Water Management Plan

TELLUS

Chandler Facility

Water Management Plan

Prepared for Tellus Holdings Limited | 6 February 2017

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Final

Report J16072RP3 | Prepared for Tellus Holdings Limited | 6 February 2017

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Date	6 February 2017	Date	6 February 2017

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Document Control

Version	Date	Prepared by	Reviewed by	Independently Peer Reviewed by
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1 Introduction

1.1 Purpose and objectives

Tellus Holdings (Tellus) is proposing to construct and operate the Chandler Facility (the Proposal) on the Maryvale pastoral lease (Northern Territory 810) approximately 120 kilometres (km) south of Alice Springs (see Figure 1.1).

A Water Management Plan (WMP) has been developed to satisfy Condition 4.5.3 of the Chandler Project Environmental Impact Statement (EIS) Terms of Reference (ToR). This condition broadly requires that the WMP shall address the management of water for the Proposal for all mine-life stages and all seasonal conditions, according to its source, quality, volume, end use or other parameters.

The purpose of the WMP is to describe the water management strategies, procedures, controls and the monitoring programs that are to be implemented in the Construction, Operational and Closure phases of the Proposal. The WMP will be updated periodically in response to changes to construction, operations, water requirements and water monitoring responses.

The objectives of this WMP include the following:

- establish a water monitoring network to assess impacts on surrounding sensitive receivers and performance against site specific water quality, level and flow criteria;
- provide a mechanism to assess monitoring results against site specific criteria to evaluate compliance;
- detail the requirement for reporting criteria exceedances to the relevant stakeholders;
- track site water balance requirements for all activities during the mine construction and operational phases;
- detail the controls to be implemented to minimise the discharge of dirty water from the site;
- detail the controls to be implemented to minimise the underground mobilisation of contaminants within local and regional groundwater systems;
- address the relevant conditions of the Terms of Reference (see Section 2.1); and
- manage water-related community complaints in a timely and effective manner.

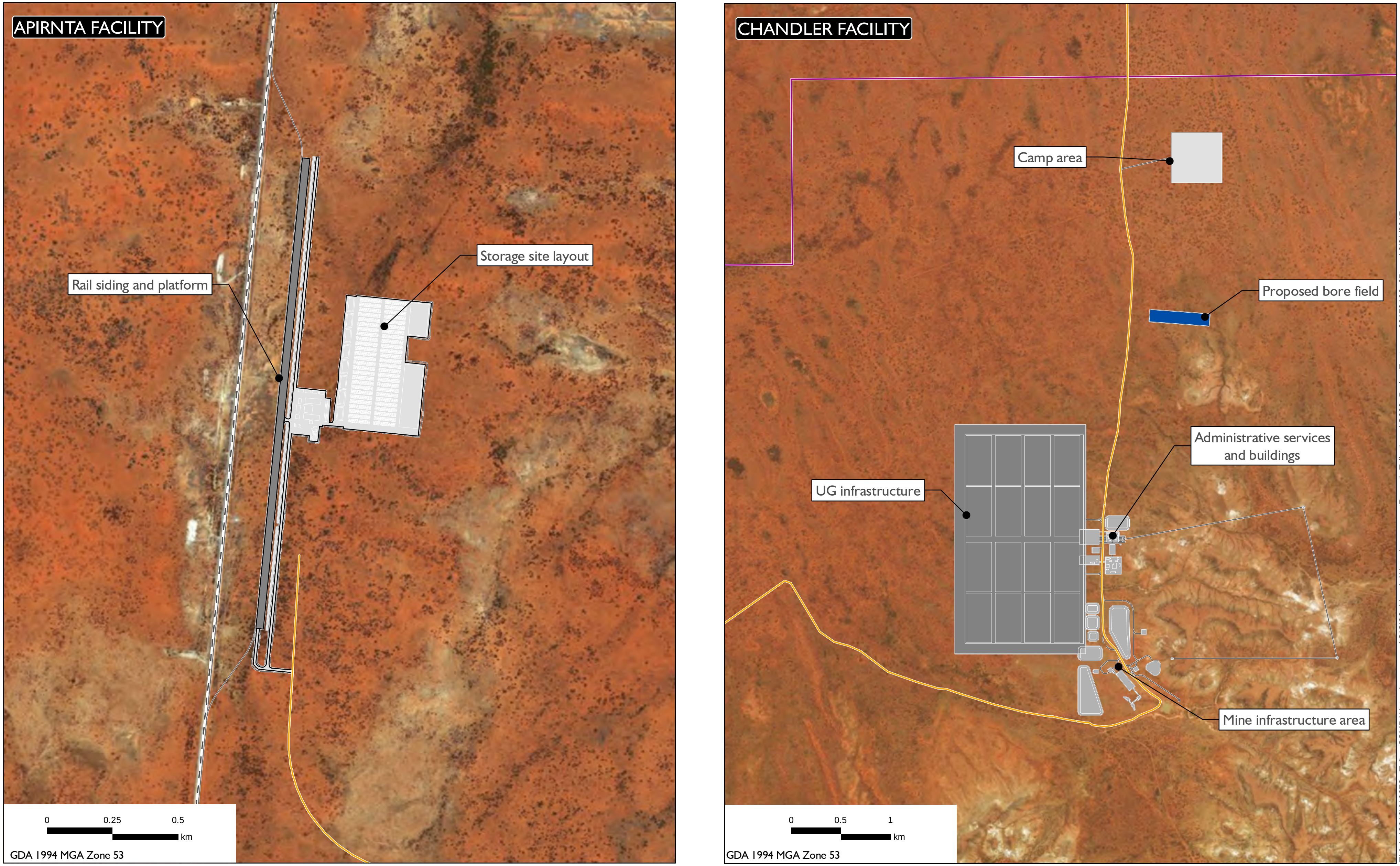
1.2 Concept proposal description

Tellus is seeking development consent under the Northern Territory *Environmental Assessment Act* (EA Act) and the *Mining Management Act* (MM Act) for the Proposal, broadly comprising:

- the mining of a high quality salt product at a depth of approximately 850 metres (m);
- provision for the permanent isolation of intractable waste or the temporary storage of materials in void spaces left from salt mining;

- the use of mining and waste emplacement methods that will replicate current global best practice techniques;
- haulage of salt and waste products via private haul roads;
- transportation of salt to port via rail;
- delivery of waste predominantly by rail; and
- transportation of workers via public and private roads.

A detailed description is provided in the Project Environmental Impact Statement (EIS).



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Project features

Chandler Facility
Water Assessment

Figure 3.1

2 Regulatory context

2.1 Statement of commitments and Terms of Reference

The Chandler Project EIS ToR issued in September 2016 stipulate the requirements for this WMP. These requirements are included in Table 2.1, along with where they are addressed in the WMP.

