BHP

Hydrological Processes Environmental Management Plan Mt Keith Satellite Project

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1. Contents

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1. Context, scope and rationale

1.1 Proposal

Mt Keith Satellite (MKS) Project (the Proposal) is currently under assessment by the Environmental Protection Authority (EPA, assessment number 2122). The Proposal has a Disturbance Footprint of 878 ha that lies within a Development Envelope of 1259 ha. The Proposal involves the development of two mine pits (Six Mile Well and Goliath), a waste rock landform, associated support infrastructure and a 20 km transport corridor north to the existing Mt Keith Mine.

1.2 Key environmental factors

The following Table 1 describes for the key environmental factor of Hydrological Processes:

- The Proposal activities which would affect the key environmental factor.
- The site-specific environmental value, existing and/or potential uses, ecosystem health condition or sensitive component of the key environmental factor which will be affected.

Table 1 – Key environmental factor, values and impacts

Key environmental factor	Activities	Values	Impacts
Hydrology Processes	Surface water diversions, and dewatering groundwater for mining activities.	Surface hydrology Jones Creek ecology Stygofauna	Impacts to the natural surface water flow as a result of placement, design and operation of mine pits and associated infrastructure. Impacts to surface water resources and their ecology, including Jones Creek, from groundwater drawdown and alterations to surface water flows, as well as disturbance, sedimentation and contamination. Impacts to stygofauna, as a result of groundwater drawdown.

1.3 Condition requirements

The Proposal is currently being assessed by the EPA (assessment 2122). This Plan addresses the requirements of the EPA Scoping document item 56 and discusses the monitoring, management closure and rehabilitation provisions for the Proposal.

1.4 Rationale and approach

The EMP will ensure that changes to the baseline hydrological condition can be defined. This will allow risk based assessment of the impacts of those changes on biological receptors dependent on hydrological processes. The risk assessments will be used as feedback to the EMP.

1.4.1 Survey and study findings

For the Jones Creek aquatic environment, baseline conditions have been defined by three studies, during which sampling was undertaken from residual pools in the creek, and an additional characterisation assessment of the creek .

The baseline catchment riparian condition has been found to be heavily degraded due to historic pastoral activities. Pools within the Jones Creek retain clear freshwater, with circumneutral to alkaline pH, and typically low concentrations of metals, with the exception of aluminium and copper, known to exceed the ANZECC (2000) 80% species protection trigger values for freshwater.

The estimated peak flood levels for Jones Creek have been used as a constraint in the design of various components of the Proposal. These estimates will not be subject to routine monitoring and adjustment, but may be subject to revision if an extreme rainfall event occurs during the operational phase.The baseline stygofauna assessment revealed that the Study Area hosts a depauperate stygofauna assemblage that is sparsely distributed and infrequently collected. The hydrogeological and stygofauna data indicate that the stygofauna assemblage present are sparsely distributed in a dendritic nature reflecting the network of habitable alluvial, regolith and fractured rock groundwater systems present, that appear to be closely associated with the Jones Creek drainage system.

1.4.2 Key assumptions and uncertainties

This Plan is informed by experience at Mt Keith and Leinster Operations, as well as baseline studies completed for the Proposal. Substantial site-specific investigation has been undertaken to determine baseline values, however as operations and monitoring commences variations will arise which will allow substantial improvement of hydrological process models.

The requirement for improvements to the models will be driven by risk-based assessment of potential impacts on biological receptors.

1.4.3 Management approach

The management approach adopted here is risk-based and uses a hierarchy of controls to avoid, minimise and rehabilitate impacts to ensure that biological diversity and integrity are maintained.

The management approach is targeted at ensuring that operations are managed to meet the environmental objective.

1.4.4 Rationale for choice of provisions

The water quality baseline is defined by samples collected from persistent pools in the creek. This provides a more practical and robust set of parameters than the highly transient chemistry which occurs during a high flow event (for which no baseline data has been collected). Water quality within the pools is expected to provide a more accurate reflection of the integration of potential changes in the catchment than water quality measurements during flow events.

