tailings Storage Facility Conceptual Cover Design Performance Modelling and Geochemical Amendments Review. Unpublished memorandum to Venturex Resources Ltd dated 29 May 2019. Document reference: B-1031-02_01_Rev0.

URS, 2007a. Geochemical Assessment of Waste Rock and Tailings: Addendum Letter Report – Sulphur Content of Tailings in Surface Storage Facilities at Selected Mines in Australia. Unpublished letter report dated 2/10/2007. Document Ref. R001-G

URS, 2007b. Panorama Copper-Zinc Project. Geochemical Assessment of Waste Rock and Tailing Materials. Conceptual WRD Design and TSF Cover Design Strategy. Unpublished report dated 5/10/2007. Report Ref. 021007.

URS, 2013a. Pilbara Cu-Zn Project Surface Water Management Plan. Unpublished report dated 15/3/2013. Report Ref. 42908251/W0773.765/0.

URS, 2013b. Underground Mine Dewatering Requirements. Unpublished draft report dated 22/03/2013. Report Ref. 42907831/W0633/B.

Venturex, 2013. Venturex Sulphur Springs Pty Ltd, Sulphur Springs Copper-Zinc Project, Mining Proposal. Unpublished submission to the WA Department of Mines and Petroleum, dated July 2013.

10.0 Report Limitations

AECOM Australia Pty Limited (AECOM) has prepared this report in accordance with the usual care and thoroughness of the consulting profession for the use of Venturex Sulphur Springs Pty Ltd and only those third parties who have been authorised in writing by AECOM to rely on the report.

It is based on generally accepted practices and standards at the time it was prepared. No other warranty, expressed or implied, is made as to the professional advice included in this report. It is prepared in accordance with the scope of work and for the purpose outlined in the contract dated July 2017.

The methodology adopted and sources of information used by AECOM are outlined in this the Report.

Where this report indicates that information has been provided to AECOM by third parties, AECOM has made no independent verification of this information unless required as part of the agreed scope of work. AECOM assumes no liability for any inaccuracies in or omissions to that information.

This Report was prepared between April 2018 and January 2020. The information in this report is considered to be accurate at the date of issue and is in accordance with conditions at the site at the dates sampled. Opinions and recommendations presented herein apply to the site existing at the time of our investigation and cannot necessarily apply to site changes of which AECOM is not aware and has not had the opportunity to evaluate. This document and the information contained herein should only be regarded as validly representing the site conditions at the time of the investigation unless otherwise explicitly stated in a preceding section of this report. AECOM disclaims responsibility for any changes that may have occurred after this time.

This report should be read in full. No responsibility is accepted for use of any part of this report in any other context or for any other purpose or by third parties. This report does not purport to give legal advice. Legal advice can only be given by qualified legal practitioners.

This report contains information obtained by inspection, sampling, testing or other means of investigation. This information is directly relevant only to the points in the ground where they were obtained at the time of the assessment. The borehole logs indicate the inferred ground conditions only at the specific locations tested. The precision with which conditions are indicated depends largely on the uniformity of conditions and on the frequency and method of sampling as constrained by the project budget limitations. The behaviour of groundwater and some aspects of contaminants in soil and groundwater are complex. Our conclusions are based upon the analytical data presented in this report and our experience. Future advances in regard to the understanding of chemicals and their behaviour, and changes in regulations affecting their management, could impact on our conclusions and recommendations regarding their potential presence on this site.

Where conditions encountered at the site are subsequently found to differ significantly from those anticipated in this report, AECOM must be notified of any such findings and be provided with an opportunity to review the recommendations of this report.

Whilst to the best of our knowledge information contained in this report is accurate at the date of issue, subsurface conditions, including groundwater levels can change in a limited time.

Therefore, this document and the information contained herein should only be regarded as valid at the time of the investigation unless otherwise explicitly stated in this report.

Except as required by law, no third party may use or rely on, this Report unless otherwise agreed by AECOM in writing. Where such agreement is provided, AECOM will provide a letter of reliance to the agreed third party in the form required by AECOM.

To the extent permitted by law, AECOM expressly disclaims and excludes liability for any loss, damage, cost or expenses suffered by any third party relating to or resulting from the use of, or reliance on, any information contained in this Report. AECOM does not admit that any action, liability or claim may exist or be available to any third party.

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Any estimates of potential costs which have been provided are presented as estimates only as at the date of the Report. Any cost estimates that have been provided may therefore vary from actual costs at the time of expenditure.

Figures

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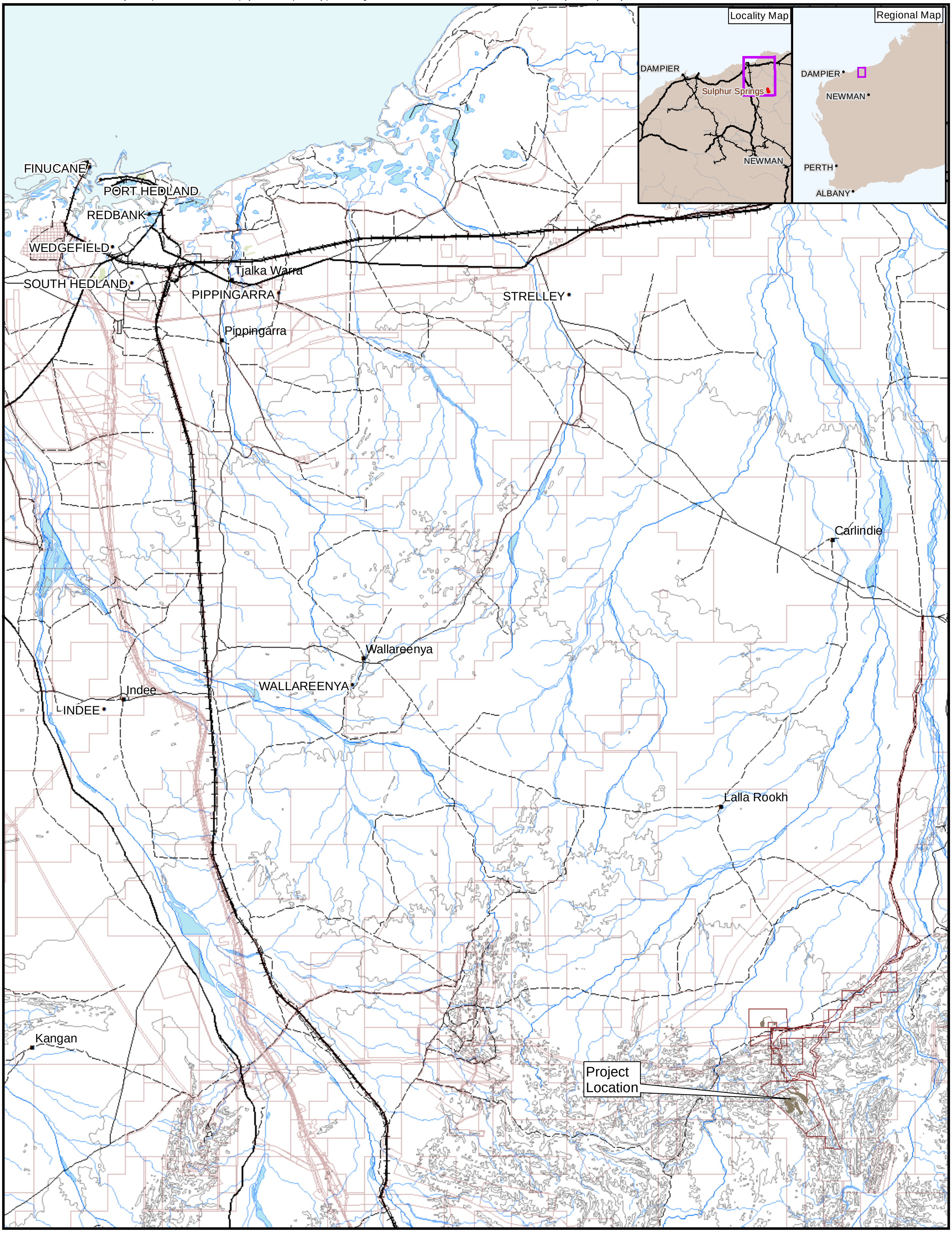