Table 2.1 Chandler Project Terms of Reference, Condition 4.5.3

Condition 4.5.3 reference	Requirements of the WMP	Report reference
a	The EIS should provide a draft Water Management Plan (WMP) that outlines clear and concise measures to mitigate identified risks of the Project to water resources. All mitigation measures in the WMP should be adequately detailed to demonstrate best practicable management and that environmental values of receiving waters will be maintained. The WMP should include but not be limited to measure that: i) avoid contamination of surface or groundwater resources (e.g. appropriate containment of hazardous materials); ii) ensure the protection and resilience of any water dependent ecosystems; iii) protect water quality and levels for existing and future users of bores and/or surface waterways, including the potable supplies; iv) avoid the exposure of sensitive biological receptors to contaminants or water of a poor quality which may be harmful; v) ensure treatment/neutralisation occurs of hazardous materials to identified safe levels, before any controlled environmental release is considered; vi) treat and manage domestic wastewater and sewage;	5.1
b	the WMP should be closely related to but separate from an Erosion and Sediment Control Plan (ESCP) for the Project. Measures to be addressed in both the WMP and ESCP should include options for minimising water use, management and treatment of clean and contaminated water (including site stormwater), and erosion and sediment control measures. It is essential that appropriate consideration of potential contaminant sources and their management is provided, such that the environment is protected from pollution in short (whilst operational), medium (post closure and under institutional control) or long term (post-institutional control);	5.1
c	the WMP and related management plans should outline details of monitoring programs to be implemented throughout the life of the Project to determine effectiveness of the proposed mitigation measures, and to monitor for impacts to water resources from the Project;	7
d	proposed monitoring should be described for leaks, spills or seepage of materials from pipelines, storage/disposal activities (including tailings disposal facilities) and transport operations to identify impacts, should they occur, to local soils, aquifers, environments, workers and/or the general public;	4.3, 5.1
e	the monitoring programs should include relevant water quality target values based on appropriate guidelines and/or standards and ideally be based on local ambient conditions. The monitoring program should outline reporting procedures and contingencies that will be implemented in the event that monitoring activities identify any performance indicators have been triggered, or other water-related hazard or emergency.	6, 8

Table 2.1 Chandler Project Terms of Reference, Condition 4.5.3

Condition 4.5.3 reference	Requirements of the WMP	Report reference
	The monitoring program should include: i) methods to monitor the impacts of the Project on surface and groundwater quality and quantity during mine operations and beyond mine closure; ii) provisions to notify and respond to environmental and human health risks associated with water quality, or other water related emergency; iii) contingency plans to be implemented should monitoring identify an unacceptable impact; and	
F	the WMP should undergo a process of peer review by an independent, appropriately qualified expert. Feedback should be included as an attachment to the WMP.	Appendix A

The WMP has been prepared by a suitably qualified consultant and reviewed by an expert Independent Peer Reviewer.

2.2 Northern Territory legislation

2.2.1 Water Act

The NT *Water Act* (*Water Act*) is the primary legislation regulating groundwater and surface water resources in the NT and is administered by the Department of Environment and Natural Resources (DENR). The *Water Act* provides the legislative framework for water planning and entitlements for most water resources in the NT, and for the investigation, allocation, use, control, protection, management and administration of surface water and groundwater resources.

Mining activities (as defined by the *Mining Management Act*) are, however, exempt from the requirements of the *Water Act*. The take of groundwater and/or surface water for mining activities or the discharge of water within mining tenements are authorised under the *Mining Management Act*. It is understood that changes to the *Water Act* were proposed by the NT government to remove the exemption of mining activities located within declared or proposed Water Allocation Plan areas. These changes have not yet been enacted. Water Allocation Plan areas can be developed within the defined Water Control Districts. However, Tellus will apply for all necessary water abstraction permits and licences as if it were operating under the *Water Act*.

In addition, if water pollution comes from a mining operation onto land that is not part of the mining title, this would be regulated under the *Water Act* and a waste discharge licence, with set water quality requirements, would be required. Please note, the Proposal will not be discharging waste water and therefore will not require a waste discharge licence. All waste water is expected to be re-used in other site operations such as hydraulic backfill processing or dust suppression.

2.2.2 Mining Management Act

The *Mining Management Act* was established to ensure the development of the NT's mineral resources in accordance with environmental standards consistent with best practice in the mining industry (*Mining Management Act*, Section 3(a)). The *Mining Management Act* aims to protect the environment by establishing a system whereby mining activities that will result in a substantial disturbance of the ground require an Authorisation. This act is administered by the Mines and Energy Division of the Department of Primary Industries and Resources (DPIR).

Activities authorised with a mining title under the *Mining Management Act* that are exempt from the *Water Act* are authorised to use water in the title area. This includes the right to take or divert naturally occurring surface water and extract groundwater. In these cases, there are no restrictions on the amount of water that can be used.

Under the *Mining Management Act*, operators of mines are also required to implement and maintain a management system for the site (as described in a Mining Management Plan or MMP). The Mining Management Plan describes the environmental management structure, environmental commitments, monitoring programs, rehabilitation and closure planning, and includes water management requirements. The MMP also requires the development of a Water Management Plan relating to the mining activities.

The *Mining Management Act* also requires payment of security to provide for the rehabilitation of Mineral Leases or to rectify environmental harm caused by mining activities.

This Water Management Plan will be assessed under the *Mining Management Act*.

2.2.3 Northern Territory Environment Protection Authority Act

The *Northern Territory Environment Protection Authority Act* establishes the NT EPA as an independent authority with duties and functions under the *Waste Management and Pollution Control Act* 1994 and the *Environmental Assessment Act*.

2.2.4 Environmental Assessment Act

The *Environmental Assessment Act* and the *Environmental Assessment Administrative Procedures* establish the framework for the assessment of potential or anticipated environmental impacts of development, and provide for protection of the environment, including water resources, water quality and resource management.

In March 2013, following determination by the Australian Government under the *Environment Protection and Biodiversity Conservation Act* 1999, the Northern Territory Environment Protection Authority (NT EPA) decided that the project requires assessment under the NT *Environmental Assessment Act* at the level of EIS.

In 2016, a variation to the 2013 Notice of Intent was reviewed by the two levels of government. The variation did not alter the level of assessment required for the Proposal.

2.2.5 Waste Management and Pollution Control Act

The *Waste Management and Pollution Control Act* was established to ensure the protection of, and where practicable to restore and enhance the quality of, the Northern Territory environment. The Act is the primary piece of environmental protection legislation in the Northern Territory and is administered by the NT EPA. The Act:

- imposes general environmental duties;
- requires the licensing of certain activities;
- establishes offences relating to the environment; and

- contains material enforcement, penalty and extension of liability provisions.

The Act does not apply to a contaminant or waste resulting from a mining activity (covered in the Mining Management Act) that is confined within the land on which the mining activity is being carried out.

2.3 Australian Government legislation

2.3.1 Environment Protection and Biodiversity Conservation Act 1999

Under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (*EPBC Act*), actions that are likely to have a significant impact on a matter of national environmental significance are assessed. The Australian Government Department of the Environment and Energy (DoEE) is responsible for administering the Act. Matters considered to be of national environmental significance include World Heritage properties, National Heritage places, threatened species and ecological communities, migratory species, wetlands of international importance ('Ramsar' wetlands), and water resources.

A referral and assessment process determines the application of the EPBC Act. The first step in this process is referral of the project to DoEE. The project is then assessed for the potential for impacts upon matters of national environmental significance, and if this is likely, to establish the significance of these impacts. If it is determined that there will be, or there is likely to be, a significant impact to a matter of national environmental significance the project is declared to be a controlled action and will require formal assessment under the *EPBC Act.*

On 17 December 2012, the project was referred to the Australian Government for consideration under the EPBC Act. On 21 February 2012, a delegate for the Minister for Sustainability, Environment, Water, Population and Communities determined that the project is a controlled action for impacts on listed threatened species and communities, but not specifically in relation to water resources or Ramsar wetlands (there are no Ramsar wetlands in the region of the project). The project will be assessed by an EIS in accordance with the bilateral agreement between the NT and Australian governments.