The selected water quality triggers are the ANZECC (2000) aquatic environment 80% species protection trigger level for freshwater and the maximum baseline values recorded to date. Although the system does not necessarily conform to the “highly disturbed” status of the ANZECC guidelines, the use of lower 80% trigger level is justified on the following:

- Baseline levels relating to pastoral impacts and natural catchment mineralisation (copper) exceed the ANZECC (2000) 80% trigger levels
- Jones Creek provides a temporary aquatic environment
- Environmental risks previously identified in scoping baseline studies have been mitigated by replacing the larger SMW pit and Jones Creek diversion with a smaller pit for which no diversion is necessary

Analytes selected for management control are those elevated in the baseline condition (nutrients, copper) and/or those of the deposit mineralogy which have potentially problematic concentration/mobility (arsenic, chromium and nickel) as defined by Nickel West experience of similar materials at nearby operations.

Since levels of mineralisation are generally very low, discharge of unmineralised clayey material could dominate impacts on the aquatic environment and also be unsightly. The selected trigger of 5% clay in sediment was selected from the baseline particle size distribution curves.

2. EMP provisions

Provisions have been developed comprising both outcome based and management based components. The provisions presented include specific trigger criteria, response actions, management targets and management actions to be implemented for the Proposal. Monitoring and reporting of performance against these criteria are also detailed.

2.1 Outcome-based provisions

2.1.1 Outcome

The following outcome-based provisions have been developed to protect the environmental values associated with Hydrological Processes:

- Prevent capture of Jones Creek streamflow by the SMW Pit
- Prevent uncontrolled discharge from pits
- Maintain acceptable sediment quality in Jones Creek
- Maintain acceptable post flow event water quality in Jones Creek pools
- Maintain the natural stormwater regime - ie existing flow paths

2.1.2 Environmental criteria (trigger criteria and threshold criteria)

Both trigger and threshold criteria have been developed for the Proposal, which are presented in Table 4. These criteria have been developed to ensure they:

- are measurable;
- are part of the causal relationship between a relevant proposal aspect and the impact on the environmental factor/s;
- are effective for tracking changes relating to the environmental factor/s;
- are scientifically credible;
- are straightforward and readily interpretable;
- include a reference or baseline; and
- can be monitored regularly.

2.1.3 Response actions (trigger level actions and threshold contingency actions)

Response actions have been assigned to each criteria and are described in Table 4. Response actions to trigger criteria are designed so that mitigation actions can occur to prevent threshold criteria being reached.

2.1.4 Monitoring

Monitoring is undertaken to assess whether the management actions are effective against the environmental objective. Monitoring measures identified in Table 4 below are specific and appropriate to the management action to which they relate.

2.1.4.1 Water and Sediment Monitoring

Impacts on the Jones Creek aquatic environment can be determined by sampling water and sediment, with the analysis of chemical and physical properties, respectively. Thirteen water sampling and five sediment sampling locations have been selected (

Table 2 and Figure 1). The majority of these locations were established during previous baseline studies.

Water samples will be taken from residual pools within the creek, typically 4-6 weeks after a flow event, when water chemistry will have stabilised and equilibrated with that of the creek sediments. All major flow events (those resulting in substantial and long duration ponding) will be subject to sampling up to a maximum of two per year. Prescribed analytes are those recorded at ecologically significant concentrations in baseline sampling and those associated with the ore mineralisation, and aligning with previous baseline studies.

Sediment samples will be taken annually during the dry season (September-November). Composite creek bed channel samples from each site will be analysed for particle size distribution.