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APPROVED BY	R.WALLIS
LAST MODIFIED	17 JAN 2020

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N

DATUM GDA 1994, PROJECTION MGA ZONE 50

0 5 10 15 20
Kilometers

Data sources:

Base Data: (c) Based on information provided by and with the permission of the Western Australian Land Information Authority trading as Landgate (2010).

LEGEND

- Site Layout (2020)
- Project Tenements
- Tenements
- Lakes
- Parks
- Railways
- Principal Road
- Road
- Track
- Contours
- Contours

Project Locality Map

VENTUREX SULPHUR SPRINGS PTY LTD

SULPHUR SPRINGS PROJECT WATER MANAGEMENT PLAN

Figure

1

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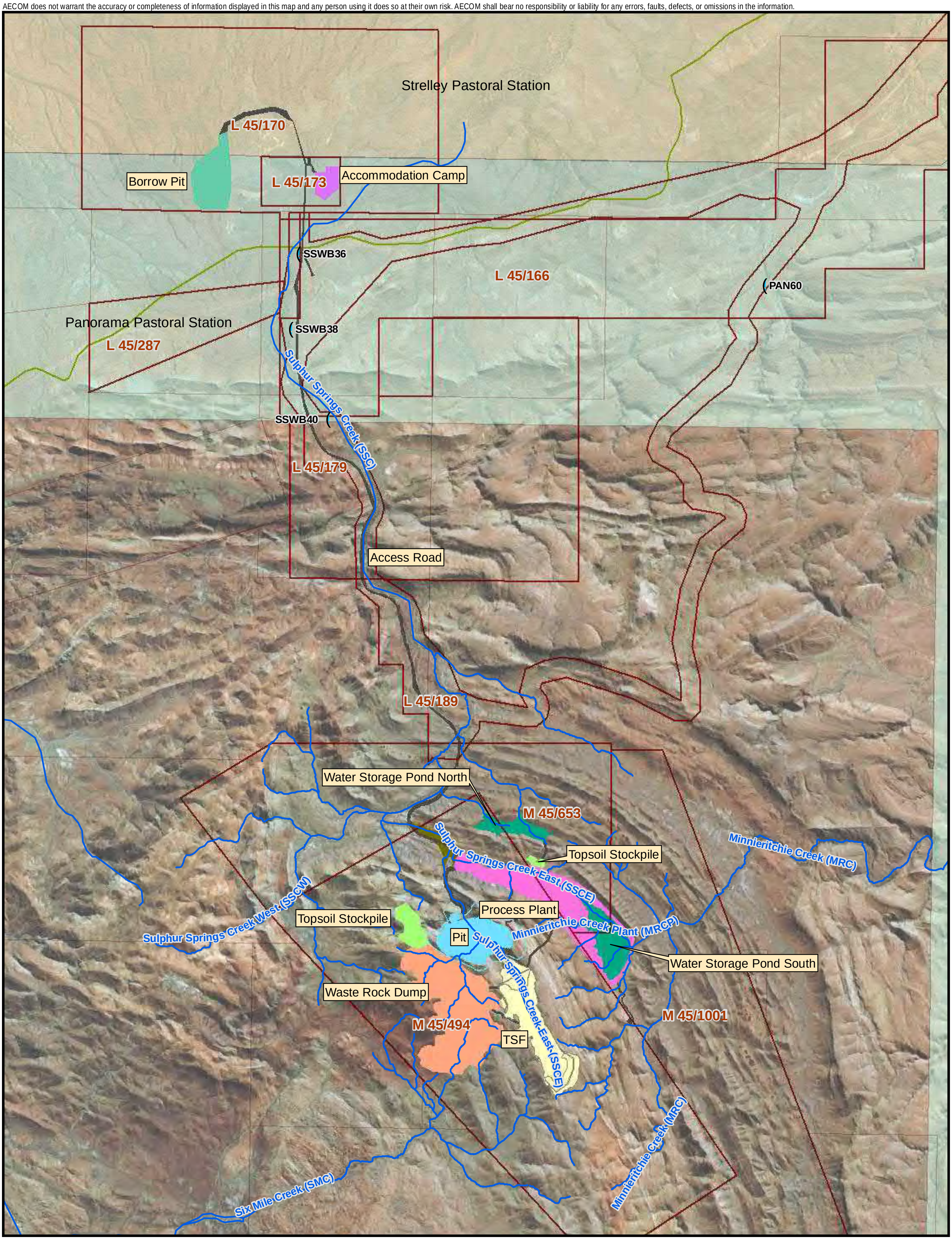

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DATUM GDA 1994, PROJECTION MGA ZONE 50

0 500 1,000 1,500 2,000
Meters

Data sources:Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Base Data: (c) Based on information provided by and with the permission of the Western Australian Land Information Authority trading as Landgate (2010).