2.4 Commonwealth policies and guidelines

2.4.1 Australian and New Zealand guidelines for fresh and marine water quality

The Australian and New Zealand guidelines for fresh and marine water quality (ANZECC/ARMCANZ 2000) set out the framework for the application of water quality guidelines. These guidelines describe requirements over a variety of marine and freshwater environments, aquatic ecosystems, primary industries, recreational water, drinking water, and related monitoring and assessment. The guidelines provide an authoritative guide for setting water quality objectives for natural and semi-natural water resources in Australian and New Zealand sustaining current or likely future environmental values (uses).

The guideline also provides guidance on the use of low-risk guideline values where baseline data limitations and/or the biophysical setting are not supported by ANZECC/ARMCANZ 2000 guideline criteria. Low-risk guideline values have been developed for various Australian geographical regions, including; *south-east Australia*, *south-west Australia*, *tropical Australia*, *south central Australia – low rainfall area*, and *New Zealand*. Low risk guideline values have been developed in consultation with state agencies and are derived from ecosystem data for unmodified or slightly-modified ecosystems.

The Chandler Project lies within the *south central Australia – low rainfall area*, and as such this default water quality criterion has been used to inform default water quality trigger values (see Section 6.2).

2.4.2 Water Quality Objectives

Water Quality Objectives are developed to protect the environmental values and goals for particular surface water and groundwater environments. Water quality objectives can therefore be used as a framework for the development of site-specific water quality criteria for projects, with anticipated potential impacts on the surface water and groundwater environments.

Water Quality Objectives for surface water are typically developed on a catchment basis, and establish:

- the community values and uses for watercourses and lakes (i.e. healthy aquatic life, water suitable for recreational activities such as swimming and boating, and drinking water); and

- the range of water quality indicators to assess whether the current condition of waterways supports those identified values and users.

Water Quality Objectives for groundwater are typically based on the natural characteristics of each aquifer system, and ensure that the beneficial use attributes of each system are not degraded over time (even if there is no use or and/or no environmental receptors).

Water Quality Objectives can assist with the selection of the most appropriate management options. Specifically, where the environmental values are being achieved in a waterway they should be protected and where an environmental value is not being achieved all activities should work towards their achievement.

3 Water context

3.1 Water context and baseline data summary

A detailed assessment of baseline surface water and groundwater information has been provided in the EIS (Chapter 7 and Chapter 8). The sections below summarise the context of the surface water and groundwater environments across the Proposal area.

3.1.1 Surface water

The Finke River and Hugh River are the major ephemeral surface water features located in the vicinity of the Proposal. Both rivers originate at the foothills of the MacDonnell Ranges, approximately 200 km north-west of the Proposal area. The Hugh River is located to the north of the Proposal and flows south-east where it has its confluence with the Finke River approximately 30 km south-east of the Proposal.

Several ephemeral drainage lines discharge to the Finke River and Hugh River along the reaches adjacent to the Proposal area. These are predominantly topographically controlled by various sand dunes, ranges and outcropping basement rock visible across the Proposal area.

The drainage lines coming off the Maryvale Hills to the east of the Chandler Facility are gully-like features. They are deeply incised, with intermittent stream flows capable of carrying small to medium angular to sub-angular rocks through the mid slopes and towards the lower slopes and sediment settlement zone. Riparian vegetation in the form of juvenile to mature Mulga, Mature Desert Oak, Salt bush, Cassia and Paper Daisy dominate the banks of the gullies (BECCA 2017).

Mary's Creek is the largest system of all the gullies followed by Oak Gully with Dingo, Ridey, Roo and Snake Gully all small by comparison and not consisting of a defined channel with banks (BECCA 2017). A map presenting the internal drainage system surrounding the Proposal area is shown in Figure 3.1.

The widespread absence of permanent surface water features across the Proposal area, combined with a depth to water table of around 80 metres, suggests that there is no groundwater and surface water connectivity in the vicinity of the Chandler Facility. Immediately surrounding the facility there is only very thin alluvium and aeolian sands, and the weathered sedimentary bedrock is generally within 10 metres of surface. The regional water table is within the underlying sedimentary rocks, although isolated occurrences of perched groundwater may periodically (and temporarily) occur within the shallow alluvium after heavy rain and flood events.

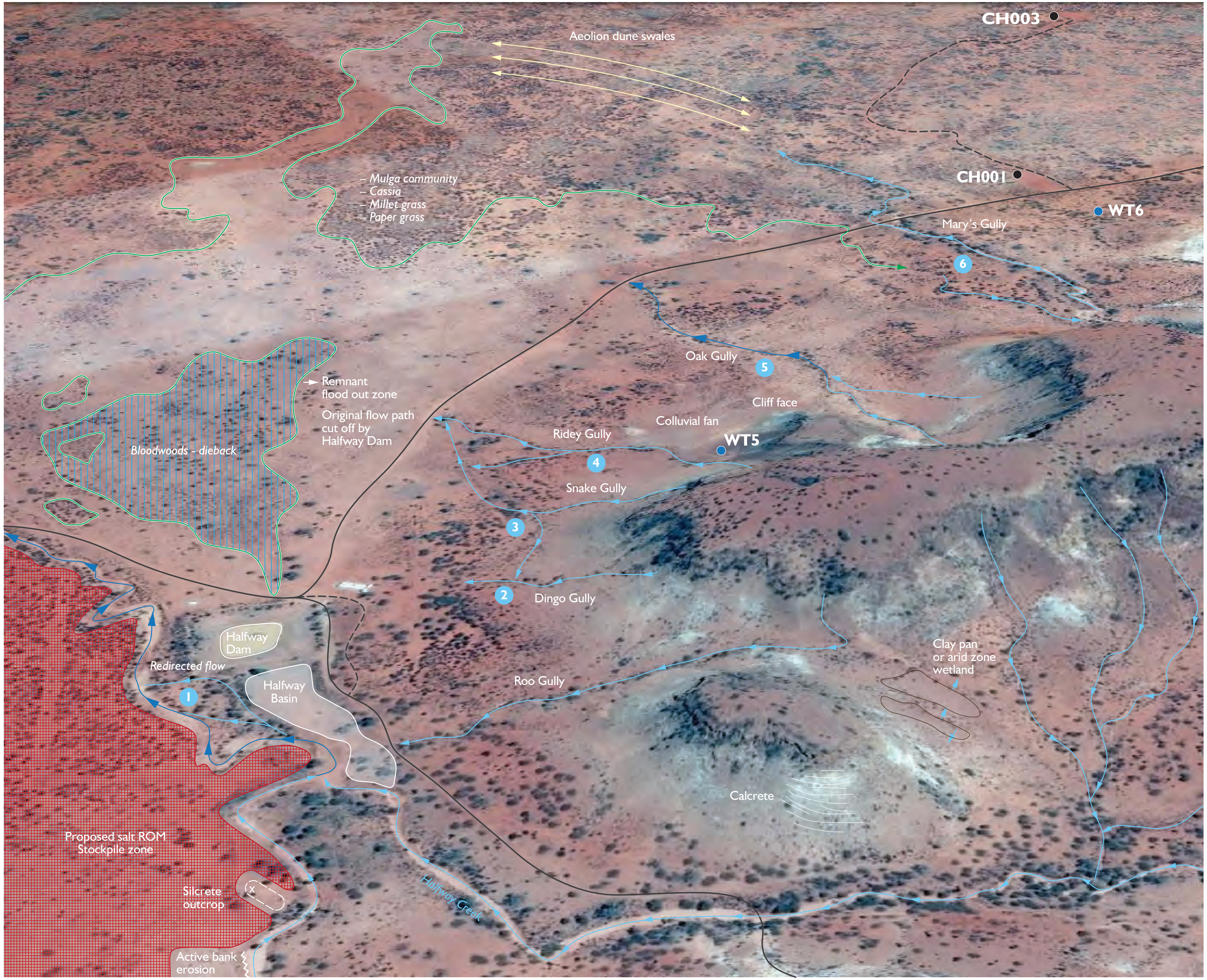
Shallow groundwater levels and gradients within the main alluvium groundwater system associated with the Finke River about 20 km to the south from the Chandler Facility indicate some potential for connectivity between shallow and deeper groundwater in that area (EMM 2016). Regional-scale connectivity is most unlikely between thin local alluvium in the tributary creeks near the Proposal (which may contain isolated occurrences of perched groundwater from time to time) and the extensive alluvium along the major feature of the Finke River.