Table 2 – Schedule of surface water (JCW) and sediment (JCS) sample locations along Jones Creek, indicating baseline side codes

Sample	Site	East	North	Baseline Site	Baseline Report
Water	JCW01	261059	6966329	None	Provisional new site
Water	JCW02	261209	6966098	STC01, JC01	Streamtec (1992), OES (2011)
Water	JCW03	261600	6965532	STC02	Streamtec (1992)
Water	JCW04	261648	6965044	WRM01	WRM (2005)
Water	JCW05	261412	6964548	JC02	OES (2011)
Water	JCW06	260896	6964174	WRM02	WRM (2005)
Water	JCW07	260637	6963492	WRM03, JC03	WRM (2005), OES (2012)
Water	JCW08	259788	6961640	JC04	OES (2012)
Water	JCW09	259626	6961441	STC04, WRM04	Streamtec (1992), WRM (2005)
Water	JCW10	259200	6959728	WRM08	WRM (2005)
Water	JCW11	258955	6959656	STC06	Streamtec (1992)
Water	JCW12	258880	6959551	WRM05, JC05	WRM (2005), OES (2012)
Water	JCW13	254144	6956371	WRM06, JC06	WRM (2005), OES (2012)
Sediment	JCS01	261059	6966329	None	Provisional new site
Sediment	JCS02	259142	6960321	1	SKM (2005)
Sediment	JCS03	259296	6959847	2	SKM (2005)
Sediment	JCS04	256971	6958087	3	SKM (2005)
Sediment	JCS05	252904	6955103	4	SKM (2005)

OES; Outback Ecology, WRM; Wetland Research and Management, SKM; Sinclair Knight Merz

2.1.4.2 Groundwater Level Monitoring

Pit dewatering will create a cone of drawdown in the groundwater table which has been investigated and predictively modelled. Deviation of the actual and model-predicted drawdown could result in changes to the assessment of impacts on stygofauna habitat. Twenty of the investigation drill holes have been completed as water level monitoring bores (Figure 1and Figure 2). Water level measurements will be recorded quarterly, with monitoring to serve as a proxy for potential impacts to stygofauna.

Table 3 – Schedule and location of groundwater monitoring bores

Bore	East	North	GL	RLWL	Depth

GOL01	260452	6962778	521.5	504.6	65
GOL07	263338	6962137	530.7	506.4	100
GOL08	260119	6962086	518.9	505.6	46
GOL10	260368	6961793	522.0		65
GOL12	260816	6961565	526	506.2	44
GOL15	260779	6960760	520.4	505.1	40
GOL20	260857	6960385	516.5	504.6	63
GOL23	262285	6960213	526.9	504.9	62
GOL25	261252	6960094	526.7	506.2	80
SMW01	261076	6966147	532.9	-	66
SMW02	259988	6966066	542.1	505.9	65
SMW13	259909	6965023	541.3	-	65
SMW16	260357	6964889	537.8	505.7	65
SMW17	261316	6964614	526.8	504.2	60
SMW19	260524	6964425	534.2	504.2	65
SMW21	260793	6964048	524.5	505.0	65
SMW22	260438	6963818	530.0	504.7	50
SMW24	260394	6963644	527.0	505.1	60
SMW25	260964	6963581	524.8	505.0	65
SWM27	260390	6963381	522.2	505.0	65

Table 4 – EMP provisions (outcome-based table)