LEGEND

- Abydos Mine Access Road Bores
- Project Tenements
- Tenements
- Panorama Pastoral Station
- Strelley Pastoral Station
- Borrow Pit
- Pit
- Process Plant
- Sediment Pond
- Site Access Roads
- Topsoil Stockpile
- TSF
- Village
- Water Storage Pond
- Waste Rock Dump

Proposed Infrastructure

VENTUREX SULPHUR SPRINGS PTY LTD

SULPHUR SPRINGS PROJECT WATER MANAGEMENT PLAN

Figure 2

Map Document: P:\605X\60547561\4. Tech Work Area\4.99 GIS\02_MXDs\10_GWM_Combined_TSFv2\G60547561_WMP_Fig 2_ProposedInfrastructure_v1_A4P.mxd (kai.du)

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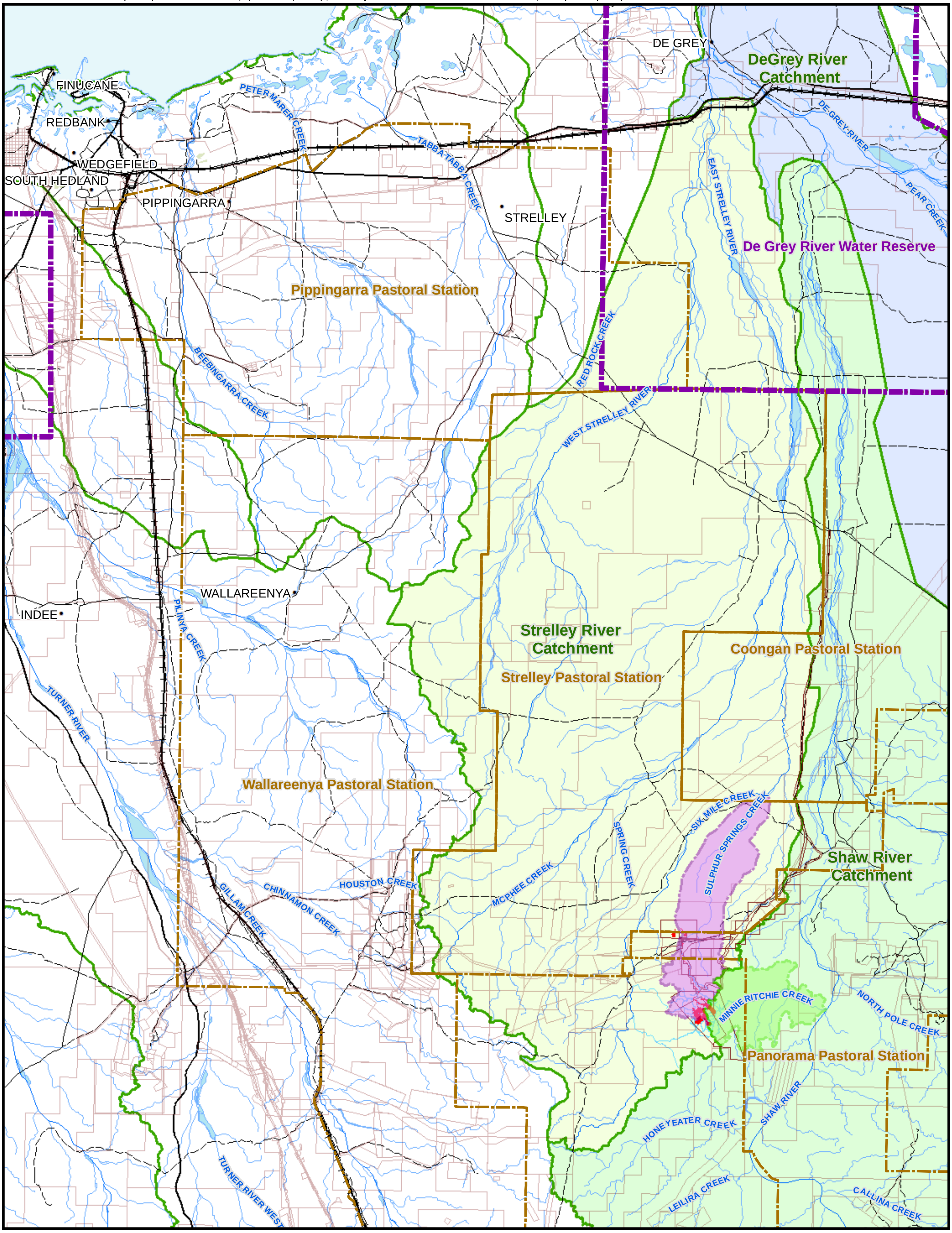

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DATUM GDA 1994, PROJECTION MGA ZONE 50
0 5 10 15 20
Kilometers

Data sources:
Base Data: (c) Based on information provided by and with the permission of the Western Australian Land Information Authority trading as Landgate (2010).

LEGEND

- Site Layout (2020)
- DeGrey River Catchment
- Shaw River Catchment
- Strelley River Catchment
- Minnieritchie Creek Catchment
- Sulphur Springs Creek Catchment
- Project Tenements
- Tenements
- Pastoral Lease Boundary
- Lakes
- Parks
- Railways
- Principal Road
- Road
- Track

Public Drinking Water Source Areas
- Groundwater

Regional Drainage Map

VENTUREX SULPHUR SPRINGS PTY LTD

SULPHUR SPRINGS PROJECT WATER MANAGEMENT PLAN

Figure
3

Map Document: P:\605X\60547561\4. Tech Work Area\4.99 GIS\02_MXDs\10_GWM_Combined_TSFv2\G60547561_WMP_Fig 3_RegionalCatchment_v1_A4P.mxd (kai.du)

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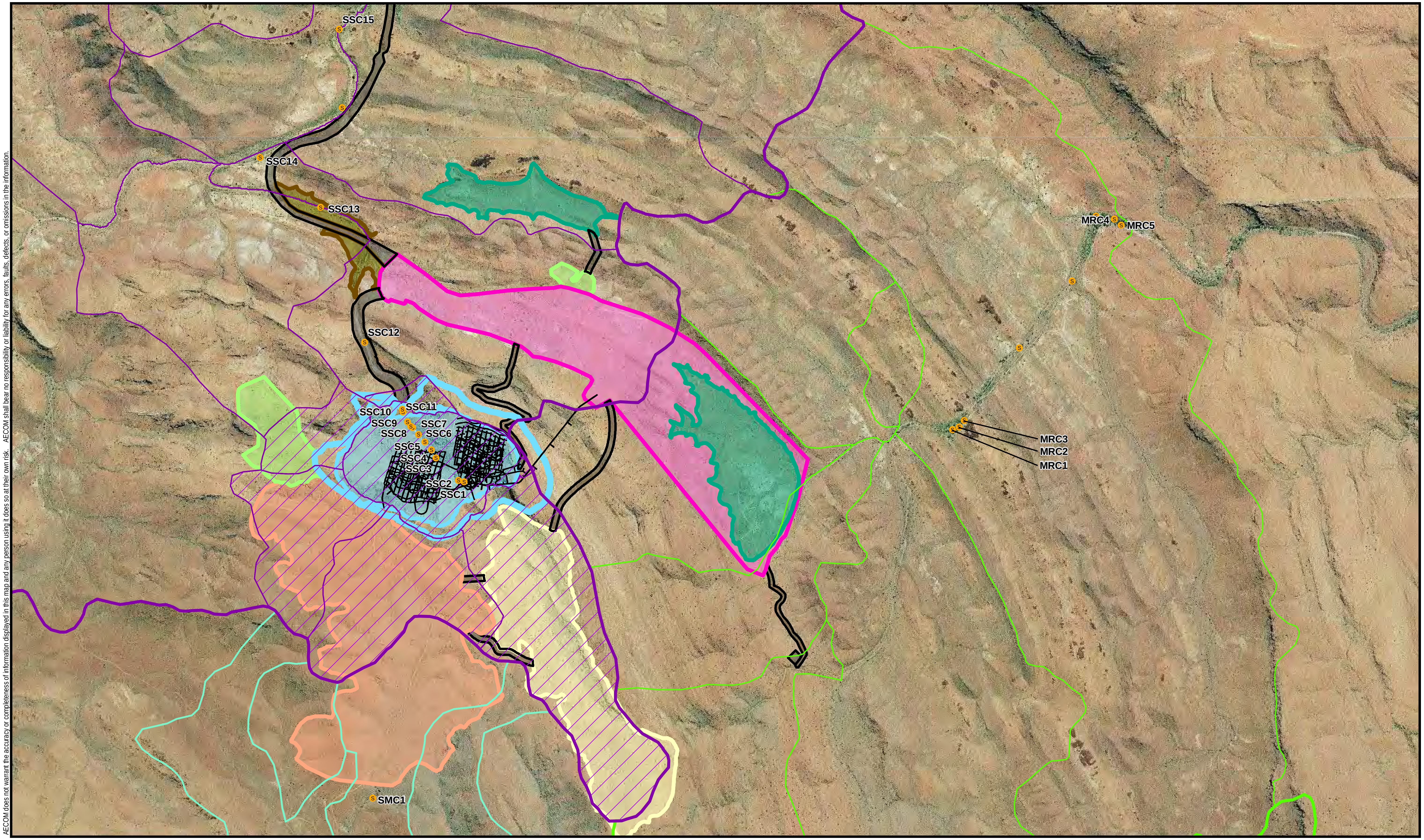