There are no groundwater monitoring bores located directly adjacent to the Finke River and screened within the deeper groundwater systems in the sedimentary rocks (i.e. Idracowra Sandstone, Horseshoe Bend Shale or Langra Formation). Therefore, it is difficult to gain a comprehensive understanding of potential connectivity between the regional water table and surface drainage features in areas along the Finke River directly down hydraulic gradient of the Chandler Facility. Characterisation of the water type of the springs located along the Finke River to the south and south-east of the Chandler Facility suggest the source of water from these springs is likely to be derived from the perched shallow alluvial sediment and not the deeper groundwater system connected to the Chandler Facility (EMM 2016).

This local and regional understanding implies a lack of connectivity generally, which would mean that any potential drawdown impacts in the deeper groundwater systems arising from Proposal dewatering through abstraction or mining activities would not impact remote surface water resources. It should also be noted that the drawdown impacts arising from the Proposal would be of such low magnitude and extent (as detailed later) that they would not reach the known spring areas tens of kilometres to the south east. This is due to the low rate of groundwater pumping throughout the Proposal life (1.7 L/s, which is broadly consistent with stock and domestic rates), the lack of continuity of the shallow alluvial aquifer, and also the limited extent of drawdown due to the relatively low permeability deeper aquifer units, and the intervening aquitard units.

KEY

- exploration bore
- groundwater monitoring bore
- first order stream
- second order stream
- surface water sub-catchment
- minor track
- road
- mine operations
- vegetation communities
- Aeolion dune swale
- Remnant flood out zone



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3.1.2 Groundwater

The Proposal area is within the Chandler Syncline, itself within the south-eastern extent of the Amadeus Basin. The Chandler Syncline hosts various local and sub-regional groundwater systems, all of which have minor confining layers and permeability barriers to groundwater flow. The basal unit overlying the Chandler Formation and target salt resource is the Giles Creek Dolostone Formation, comprising predominantly dolomitic calcareous shales and sand and silt sediment. Overlying the Giles Creek Dolostone Formation is the Jay Creek Limestone Formation, comprising predominantly of marine shale, silt and sand sediments and thin beds of dolomite.

Overlying the Jay Creek Limestone Formation is the Stairway Sandstone Formation, a thick geological sequence comprising predominantly continental coarse to medium grained sandstone within interbedded minor silt and shale beds. Overlying the Stairway Sandstone Formation is the Langra Formation, a geological unit subdivided into three member units, represented at depth by interbedded silt and shale beds, gradually transitioning into extensive fine to medium grained sand.

Overlying the Langra Formation is the Horseshoe Bend Shale Formation, a massive siltstone and quartzitic sandstone deposit. Directly above the Horseshoe Bend Shale Formation and partially eroded at surface across the Proposal area is the Idracowra Sandstone, a kaolinitic sandstone represented across the Maryvale Hills and discontinuous across the Proposal area. The geological setting underlying the Proposal area has been conceptualised in Figure 3.2 below.

In the immediate vicinity of the Chandler Facility there are two distinct groundwater systems:

- A near surface sediment groundwater system (within shallow alluvium and aeolian sands); and
- A fractured rock groundwater system (within the sedimentary rocks).

The shallow alluvial system is localised, perched and ephemeral. The deeper fractured rock system is sub-regional in extent and contains numerous (permanent) aquifers. The regional water table occurs within the sedimentary rock sequence.

Locally in the vicinity of the Proposal area, there is limited recharge from direct rainfall to deeper aquifers but minor recharge is expected to occur via infiltration from overlying alluvial systems during major flooding events. Minor direct rainfall recharge may possibly occur locally, but the low rainfall and high evaporation means this volume would be minimal and the presence of stratified low permeability clays and silts in the middle and lower members of the Langra Formation is more likely to result in the formation of localised perched groundwater systems in the upper Langra Formation and Horseshoe Bend Shale Formation.

Consistent with topographic gradients, hydraulic gradients are very gentle in the south-eastern extent of the Amadeus Basin, and the broad flow direction in all groundwater systems is generally from north-west to south-east. However, the basement structure (typically associated with folding) influences the groundwater flow direction in certain areas across the Proposal area.

The horizontal hydraulic conductivity in geological units is likely to be highly variable, due to the depositional environments and volume of clay; substantial lateral flow through Formations is therefore not expected.

Locally there is an upwards hydraulic gradient from the Langra Formation to the Horseshoe Bend Shale Formation based on pressure head differences observed through groundwater monitoring, but there is no evidence of substantial flow volumes between these units. Elsewhere, within the 25 km spatial buffer around the Chandler Facility, landholder bores located within the shallow alluvium report shallow groundwater levels which are likely to be perched systems, with very little vertical leakage to the underlying Idracowra Sandstone Formation and Horseshoe Bend Shale Formation.

Water quality is generally potable within shallow alluvial groundwater accessed by landholder bores to the north and west of the Chandler Facility, particularly at Titjikala. Whereas groundwater quality observed within the Horseshoe Bend Shale and Langra local groundwater systems at the Chandler Facility is poor and moderately saline. Salts originating from the marine depositional environment, and the enhanced climatic nature of the environment (ie low precipitation/high evaporation), coupled with negligible recharge and long groundwater residence times is likely to contribute to the poor groundwater quality observed within the Chandler Syncline.

The saline groundwater quality within the Chandler Syncline differs markedly from the potable water quality reported for the Mereenie Aquifer System about 100 km north within the Northern Amadeus Basin. The Chandler Syncline system is a separate groundwater system that is not connected to the groundwater sources utilised for the Alice Springs Water Supply. The evidence confirms that the Chandler Syncline system is distinct and separate from the Mereenie Aquifer System in terms of geological structure, lithological units, groundwater systems, groundwater flow properties, hydraulic gradients and hydrogeochemistry.