Purpose of EMP or Schedule	EPA Scoping document item 56		
EPA factor/s and objective/s	To maintain the hydrological regimes of groundwater and surface water so that environmental values are protected		
Outcome/s	• Prevent capture of Jones Creek streamflow by the SMW Pit • Prevent uncontrolled discharge from pits • Maintain acceptable sediment quality in Jones Creek • Maintain acceptable post flow event water quality in Jones Creek pools • Maintain the natural stormwater regime - ie existing flow paths		
Key environmental values	• Surface hydrology • Jones Creek ecology • Stygofauna		
Key impacts and risks	• Impacts to the natural surface water flow as a result of placement, design and operation of mine pits and associated infrastructure. • Impacts to surface water resources such as Jones Creek from groundwater drawdown and alterations to surface water flows. • Impacts to the ecology of Jones Creek, as a result of disturbance, sedimentation, changes in surface hydrology and contamination. • Impacts to stygofauna, as a result of groundwater drawdown and mounding.		
Outcome-based provisions			
Environmental criteria • Trigger criteria • Threshold criteria	Response actions: • Trigger level actions • Threshold contingency actions	Monitoring	Reporting
1. Prevent capture of Jones Creek streamflow by the SMW Pit			
Trigger: Rainfall event of 1:100 year ARI in duration range 1-12 hours Threshold: Maintain non-erodible bund at limits of SMW Pit disturbance area to a minimum elevation 1 metre above the estimated 1:1000 year ARI flood level	Revise peak flood level estimate and check bund elevation meets threshold criteria Revise peak flood level estimate and construct higher bund	Hourly rainfall at project site Peak flow event water level	Include in Annual Environmental Report: • Relevant rainfall data • Relevant peak water levels • Revised estimation • Describe Bund modifications
2. Prevent uncontrolled discharge from pits			
Trigger: water levels greater than baseline static water level at pit Threshold: Minimum buffer of 10 metres between maximum pit water level and lowest elevation of natural ground surface at pit crest (spill elevation)	Revise pit water level model Catchment management measures including bunding, diversion, revegetation	Operational pit water levels to be maintained below working level Monthly pumping and rainfall records	Include in Annual and Triennial reports in accordance with Groundwater Well Licence Operating Strategy

Outcome-based provisions			
3. Maintain acceptable sediment quality in Jones Creek			
Trigger: > 5% clay sized particles	Investigate sources If found to be a long-term persistent project related impact, then institute improved management of disturbed area runoff, including: ○ Increased first flush containment capacity ○ Drainage and bunding measures ○ Improved vehicle sediment tracking controls	Annual dry season sediment sampling at scheduled locations. Composite surface channel samples across main channel.	Include in Annual Environmental Report: • Sediment data
4. Maintain acceptable post flow event water quality in Jones Creek pools			
Triggers Salinity > 350 µS/cm Turbidity > 25 NTU pH outside range 5-8 Total Nitrogen > 2.5 mg/L Total Phosphorous > 0.1 mg/L Dissolved arsenic > 140 µg/L Dissolved chromium >40 µg/L Dissolved copper >15 µg/L Dissolved nickel >15 µg/L	Investigate sources If found to be a long term persistent project related impact, then institute improved management of disturbed area runoff, including: ○ Increased first flush containment capacity ○ Drainage and bunding measures ○ Improved vehicle sediment tracking controls	Water quality samples at scheduled locations (water holes), at 4-6 weeks after cease to flow. Maximum of 2 rounds of samples per year.	Include in Annual Environmental Report: • Water quality data

Outcome-based provisions			
5. Maintain the natural stormwater regime - ie existing flow paths			
Triggers: Excessive erosion of cut surfaces on haul roads Excessive flow and erosion in haul road table drains Excessive ponding upstream of haul roads and WRD	Revise drainage, bunding and roadway levels to restore flow paths	Routine operational inspections by site Environmental Staff after intense rain events	Include description of modifications in Annual Environmental Report:

2.2 Management-based provisions

Management provisions have been developed consistent with the mitigation hierarchy. A number of management actions are identified which seek to ensure the management objectives are met. The management objectives are principally targeted at ensuring management of potential direct and indirect impacts.

2.2.1 Objective

The objective of management-based provisions is to maintain the hydrological regimes of groundwater and surface water so that environmental values are protected.

2.2.2 Management actions

Management actions have been developed to assess and manage risk from potential direct and indirect impacts of the Proposal. Direct impacts that have been identified include:

- Impacts to the natural surface water flow as a result of placement, design and operation of mine pits and associated infrastructure.
- Impacts to surface water resources such as Jones Creek from groundwater drawdown and alterations to surface water flows.
- Impacts to the ecology of Jones Creek, as a result of disturbance, sedimentation, changes in surface hydrology and contamination.
- Impacts to stygofauna, as a result of groundwater drawdown.

2.2.3 Management targets

Management targets presented in Table 5 are proposal-specific and are used to assess whether the management actions are effective.