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DATUM GDA 1994, PROJECTION MGA ZONE 50

0 100 200 300 400

Meters

Data sources:Panorama, URS

Base Data: (c) Based on information provided by and with the permission of the Western Australian Land Information Authority trading as Landgate (2010); Geoscience Australia; Streetpro

LEGEND

- Surface Water Pools
- Minnieritchie Creek Catchment
- Minnieritchie Creek Sub-Catchment
- Pit Catchment
- Pit Sub-Catchment
- Six Mile Creek Sub-Catchment
- Sulphur Springs Creek Catchment
- Sulphur Springs Creek Sub-Catchment

Domains

- Pit
- Process Plant
- Sediment Pond
- Site Access Roads
- Topsoil Stockpile
- TSF
- Water Storage Pond
- Waste Rock Dump

Mine Area Drainage Map

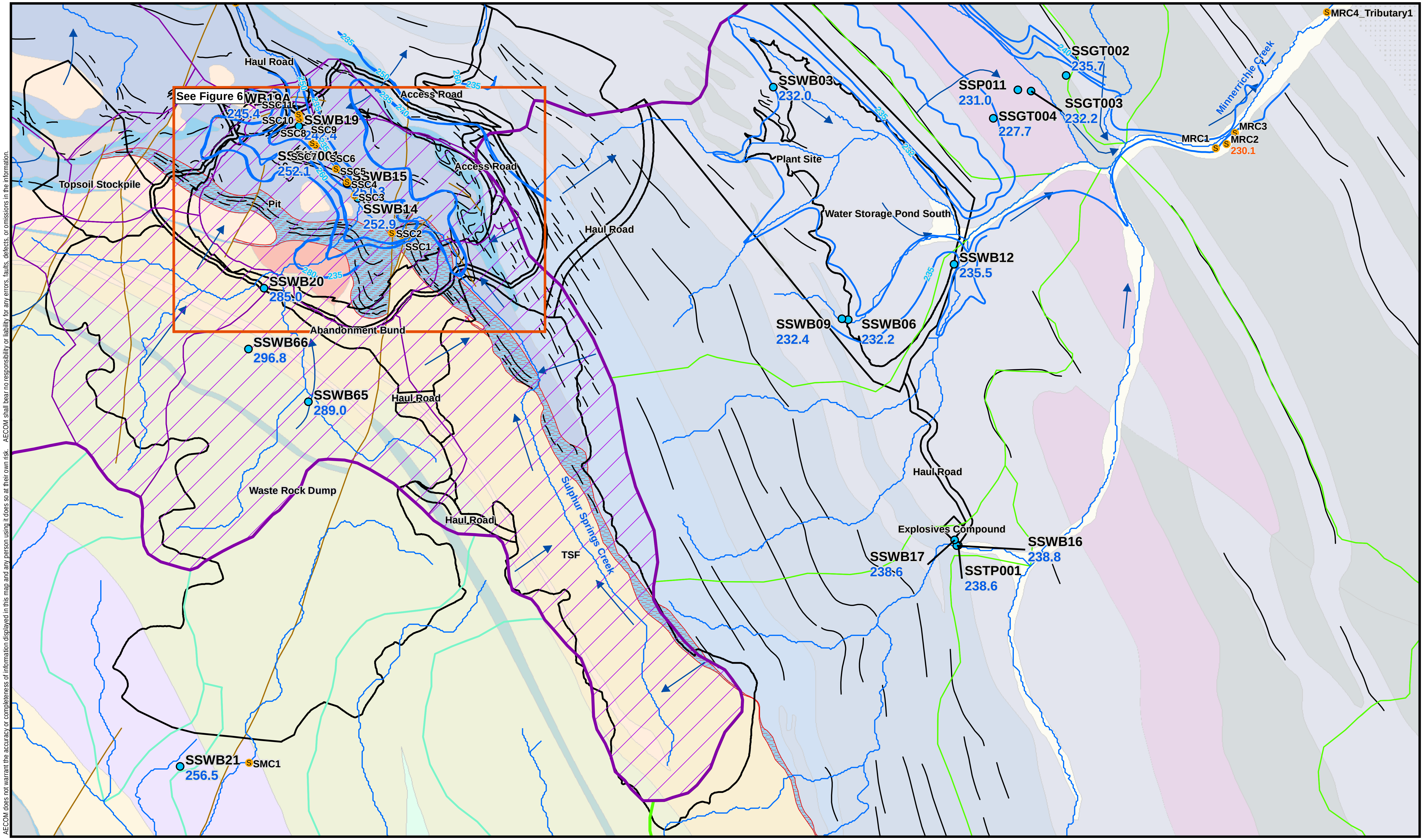
VENTUREX SULPHUR SPRINGS PTY LTD

SULPHUR SPRINGS PROJECT
WATER MANAGEMENT PLAN

Figure
4

Map Document: P:\605X\60547561\4. Tech Work Area\4.99 GIS\02_MXDs\10_GWM_Combined_TSFv2\G60547561_WMP_Fig 4_MineAreaDrainage_v1_A3L.mxd (kai.du)

A3 size



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DATUM GDA 1994, PROJECTION MGA ZONE 50
0 100 200 300 400
Meters

Data sources:CBH, URS, Venturex

Base Data: (c) Based on information provided by and with the permission of the Western Australian Land Information Authority trading as Landgate (2010); Geoscience Australia; Streetpro