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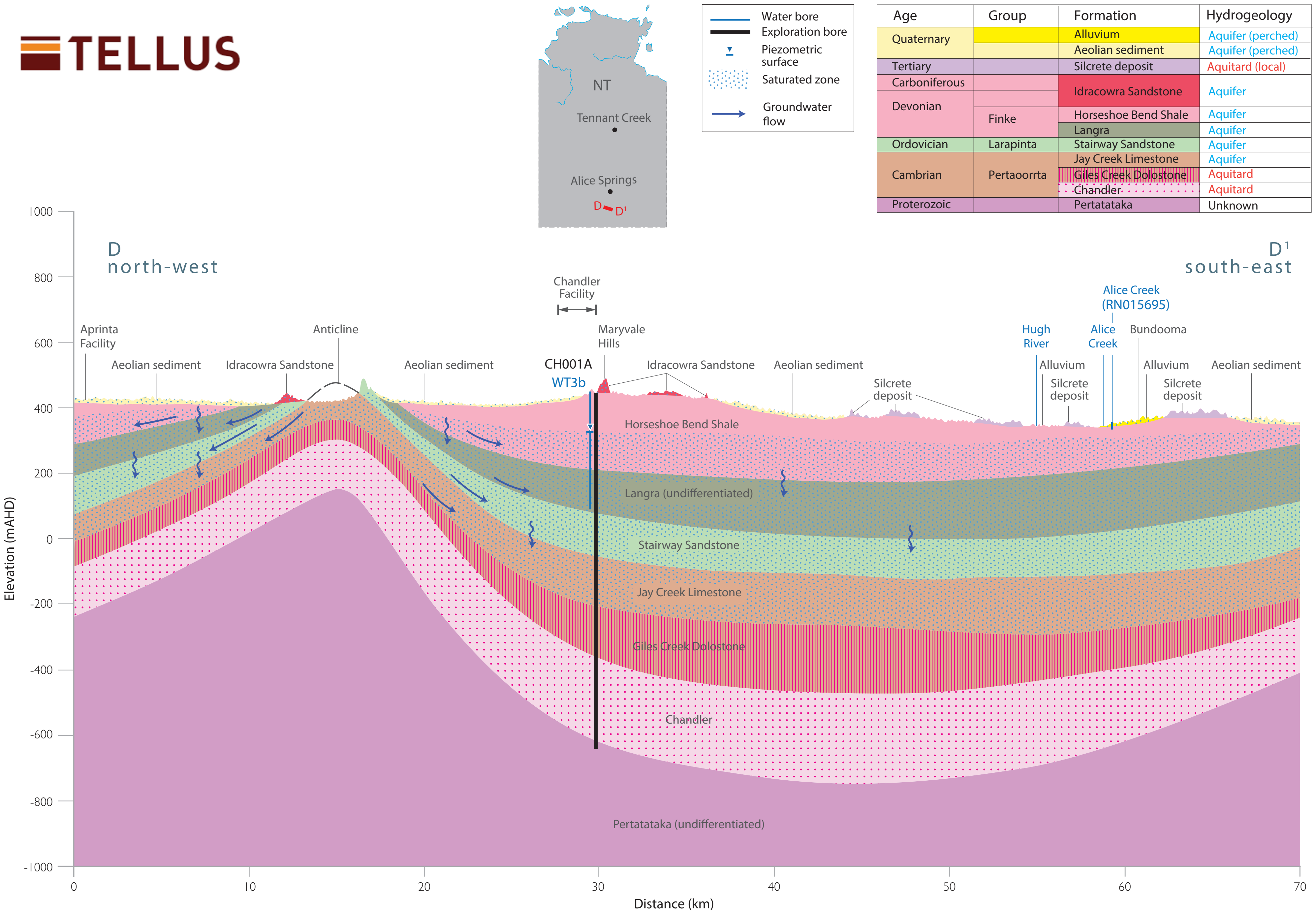

NT
Tennant Creek
Alice Springs
D
D¹
Water bore
Exploration bore
Piezometric surface
Saturated zone
Groundwater flow
Age
Group
Formation
Hydrogeology
Quaternary
Alluvium
Aquifer (perched)
Aeolian sediment
Aquifer (perched)
Tertiary
Silcrete deposit
Aquitard (local)
Carboniferous
Idracowra Sandstone
Aquifer
Devonian
Finke
Horseshoe Bend Shale
Aquifer
Langra
Aquifer
Ordovician
Larapinta
Stairway Sandstone
Aquifer
Cambrian
Pertaoorrta
Jay Creek Limestone
Aquifer
Giles Creek Dolostone
Aquitard
Chandler
Aquitard
Proterozoic
Pertatataka
Unknown
D
north-west
D¹
south-east
Chandler Facility
Alice Creek (RN015695)
Aprinta Facility
Anticline
Maryvale Hills
Hugh River
Alice Creek
Bundooma
Aeolian sediment
Idracowra Sandstone
Aeolian sediment
CH001A
WT3b
Idracowra Sandstone
Aeolian sediment
Silcrete deposit
Alluvium
Silcrete deposit
Alluvium
Silcrete deposit
Aeolian sediment
Horseshoe Bend Shale
Langra (undifferentiated)
Stairway Sandstone
Jay Creek Limestone
Giles Creek Dolostone
Chandler
Pertatataka (undifferentiated)
Elevation (mAHD)
1000
800
600
400
200
0
-200
-400
-600
-800
-1000
0
10
20
30
40
50
60
70
Distance (km)

4 Concept Proposal activities and potential impacts

A detailed risk assessment has been completed in both the Groundwater Assessment and Surface Water Assessment (Chandler Facility EIS 2017). The risk assessment considered potential risks arising through the construction, operation, and closure phases of the Proposal. The key Proposal activities and associated risks have been summarised below.

4.1 Concept proposal activities

The construction and operational stages of the Proposal will comprise the surface establishment of hard standing infrastructure, including the construction of mine infrastructure, consisting broadly of paved roads, workers accommodation, storage warehouses, office buildings and mine machinery. Surface infrastructure will have a disturbance footprint limited primarily to topographically low lying areas, distant from ephemeral surface water features and nearby communities.

Underground infrastructure will broadly comprise the establishment and operation of a mine decline shaft, ventilation shafts, an underground mine, and underground fuel and water storages. The surface disturbance footprint of these project components is limited.

The Proposal will receive, temporarily manage and store waste at surface and underground. The management of this component of the Proposal is critical, with the implementation of industry best practice environmental management measures ensuring risks are substantially reduced.

4.2 Mine water balance

A water balance combining the mine water management system, abstracted saline and potable groundwater, and saline water intercepted during construction has been prepared for the construction and operational phases (Chandler Facility EIS 2016). The water balance is based on the conceptual mine plan and will be updated following the completion of detailed design.

The conceptual mine water balance is detailed in Table 4.1.

Table 4.1 Water balance (average rainfall year – 204 mm/yr)

Parameter	Construction (ML/year)[1]	Operation -Year 1 (ML/yr)
Inflows to water management system		
Groundwater inflow to shafts	0	0
Catchment runoff	203	203
Direct rainfall on water storages	143	143
Raw water supply for processing/dust suppression activities	54	91.9
Potable water supply	16	12
Total inflows	416	449.9
Outflows from water management system		
Net site water management system	70	103.9
Uncontrolled releases	0	0
Evaporation	346	346
Total outflows	416	449.9

Table 4.1 Water balance (average rainfall year – 204 mm/yr)

Parameter	Construction (ML/year)[1]	Operation -Year 1 (ML/yr)
Net change in total site water inventory	**0**	**0**

Notes: 1. ML/year = megalitres per year.

4.3 Potential impacts

4.3.1 Surface water

The key Construction and Operational activities that could result in adverse impacts to the surface water environment are associated with increased impervious areas creating greater runoff volumes and velocities (from the construction and operation of the Mine Infrastructure Area (MIA) at the Chandler Facility, haulage roads and the Apirnta Facility). The potential impacts from high intensity rainfall and runoff in the Proposal area include:

- localised flooding and/or bank scouring at the outlet of natural reaches of the drainage system; and
- increased pollutant loads impacting the local discharge areas.