2.3 Monitoring

Monitoring is undertaken to assess whether the management actions are effective against the environmental objective. Monitoring measures identified in 5 are specific and appropriate to the management action to which they relate.

Table 5 – EMP provisions (management-based table)

Purpose of EMP or Schedule	To satisfy EPA Scoping document item 56		
EPA factor/s and objective/s	To maintain the hydrological regimes of groundwater and surface water so that environmental values are protected		
Outcome/s	• Prevent capture of Jones Creek streamflow by the SMW Pit • Prevent uncontrolled discharge from pits • Maintain acceptable sediment quality in Jones Creek • Maintain acceptable post flow event water quality in Jones Creek pools • Maintain the natural stormwater regime - ie existing flow paths		
Key environmental values	• Surface hydrology • Jones Creek ecology • Stygofauna		
Key impacts and risks	• Impacts to the natural surface water flow as a result of placement, design and operation of mine pits and associated infrastructure. • Impacts to surface water resources such as Jones Creek from groundwater drawdown and alterations to surface water flows. • Impacts to the ecology of Jones Creek as a result of disturbance, sedimentation, changes in surface hydrology and contamination. • Impacts to stygofauna, as a result of groundwater drawdown and mounding.		
Management-based provisions			
Management actions	**Management targets**	**Monitoring**	**Reporting**
Minimise sediment discharge from within disturbed areas	Concentrated sediment-laden stormwater flows from disturbed areas are routed to first-flush check dams with capacity equal to 4mm depth over catchment area	Site inspections during and after rain events to check: • Vehicle cleanliness at creek crossings • Check dam containment capacity versus rainfall total • magnitude and turbidity of through-flow above storage capacity • loss of live storage capacity due to sediment build up	Annual Environmental Report detailing necessary revisions to control systems including disturbed area drainage and first flush check dams
Determine and predict drawdown impacts sufficient to support risk assessment for biological receptors	Support assessment of impacts on biological receptors	Quarterly water level monitoring at scheduled bores	Annual and Triennial reports in accordance with Groundwater Well Licence Operating Strategy

3. Reporting

Reporting requirements can be fulfilled by incorporating outcomes into existing scheduled reports including:

- Annual Environmental Report to DMIRS
- Annual Report to DEWR under EPA Act licence
- Annual and Triennial Reports to DEWR under RIWI Act licence (Groundwater Well Licence)
- Adaptive management and review of the EMP

Adaptive Management

Adaptive management shall be achieved through ongoing training, supervision and monitoring of operational performance. Area inspections, audits and task observations may be used to assess performance and identify procedural or technical variance in operational practices that can then be remediated.

Through an annual review and reporting process the following will occur:

- Define operational issues and proposed changes to the plan.
- Implement management and mitigation measures.
- Monitor and evaluate performance against amended environmental provisions.
- Adjust management and mitigation measures and monitoring where required to meet the outcome or objective.

Trigger values are considered achievable and appropriate. Adaptive management would be achieved through adjustment of operational procedures to improve performance against monitoring results. In particular this may result in increased/improved stormwater routing, retention and detention.

Other possible adaptive management scenarios include:

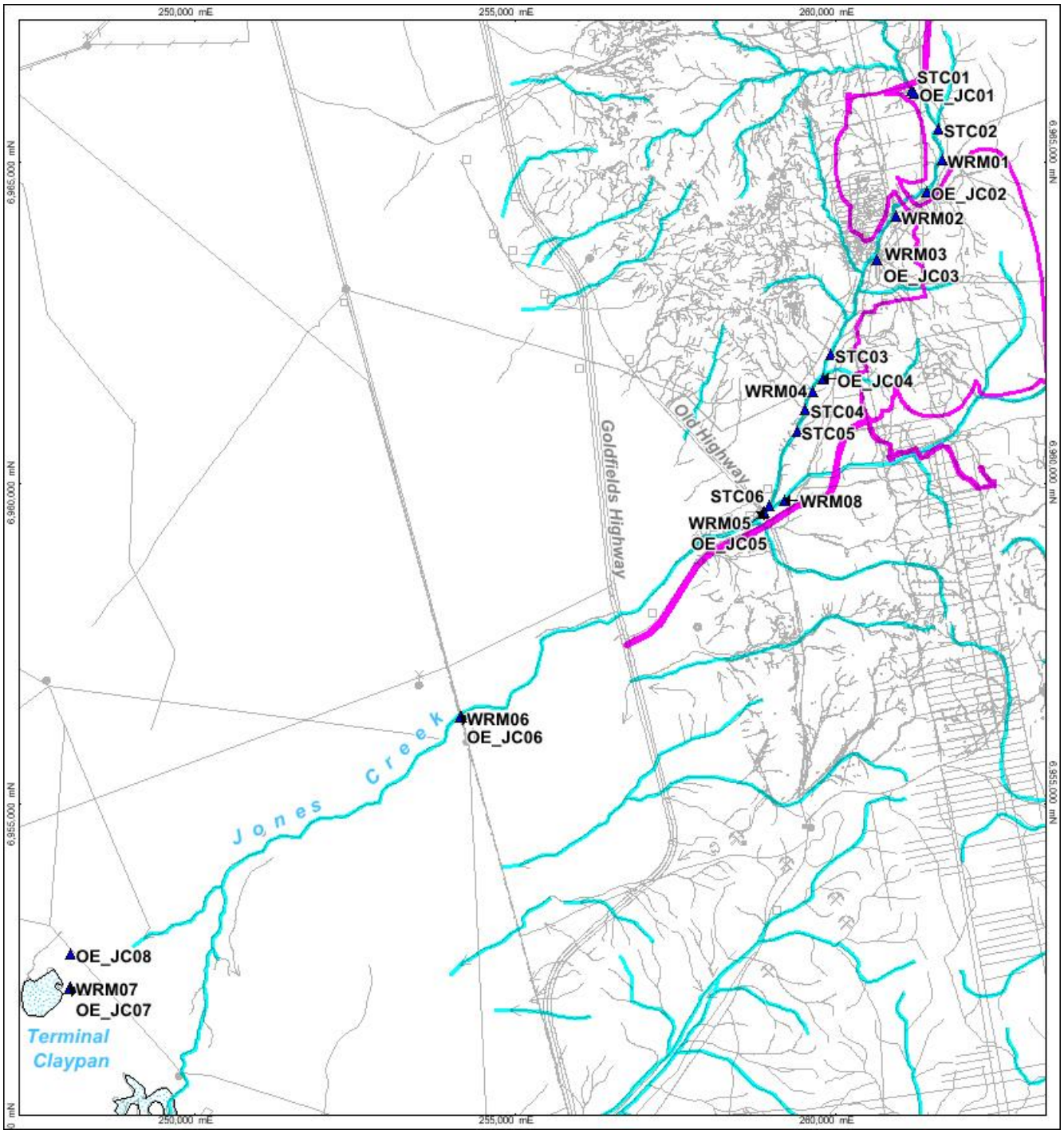
Revision of trigger levels due to external factors - Implementation of the management plan will result in Nickel West becoming Catchment Managers for an area much larger than the area of disturbance and including pastoral country and public roads. Should investigation of any trigger exceedance identify persistent causes which are beyond the control of Nickel West, a change in baseline may warrant an increase in the trigger levels.

Revision of trigger levels due to more detailed impact assessment – As per the ANZECC aquatic water quality guidelines, trigger values may be subject to amendment on the basis of site specific evaluation.

Revision of monitoring program – based on increased data collection as the Proposal progresses and to accommodate flexibility in response monitoring results and the temporary and fluctuating nature of the environment.

4. Stakeholder consultation

This plan is submitted as a preliminary draft for consultation. Stakeholder consultation shall be monitored and reported through revision of this Plan for its finalisation and implementation.