LEGEND

- Surface Water Pools
- 175.44 Surface Water Levels, 2017
- Wet Season Groundwater Levels
- 360.5 Wet Season Groundwater Level (2007-2012)
- Inferred Groundwater Flowpath
- Inferred Groundwater Elevation Contours (m AHD)
- Geological Structures
- Faults
- Proposed Infrastructure Footprint
- Subcrop Distribution of Marker Chert
- Minnieritchie Creek Catchment
- Minnieritchie Creek Sub-Catchment
- Pit Catchment
- Pit Sub-Catchment
- Six Mile Creek Sub-Catchment
- Sulphur Springs Creek Catchment
- Sulphur Springs Creek Sub-Catchment

Geology

- Dolerite - microdiorite
- Microdiorite
- Felsic andesite
- Alluvium
- Laterite
- Gossan
- Polymict breccia (Sulphur Springs)
- Quartzite
- Sandstone, subordinate siltstone
- Chert
- Rhyolite, mainly coherent
- Dacite, mainly coherent
- Andesite hyaloclastite
- Andersite, basalt
- Dolerite - gabbro
- Pyroxenite, peridotite
- Siltstone, BIF and subordinate sandstone

Note: Groundwater level data in the pit area measured in Oct/Nov 2012; elsewhere they were measured in 2007

Project Area Hydrogeology (Wet Season)

VENTUREX SULPHUR SPRINGS PTY LTD

SULPHUR SPRINGS PROJECT WATER MANAGEMENT PLAN

Figure
5

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Map Document: P:\605X\60547561\4. Tech Work Area\4.99 GIS\02_MXDs\10_GWM_Combined_TSFv2\G60547561_WMP_Fig 5_ProjectAreaHydrogeology_v2_A3L.mxd (kai.du)

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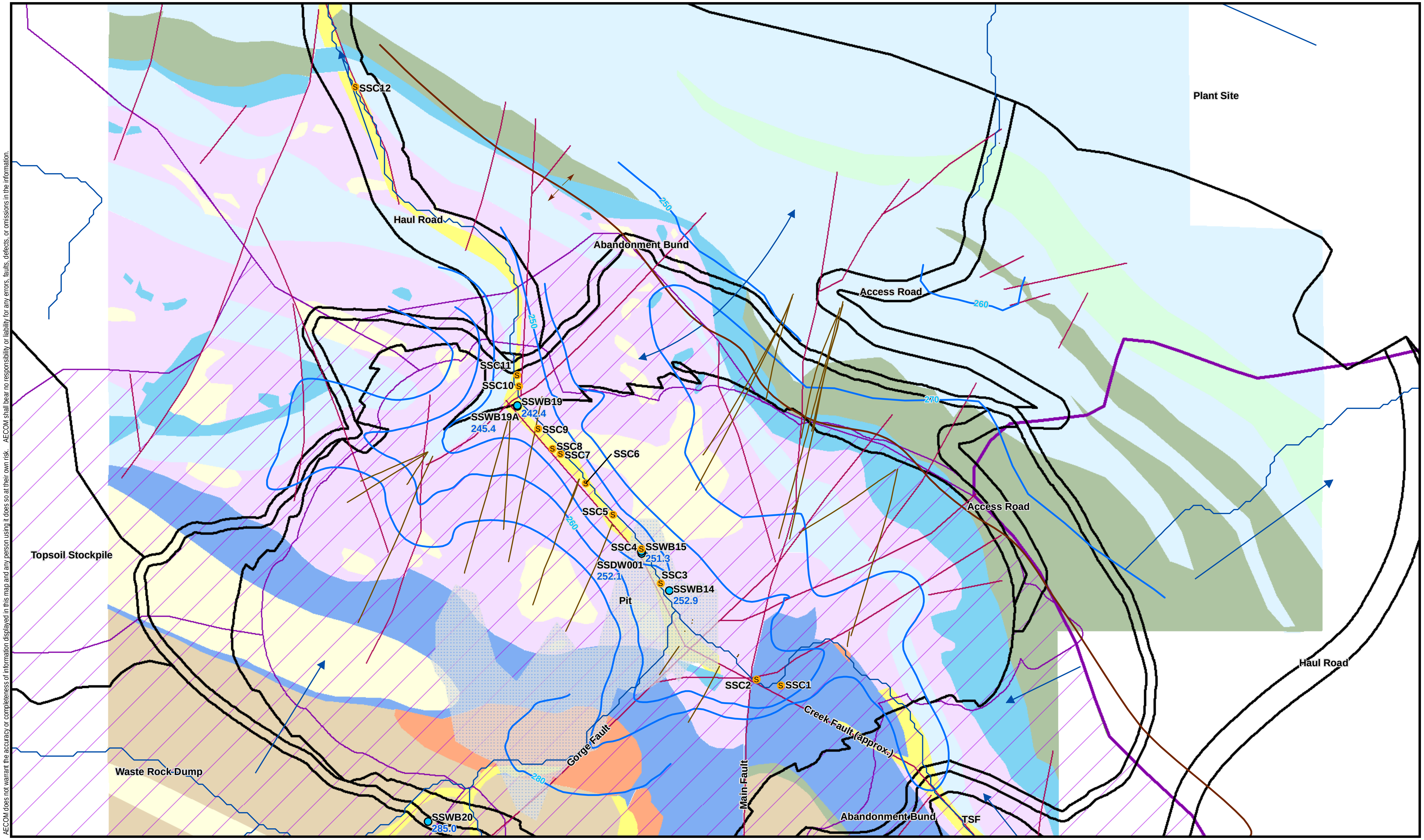

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DATUM GDA 1994, PROJECTION MGA ZONE 50

0 50 100 150 200

Meters

Data sources:URS, Venturex

Base Data: (c) Based on information provided by and with the permission of the Western Australian Land Information Authority trading as Landgate (2010); Geoscience Australia; Streetpro

LEGEND

- Surface Water Pools
- Wet Season Groundwater Levels
- 360.5 Wet Season Groundwater Level
- Inferred Groundwater Flowpath
- Inferred Groundwater Elevation Contours Oct/Nov 2012 (m AHD)
- Borehole Traces
- Faults
- Divide
- Drainage Divide
- Key Drainage Features
- Void
- Proposed Infrastructure Footprint
- Minnieritchie Creek Catchment
- Minnieritchie Creek Sub-Catchment
- Pit Catchment
- Pit Sub-Catchment
- Sulphur Springs Creek Catchment
- Sulphur Springs Creek Sub-Catchment

Geology

- Sandstone
- Upper chert
- Marker chert
- Polymict breccia
- Rhyodacite
- Siltstone
- Ore Body
- Dacite
- Undifferantiated 1
- Undifferantiated 2

Mine Site Hydrogeology (Wet Season)

VENTUREX SULPHUR SPRINGS PTY LTD

SULPHUR SPRINGS PROJECT WATER MANAGEMENT PLAN

Figure

6

Map Document: P:\605X\60547561\4. Tech Work Area\4.99 GIS\02_MXDs\10_GWM_Combined_TSFv2\G60547561_WMP_Fig 6_MineSiteHydrogeology_v1_A3L.mxd (kai.du)