While the Construction and Operation of the Proposal represents a small portion of the total catchment area, surface water runoff is considered a source of pollutants which could be transported into the surrounding landscape. Potential contaminants include hydrocarbons, solvents and oils from construction and operational activities, plus salt and waste materials temporarily stored during operational activities. Pollutants could leak, spill or seep from pipelines, storage/disposal activities, and into drains along transport routes. However site controls which include bunded areas, site drainage and sumps, routine inspection of facilities and monitoring will minimise the escape of contaminants into the local environment.

The internal drainage system conceptualised across the Proposal area constrains the extent of contaminated surface water runoff to the Proposal area. This internal drainage system is also evident across the Chandler Haul Road, the Proposals major transportation route between the Apirnta Facility and the Chandler Facility.

Whilst the construction and operation of the Proposal have the potential to impact the local surface water environment, the Proposal will also likely contribute to the long term regeneration of vegetation downstream of Halfway Dam (near the Chandler Facility). The dam is currently preventing natural drainage entering Halfway Creek, resulting in the gradual dieback of native plant communities that are dependent on these ephemeral flows. Tellus propose to divert (where possible) clean water around project infrastructure to ensure sensitive receptors maintain access to ephemeral flows.

4.3.2 Erosion and sedimentation

Excessive (or accelerated) erosion caused by the construction of hard stand impermeable infrastructure has the potential to impact the "on-site" and "off-site" drainage system.

Alterations to the surface landforms can influence flow velocities, sedimentation and scouring of the landscape. The internal drainage system surrounding the Chandler Facility is designed to constrain potential impacts to the immediate area.

Construction of hard standing infrastructure at the Apirnta Facility has the potential to result in: bank scouring, increased flow velocities and wash-outs downstream of this facility.

4.3.3 Groundwater

The Proposal will intercept multiple fractured rock aquifers through mine construction. The construction of a mine decline and ventilation shafts will intercept the Horseshoe Bend Shale, Langra Formation, Stairway Sandstone and Jay Creek Limestone groundwater systems. Groundwater inflow is expected during construction, although the aquifer characteristics of these formations indicate groundwater inflow volumes will be very small.

Localised groundwater depressurisation in the fractured rock aquifer is likely to result from these groundwater inflows into the mine.

The Proposal water demand also requires the operation of multiple groundwater abstraction bores. The Construction and Operational water demand of approximately 3.42 L/s is estimated to result in a 0.4 m drawdown in groundwater levels at a distance of 1 km from abstraction sources (EMM 2016). This drawdown effect is not anticipated to impact any environmental receptors or landholder bores.

The long term storage of waste material in the Chandler Formation presents a potential deep groundwater contamination risk. The impermeable halite resource underlies the Giles Creek Formation. The Giles Creek Formation unit is greater than 200 m in thickness at the site, and is considered to be massive and of limited fracture potential, effectively acting as an overlying aquitard unit. The risk of groundwater interaction in the shallower fractured rock aquifers with stored waste contaminants located at depths around 850 metres below surface is therefore considered highly unlikely (EMM 2016).

Shallow (ephemeral) groundwater that may occur from time to time in the shallow alluvial and aeolian sediments will be the main receptor if there are pollutant losses from leaks, spills or seepages from pipelines and storage/disposal activities. Shallow groundwater monitoring at each of the Chandler and Apirnta Facilities will provide early identification of any losses into the subsurface. Given that this aquifer system is ephemeral, there is expected to be minimal connectivity with deeper aquifers, and there is no surface water - groundwater connectivity in the local area, the human health and environmental risks associated with sub-surface losses are considered negligible.

5 Environmental management measures

5.1 Environmental requirements and control measures

A range of environmental requirements and control measures for the Proposal are identified in various documents, including: the EIS, Sediment and Erosion Management Plan (SEMP), EIS ToR, and Tellus Holdings' internal Environmental Management System (EMS). Specific management measures required to address potential impacts to surface water, groundwater, and erosion and sediment control are outlined in Table 5.1, in accordance with the requirements of the EIS ToR.

Table 5.1 Water management measures

Management ID	Measure/requirement	When to implement	Responsibility	Reference document
General				
WMP 1	Localised depressurisation of groundwater systems will be monitored with data loggers in monitoring bores to ascertain potential of the Proposal to impact local groundwater users. Groundwater level data will be reviewed and reported on in Annual Environmental Monitoring Reports (AEMRs). Reporting (every four months {April, August and December}) will consider seasonality, comparison of data with project activities and ambient water quality monitoring.	Pre-construction, Construction, Operations, Post-closure	Environment & Approvals Manager	EIS, WMP
WMP 2	A hydrocensus (condition) survey of local groundwater users is proposed to be undertaken prior to Construction to ascertain bore condition and current status of the bores located within a 25 km spatial buffer around the proposed Chandler Facility. This process will involve consultation with local groundwater users, with an end purpose of establishing baseline conditions of existing local groundwater users.	Pre-construction	Environment & Approvals Manager	EIS, WMP
WMP 3	Four additional water monitoring sites will be constructed as nested sites. The sites will be constructed to observe shallow groundwater, and monitor deeper systems, predicted to be intercepted through mining activities. Bores will monitor groundwater levels and quality near Titjikala, the Finke River, and within the deeper groundwater systems (Stairway Sandstone and Jay Creek Formations) near the proposed mine portal. Shallow monitoring of ephemeral groundwater in aeolian/alluvial sediments at the Chandler and Apirnta Facilities will be installed to monitor any pollutant losses into the sub-surface.	Pre-construction	Environment & Approvals Manager	EIS, WMP
WMP 4	A groundwater isotope study will be completed for monitoring bores prior to Construction. The isotope study will provide objective data to confirm the relationship between shallow and deeper groundwater systems, and confirm the origin and residence time of groundwater.	Pre-construction	Environment & Approvals Manager	EIS, WMP
WMP 5	This WMP will be updated during Detailed Design as the site Water Management System (WMS) design becomes available. Tellus will track site water balance requirements for all activities during the mine construction, operational and closure phases of the Proposal.	Pre-construction (detailed design), Construction, Operations, Post-closure	Design Manager, Environment & Approvals Manager	EIS, WMP
Ecosystems potentially dependent on groundwater				
WMP 6	Despite there being no known Groundwater Dependent Ecosystems (GDE's) in the immediate vicinity of the Proposal, potential (GDEs) will be monitored and modelled through Detailed Design if identified to be potentially impacted by the proposed WMS. A monitoring program will be established if potential GDEs are identified to be impacted through the Construction, Operation or Closure of the Proposal.	Pre-construction (detailed design)	Design Manager, Environment & Approvals Manager	EIS, WMP
Groundwater management				
WMP 7	The management of groundwater and surface water inflow into the mine portal and ventilation shafts, including the design and capture of this water will be undertaken in consultation with the Department of Primary Industry and Resources who administer the Mine Management Plan.	Construction	Design Manager	EIS
WMP 8	Preference will be given to reuse of groundwater inflow over potable water for construction activities where reasonable and feasible.	Construction	Environment & Approvals Manager	EIS
WMP 9	The groundwater model developed for the EIS may be refined or further developed to verify the predictions within the environmental impact statement if water level variations outside of the natural range are observed. Modelling will be consistent with established guidelines, which allow for analytical or numerical modelling if appropriate for the project context and risks, subject to discussion and agreement with government agencies.	Operations	Environment & Approvals Manager	EIS
WMP 10	Prioritisation will be given to the re-use of groundwater inflows and the capture of surface water runoff as a means of meeting construction and operational water demands.	Construction, Operations	Environment & Approvals Manager	EIS
WMP 11	Groundwater abstraction will be monitored in production bores. A cumulative flow meter will be fitted to each production bore, and pressure transducers installed in each bore to monitor groundwater drawdown at source.	Construction, Operations, Post-closure	Design Manager	EIS
Surface water management				
WMP 12	A monitoring program developed as part of this plan to monitor water quality upstream and downstream in local drainages shall be implemented.	Pre-construction	Environment & Approvals Manager	EIS
WMP 13	Scour and erosion protection measures and energy dissipation shall be implemented down gradient of drainages to attenuate flows, manage flow velocities and contain surface water runoff.	Construction	Design Manager	EIS, SEMP
WMP 14	A maintenance protocol will be established during detailed design to check the adequacy of water retention infrastructure.	Pre-construction	Design Manager	EIS, SEMP
WMP 15	All refuelling and maintenance of vehicles and machinery will be undertaken in established hard-standing, bunded areas to prevent the surface migration of hydrocarbons, solvents and oils.	Construction, Operations, Post-closure	Environment & Approvals Manager	EIS
WMP 16	Operational transportation of all waste product, oils, diesel, and petrol will be done so on defined haulage routes, where potential spills can be captured in channels adjacent to Proposal haulage routes.	Construction, Operations, Post-closure	Environment & Approvals Manager	EIS
Erosion and sediment control				
WMP 17	A refined WMS in conjunction with a SEMP will be developed during detailed design to ensure floodwaters or sheet flows draining to the proposed Chandler Facility and Apirnta Facility are either managed or diverted around project activities.	Pre-construction (detailed design)	Design Manager	EIS