Legend:
WRM – stream pool sampling locations
OE – creek and clay pan sampling locations
MWES Consulting, 2017b

Figure 1: Surface water sampling locations

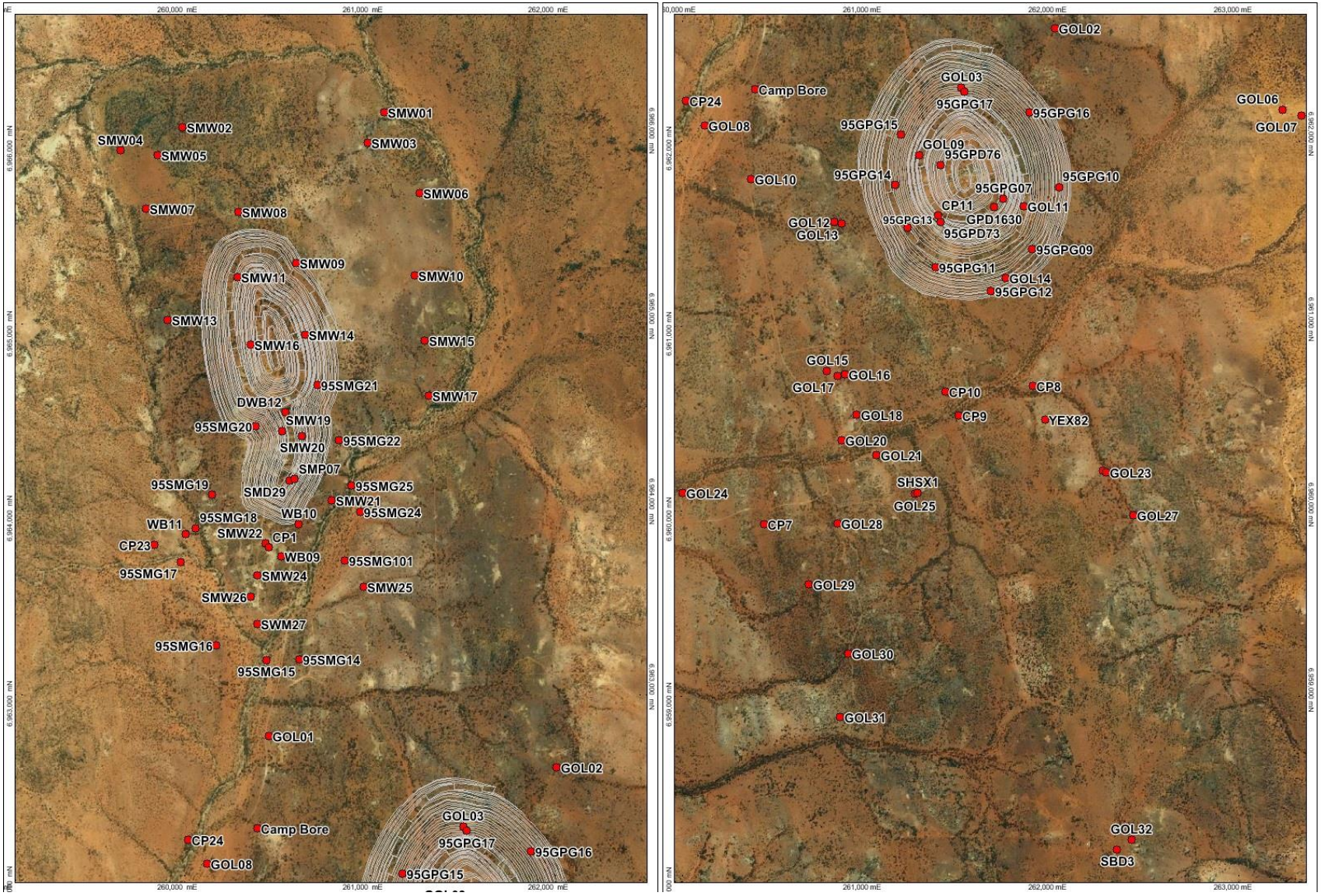


Figure 2: Bore locations