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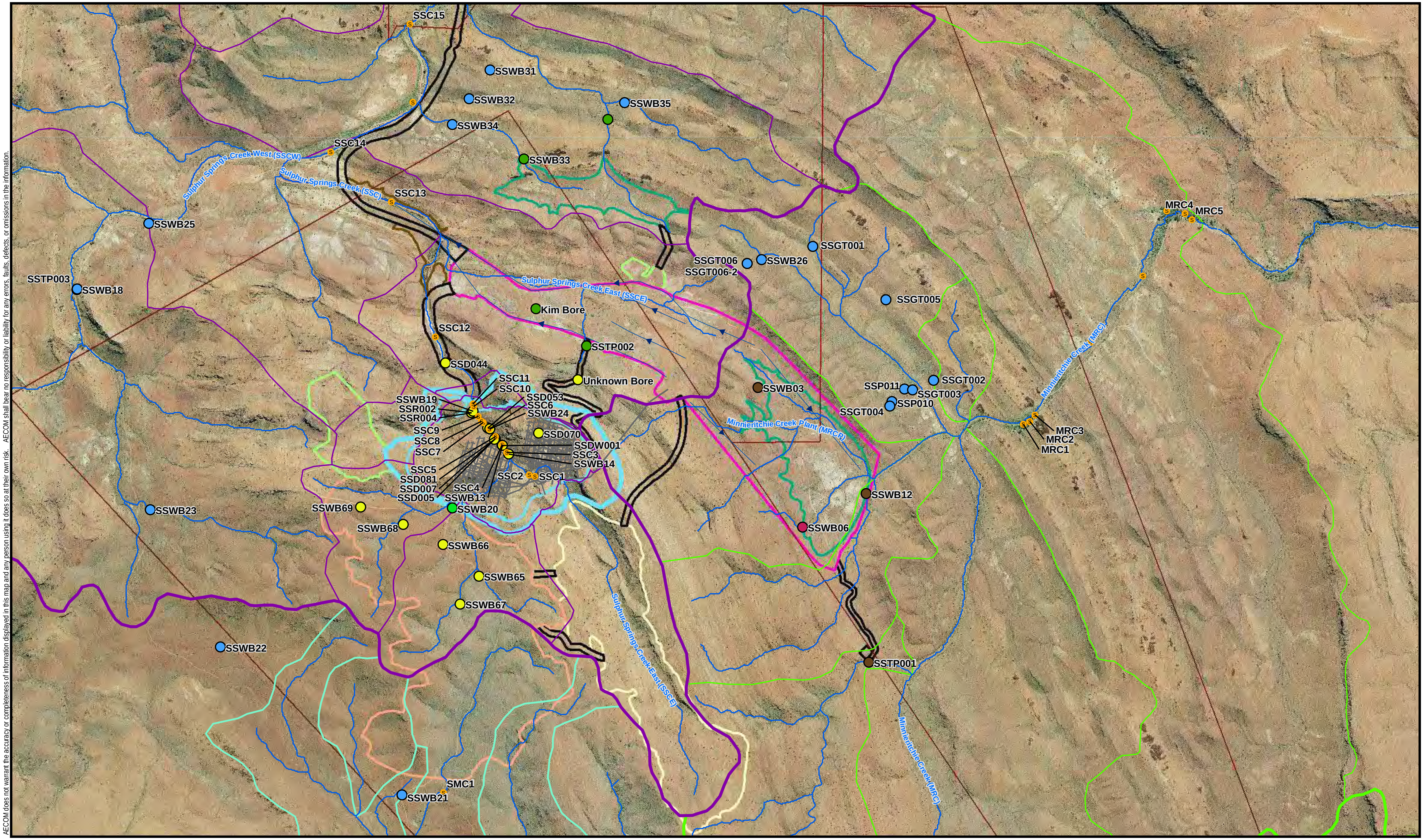

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DATUM GDA 1994, PROJECTION MGA ZONE 50

0 100 200 300 400

Meters

Data sources:Panorama, URS

Base Data: (c) Based on information provided by and with the permission of the Western Australian Land Information Authority trading as Landgate (2010); Geoscience Australia; Streetpro

LEGEND

Domains
- Pit
- Process Plant
- Sediment Pond
- Site Access Roads
- Topsoil Stockpile
- TSF
- Water Storage Pond
- Waste Rock Dump

- Mine Site Observation Bore
- Mine Site Production Bore
- Processing Area Observation Bore
- Processing Area Production Bore
- Regional Production Bore
- Regional Observation Bore

- Surface Water Pools
- Project Tenements

Mine Site Groundwater Bores and Surface Water Pool Locations

VENTUREX SULPHUR SPRINGS PTY LTD

SULPHUR SPRINGS PROJECT WATER MANAGEMENT PLAN

Figure

7

Map Document: P:\605X\60547561\4. Tech Work Area\4.99 GIS\02_MXDs\10_GWM_Combined_TSFv2\G60547561_WMP_Fig 7_MineSiteGWBoresPools_v1_A3L.mxd (kai.du)

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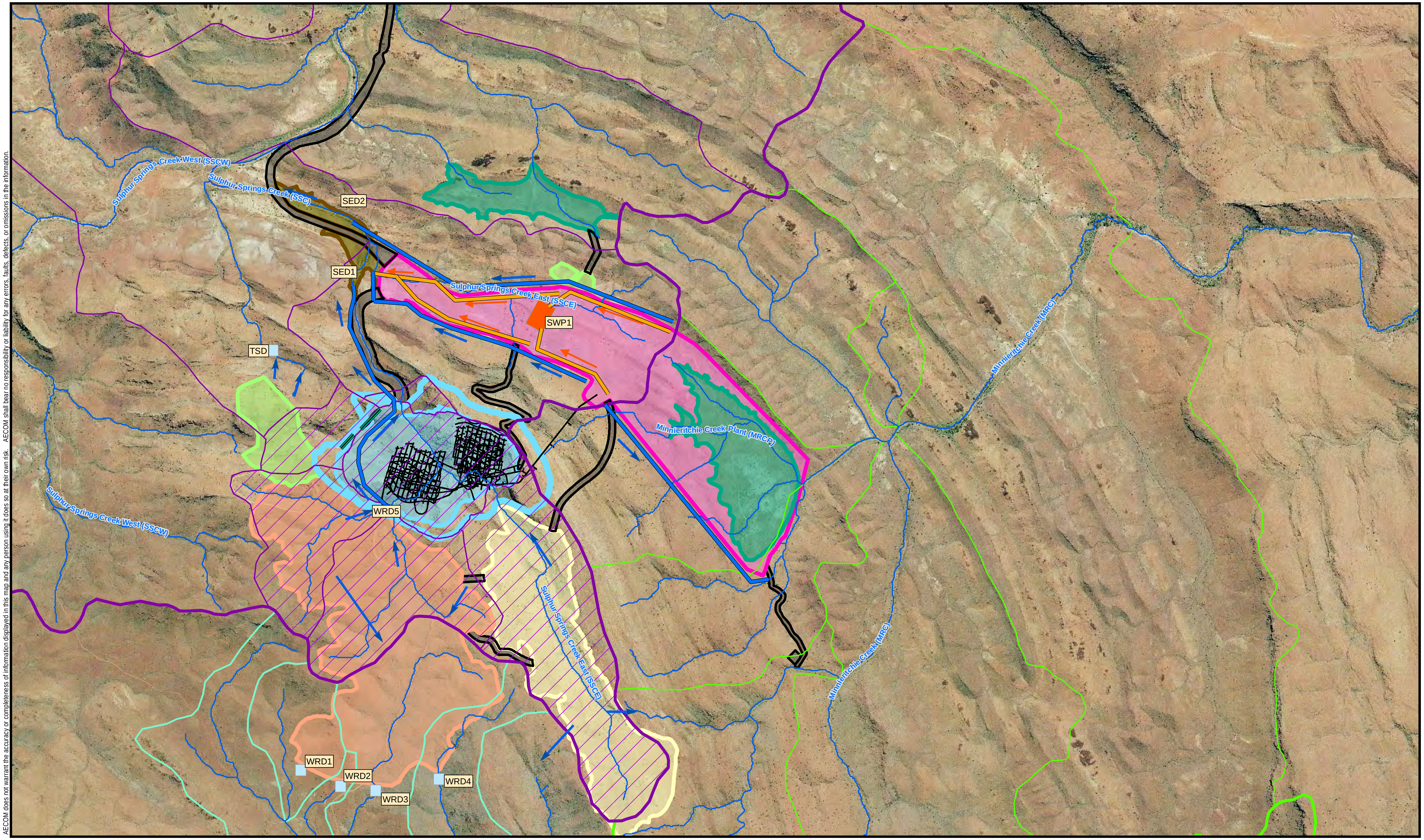