Table 5.1 Water management measures

Management ID	Measure/requirement	When to implement	Responsibility	Reference document
Monitoring Program				
WMP 18	A water monitoring program will be implemented for the Construction, Operational and Post-closure phases of the Proposal. The monitoring program will be prepared in consultation with the NT EPA, and independently peer reviewed.	Pre-construction	Environment & Approvals Manager	WMP
WMP 19	A water monitoring network shall be established prior to Construction. Monitoring will be undertaken in accordance with the WMP.	Pre-construction	Environment & Approvals Manager	WMP
Records				
WMP 120	Records of all water quality monitoring results, rainfall records, groundwater level and flow measurements will be maintained and provided to NT regulators every four months. The proponent nominates the months of April, August and December.	Pre-construction, Construction, Operation, Post-closure	Environment & Approvals Manager	WMP_V1

6 Water quality objectives and criteria

The performance objectives of this WMP focus on water quality, groundwater drawdown and the maintenance of the ephemeral surface water environment, and therefore, the indirect protection of environmental, groundwater, and surface water users. The proposed criteria provide a framework for the ongoing assessment of groundwater levels, surface water flow and water quality during concept Proposal Construction, Operation and Post-Closure.

6.1 Surface water quality objectives

Due to the 'flashy' ephemeral surface water flow nature of the semi-arid to arid environment of south-central Australia, the establishment of surface water quality objectives has not previously been considered.

Tellus intend to monitor drainage lines bisecting the Maryvale Hills for flow velocities, flow depth and sediment base loads, and where appropriate, installing diversion channels directing runoff around the Proposal area.

The broader (regional) downstream environmental receptors or consumptive users (along the Hugh and Finke Rivers) are typically dependent on episodic surface water flows to maintain seasonal stock and domestic supplies and riparian vegetation communities. These users would typically be considered when developing surface water quality objectives, however both the Chandler and the Apirnta facilities are remote from these surface water features and local runoff is unlikely to reach these receptors except in the event of an extreme rainfall and flood event.

6.2 Development of trigger values

6.2.1 Surface water quality

Reliance on guideline values included in the *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZECC/ARMCANZ 2000) is considered industry best practice unless baseline monitoring data or specified water quality objectives are available to develop site specific trigger values.

Due to the lack of local surface water receptors and limited baseline data, it is considered appropriate to apply the guideline values for the *South central Australia – low rainfall area* (ANZECC/ARMCANZ 2000). These guideline values are relevant to the Chandler Project to ensure the protection of the environment for 'slightly disturbed ecosystems' and are used to assess the risk of adverse effects to nutrients, biodegradable organic matter and pH in ephemeral surface water systems. They are proposed for application to local surface water monitoring locations. Data collected at remote sites along the Hugh and Finke Rivers will be used for comparative purposes only.

Default water quality criteria are provided in Table 6.1. Tellus are committed to developing local catchment-specific water quality criteria (ie based initially on the low rainfall area guidelines, and updated as additional monitoring data become available). The WMP will be revised prior to the Construction phase of the Project following the collection of local surface water quality samples to ensure that site runoff and water quality criteria are consistent with the natural environment. Project surface water quality criteria will also be expanded to include major cations/anions and selected trace metals to ensure comprehensive water quality criteria is developed consistent with project activities.

i Surface water quality criteria

Preliminary site specific surface water quality criteria are presented in Table 6.1.

Table 6.1 Site specific surface water quality criteria

Analyte	Units	Local site(s)
Oil and grease		No visible sign
pH	pH units	6.5-9
Dissolved oxygen	% saturation	Lower limit = 90
Salinity (electrical conductivity)	µS/cm[1]	100-5,000
Turbidity	NTU[2]	1-50
Total phosphorous	µg/L[3]	100
Total nitrogen	µg/L	1,000
Ammonium	µg/L	25

Notes: 1. microSiemens per centimetre;
2.nephelometric units; and
3.micrograms per litre

6.2.2 Groundwater quality

The existing Stage 1 groundwater monitoring network targets the fractured rock groundwater system and two deep aquifer systems; Horseshoe Bend Shale, and Langra Formation. Further groundwater monitoring bore drilling (Stage 2) is scheduled for later 2017, subject to planning approval. The Stage 2 drilling program will involve the construction and installation of bores, targeting the shallow alluvium supporting groundwater supplies adjacent to the distant Finke River and Hugh River. Locally the expanded program will also include further nested installations into the aeolian sediment, Horseshoe Bend Shale and Langra groundwater systems, and a deep nested monitoring bore targeting the Stairway Sandstone and the Jay Creek Limestone groundwater systems.

ANZECC/ARMCANZ (2000) advocate the use of site specific criteria where comprehensive (>24 consecutive months) monitoring data is available. The existing groundwater monitoring has a data record of approximately 13 months with 6 groundwater sampling events. The historic water quality monitoring data has been used to develop 'formation-specific' water quality criteria, using water quality results obtained from the existing monitoring network, grouping individual sites into their respective geological formations (i.e. Horseshoe Bend Shale and Langra Formation).

As recommended by ANZECC/ARMCANZ (2000) guidelines, the formation-specific water quality criteria were determined by calculating the 80^{th} percentile values for the available parameters. A percentile is the value below which a given percentage of observations fall. The 80^{th} percentile is therefore the value below which 80% of observations are found. Using these percentiles removes anomalous data that is outside of the normal range (defined here as 0 – 80 % of values).