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DATUM GDA 1994, PROJECTION MGA ZONE 50
0 100 200 300 400
Meters

Data sources:Panorama, URS

Base Data: (c) Based on information provided by and with the permission of the Western Australian Land Information Authority trading as Landgate (2010); Geoscience Australia; Streetpro

LEGEND

- Key Drainage Features
- Minnieritchie Creek Catchment
- Minnieritchie Creek Sub-Catchment
- Pit Catchment
- Pit Sub-Catchment
- Six Mile Creek Sub-Catchment
- Sulphur Springs Creek Catchment
- Sulphur Springs Creek Sub-Catchment

Domains

- Pit
- Process Plant
- Sediment Pond
- Site Access Roads
- Topsoil Stockpile
- TSF
- Water Storage Pond
- Waste Rock Dump

Recommended Water Management Infrastructure

- Surface Water Diversion Bund
- Surface Water Drainage Channel
- Surface Water Flow Direction
- Process Area Stormwater Drainage Channel
- Process Area Stormwater Drainage Direction
- Process Area Stormwater Pond
- Sediment Pond

Proposed Water Management During Operations

VENTUREX SULPHUR SPRINGS PTY LTD

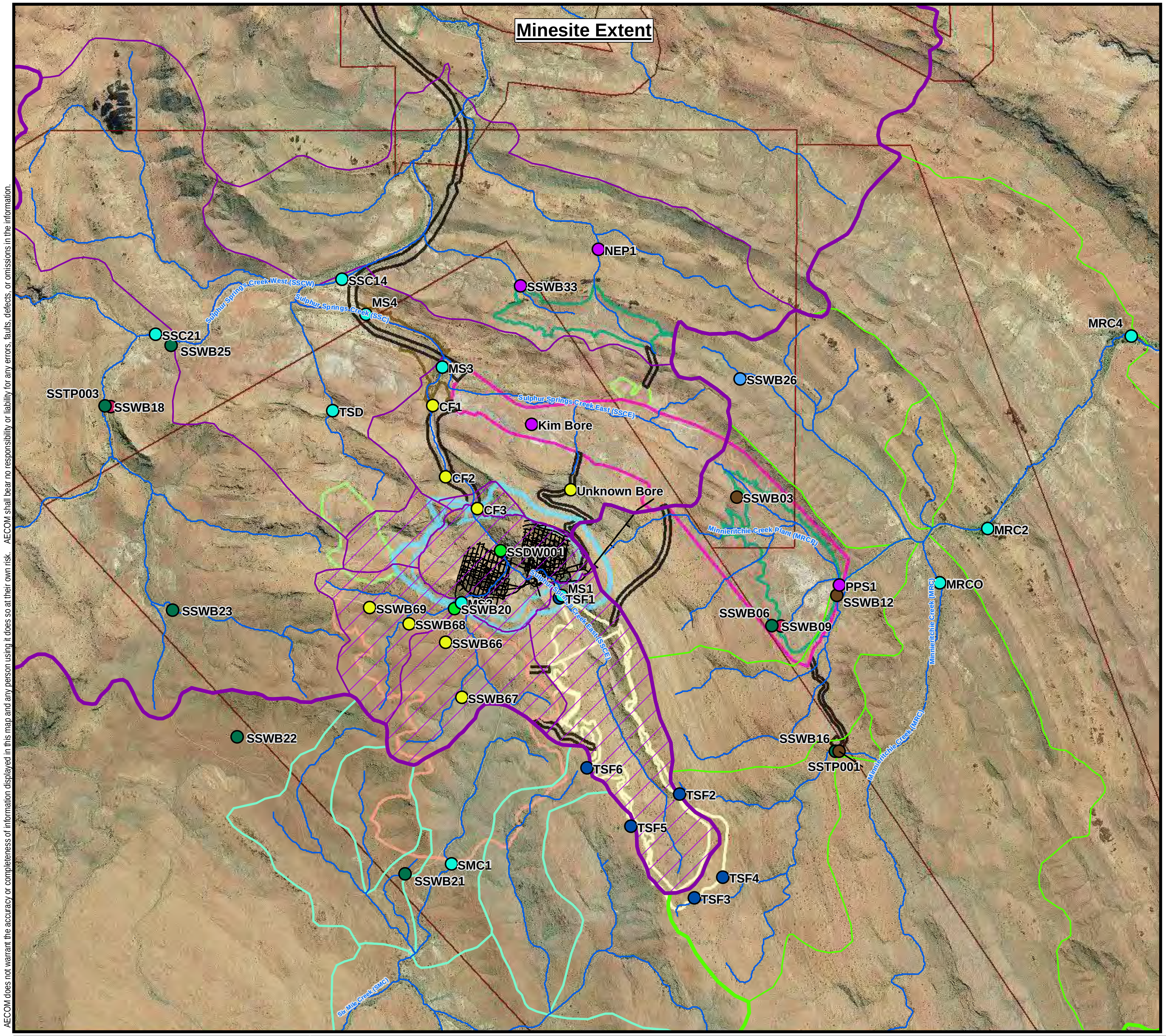
SULPHUR SPRINGS PROJECT WATER MANAGEMENT PLAN

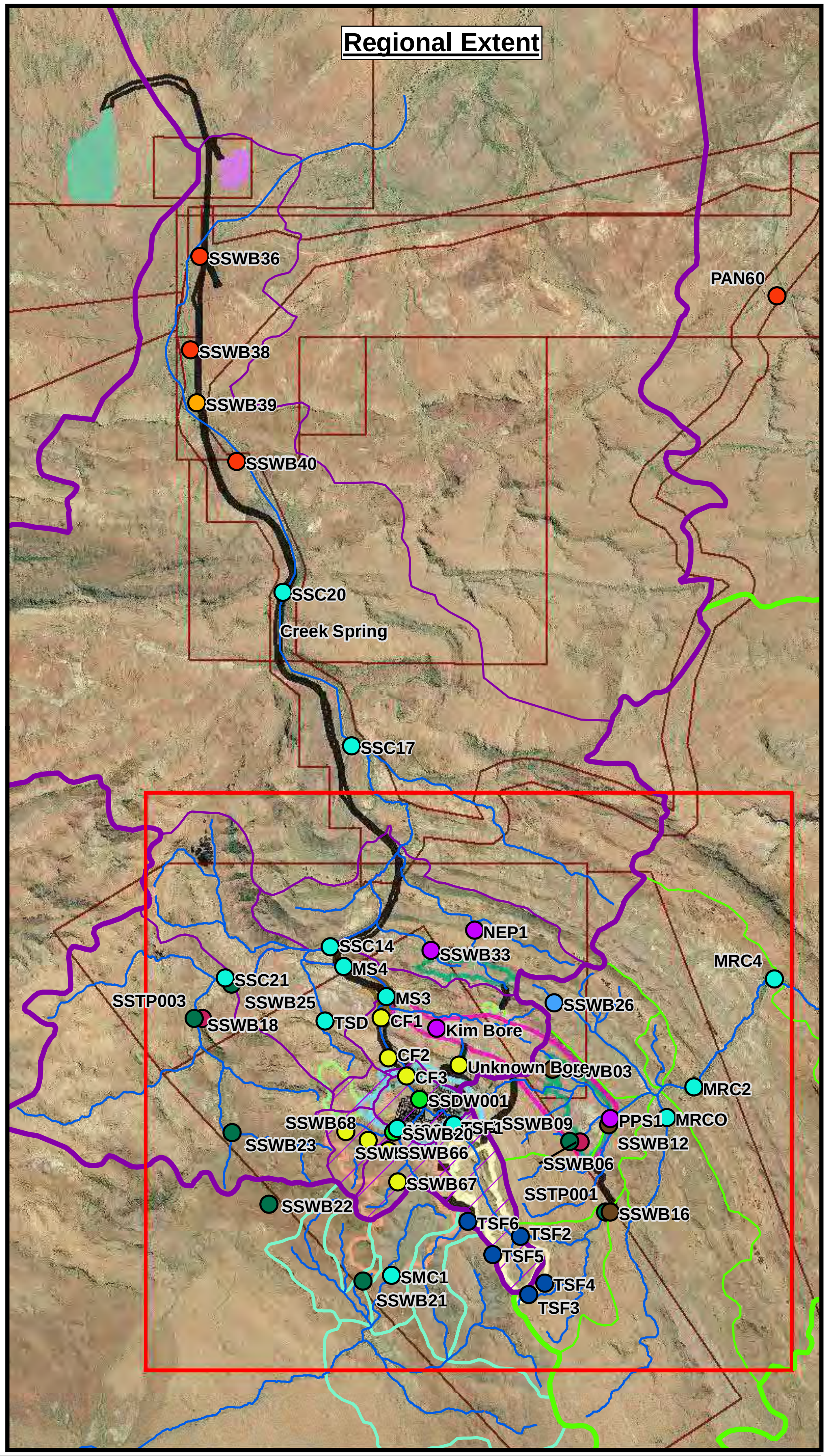
Figure

8

Map Document: P:\605X\60547561\4. Tech Work Area\4.99 GIS\02_MXDs\10_GWM_Combined_TSFv2\G60547561_WMP_Fig 8_WaterMgtInfrastructure_v3_A3L.mxd (kai.du)

A3 size





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DATUM GDA 1994, PROJECTION MGA ZONE 50

0 100 200 300 400

Meters

Data sources:Panorama, URS, Knight Piesold, 2018

Base Data: (c) Based on information provided by and with the permission of the Western Australian Land Information Authority trading as Landgate (2010); Geoscience Australia; Streetpro

LEGEND

Domains
- Borrow Pit
- Pit
- Process Plant
- Sediment Pond
- Site Access Roads
- Topsoil Stockpile
- TSF
- Village
- Water Storage Pond
- Waste Rock Dump

- Project Tenements

- Minnieritchie Creek Catchment
- Minnieritchie Creek Sub-Catchment
- Pit Catchment
- Pit Sub-Catchment
- Six Mile Creek Sub-Catchment
- Sulphur Springs Creek Catchment
- Sulphur Springs Creek Sub-Catchment

- Access Road Observation Bore
- Access Road Production Bore
- Mine Site Observation Bore
- Mine Site Production Bore
- Processing Area Observation Bore
- Processing Area Production Bore

- Regional Observation Bore
- Regional Production Bore
- Regional Observation Bore
- Surface Water Monitoring Site
- TSF Area Observation Bore

Recommended Monitoring Locations

VENTUREX SULPHUR SPRINGS PTY LTD

SULPHUR SPRINGS PROJECT WATER MANAGEMENT PLAN

Figure

9

Map Document: P:\605X\60547561\4. Tech Work Area\4.99 GIS\02_MXDs\10_GWM_Combined_TSFv2\G60547561_WMP_Fig 9_Rec_Mon_Locs_v1_A3L.mxd (kai.du)

A3 size

Appendix A

Existing Venturex Licence to Take Water

LICENCE TO TAKE WATER

Granted by the Minister under section 5C of the Rights in Water and Irrigation Act 1914

Licensee(s)	Venturex Sulphur Springs Pty Ltd		
Description of Water Resource	Pilbara Pilbara - Fractured Rock	**Annual Water Entitlement**	150,000kL
Location of Water Source	M45/1001 M45/494 M45/653		

Authorised Activities	**Taking of water for**	**Location of Activity**
	Dust Suppression for mining purposes	M45/1001 M45/494 M45/653
	General campsite purposes	M45/1001 M45/494 M45/653
	Mineral exploration activities	M45/1001 M45/494 M45/653
Duration of Licence	From 30 April 2018 to 30 April 2028	

This Licence is subject to the following terms, conditions and restrictions:

1. The licensee must install an approved meter to each water draw-point through which water is taken under this licence.

2. The meter(s) must be installed in accordance with the provisions of the document entitled "Guidelines for Water Meter Installation 2009" before any water is taken under this licence.

3. The annual water year for water taken under this licence is defined as 1 May to 30 April.

End of terms, conditions and restrictions

This Licence is granted subject to the Rights in Water and Irrigation Regulations 2000.