Formation-specific criteria will be re-assessed and revised following commissioning of the Stage 2 groundwater monitoring network and any additional sampling events completed 'pre-construction'. The formation-specific criteria will also be expanded in future revised WMPs to ensure criteria are refined for a comprehensive suite of analytes that targets key parameters which may be influenced through Construction, Operational and Post Closure phases of the Project (particularly the waste disposal activities).

i Groundwater quality criteria

Preliminary formation specific groundwater water quality criteria are presented in Table 6.2.

Table 6.2 Formation-specific groundwater quality criteria

Analyte	Units	Horseshoe Bend Shale	Langra Formation	Stairway Sandstone[4]	Jay Creek Limestone[4]	Aeolian/ Alluvium[4]
pH (field)	pH units	8-8.1	7.9-8.2			
EC (field)	µS/cm[1]	18,000	19,920			
Total dissolved solids	mg/L[2]	13,200	13,900			
Chromium (VI)	µg/L[3]	15	33.8			
Copper	µg/L	13.2	3.6			
Lead	µg/L	18.4	2.4			
Nickel	µg/L	12.6	9.6			
Zinc	µg/L	3,712	1,247			
Iron	µg/L	14,244	1,800			
Ammonia as N	mg/L	0.134	0.038			
Nitrite as N	mg/L	0.015	0.014			
Nitrate as N	mg/L	5.6	0.4			
Total phosphate	mg/L	0.02	0.015			

Notes: 1. microSiemens per centimetre;
2. milligrams per litre; and
3. micrograms per litre
4. criteria to be developed following Stage 2 construction

6.2.3 Groundwater levels

Approximately twelve months of baseline groundwater level data are available from the Stage 1 monitoring bores across the two aquifer systems.

For each of the assessed monitoring bores, the minimum, mean and maximum groundwater levels are identified, together with the standard deviation from the mean. Some monitoring bores show a slow recovery of groundwater levels after purging and sampling. This data is not included in the calculations as it does not represent natural variability in groundwater levels.

The groundwater level threshold based on the available data is developed as follows:

$$\text{Threshold} = (\text{standard deviation from mean}*2)*20\% \qquad \textit{Equation 1}$$

An arbitrary 20% buffer is applied to the natural variability range observed in the 12 months of available data to account for possible greater variability which is expected to occur during more extreme seasons.

Groundwater levels will also be compared to the results of the analytical model (EMM 2017) to determine if drawdown exceeds the predictions.

Following installation of the Stage 2 monitoring bores and the ongoing collation of groundwater level data, the WMP will be updated to include formation-specific hydrographs that describe baseline conditions. The hydrographs will present rainfall, groundwater elevation, upper/lower threshold limits and identify where monthly sampling has induced temporary groundwater drawdown.

7 Monitoring program

7.1 Monitoring objectives

The primary objective of this WMP is to measure and assess potential impacts of the Proposal on water quality, groundwater levels and surface water flow in the surface water features, groundwater systems and natural environment within the Project area.

To achieve this objective, groundwater and surface water monitoring is being undertaken.

The monitoring locations, sampling parameters and frequency of monitoring are outlined in this section.

The information collected during the monitoring program will also be used to inform project management responses aimed at reducing or halting any adverse impacts detected during the Construction, Operational and Post Closure phases of the Proposal.

7.2 Monitoring study design

The monitoring program involves repeat sample collection and related measurements at existing and proposed static locations within the catchment area surrounding the Project activities (see Figure 7.1 and Figure 7.2). The collection of repeat data over a known time period enables an assessment of changes in water quality, groundwater levels and surface water condition that may result from the implementation of the Project. This program is described by the Australian guidelines for water quality monitoring and reporting as a ’study that measures change’ (ANZECC/ARMCANZ 2000: 3-3). The basic premise of this methodology is that suitable spatial and temporal monitoring is built into the study design.

7.2.1 Surface water study design

Tellus propose to implement a Before-After-Control-Impact approach to surface water monitoring. This involves the collection of data before and after a known activity that has the potential to impact the environment is initiated (ANZECC/ARMCANZ 2000).

In addition, the selection of local monitoring locations for surface water has incorporated an upstream (or control) site and a downstream (or impact) site (ANZECC/ARMCANZ 2000), where possible. This type of monitoring program allows for measurement of trends in water quality and simple correlations between characteristics such as background quality, rainfall, potential discharge quality and specifically analytes within the analytical suite.

The inclusion of control and impact sites where possible means that the study can capture any natural variation in water quality between the upstream and downstream locations. In addition, regional surface water sampling sites will be established on the Hugh and Finke Rivers (near the groundwater monitoring locations) for comparative purposes.

The following surface water locations identified below in Table 7.1 and shown in Figure 7.1 will be monitored. The sites have been identified as the ideal locations to identify potential impacts arising from the construction, operation, and closure of the Proposal.

Table 7.1 Surface water monitoring locations

Site name	Waterway	Purpose
SW01 (u)[1]	Halfway Creek	Upstream of Chandler Facility Mine Infrastructure Area. Control site monitoring Halfway Creek upstream of project activities.
SW01 (d)[2]	Halfway Creek	Downstream of Chandler Facility monitoring potential impacts associated with alterations to the flow regime and quality.
SW02	Ridey Gully	Upstream of Chandler Facility Mine Infrastructure Area. Expanded baseline monitoring.
SW03 (u)	Oak Gully	Upstream of Chandler Facility Mine Infrastructure Area. Control site monitoring Oak Gully upstream of project activities.
SW03 (d)	Oak Gully	Downstream of Chandler Facility monitoring potential impacts associated with alterations to the flow regime and quality.
SW04	Unnamed drainage line	Downstream of Apirnta Facility, monitoring potential impacts associated with alterations to the flow regime and quality.
SW05[3]	Hugh River	Remote sites located downstream of Apirnta and Chandler Facilities, monitoring potential impacts associated with the construction, operation and closure of these facilities.
SW06[3]	Finke River	

Notes: *1.upstream site*
2.downstream site
3.regional site

7.2.2 Groundwater study design

Groundwater monitoring bores have been selected for their appropriateness in terms of gathering relevant spatial and temporal scale data. Bores targeting the alluvium/aeolian sediment, Horseshoe Bend Shale, Langra, Stairway Sandstone, and the Jay Creek Formations have been selected across the Proposal area as a means to capture groundwater level behaviour within the these aquifer systems. Most locations are sited at the Chandler facility surrounding the mine site. Nested sites targeting discrete zones within the different Formations provide information on the levels within those units, and the potential vertical gradients between shallower and deeper Formations. This is important for the ongoing conceptualisation of the groundwater environment, including recharge and discharge characteristics in the deeper groundwater systems and responses to pumping stresses.

Monitoring bores have been located to capture potential impacts at a local and regional scale. Multiple nested sites have been located directly adjacent to the Chandler Facility and the proposed accommodation village just northeast of the Chandler mine infrastructure area. These sites will monitor local depressurisation and potential contamination of the groundwater systems intercepted by the Proposal. A nested site is also located adjacent to the Apirnta Facility to monitor for potential impacts arising from loading/unloading and temporary storage of salt and waste materials. Regional sites are located as proxy sites between the Proposal and sensitive environmental receivers.

Table 7.2 lists the sites proposed for ongoing groundwater monitoring. Figure 7.2 shows the completed (Stage 1) and proposed (Stage 2) locations of the groundwater monitoring sites. The WMP will be updated as additional monitoring sites are included.

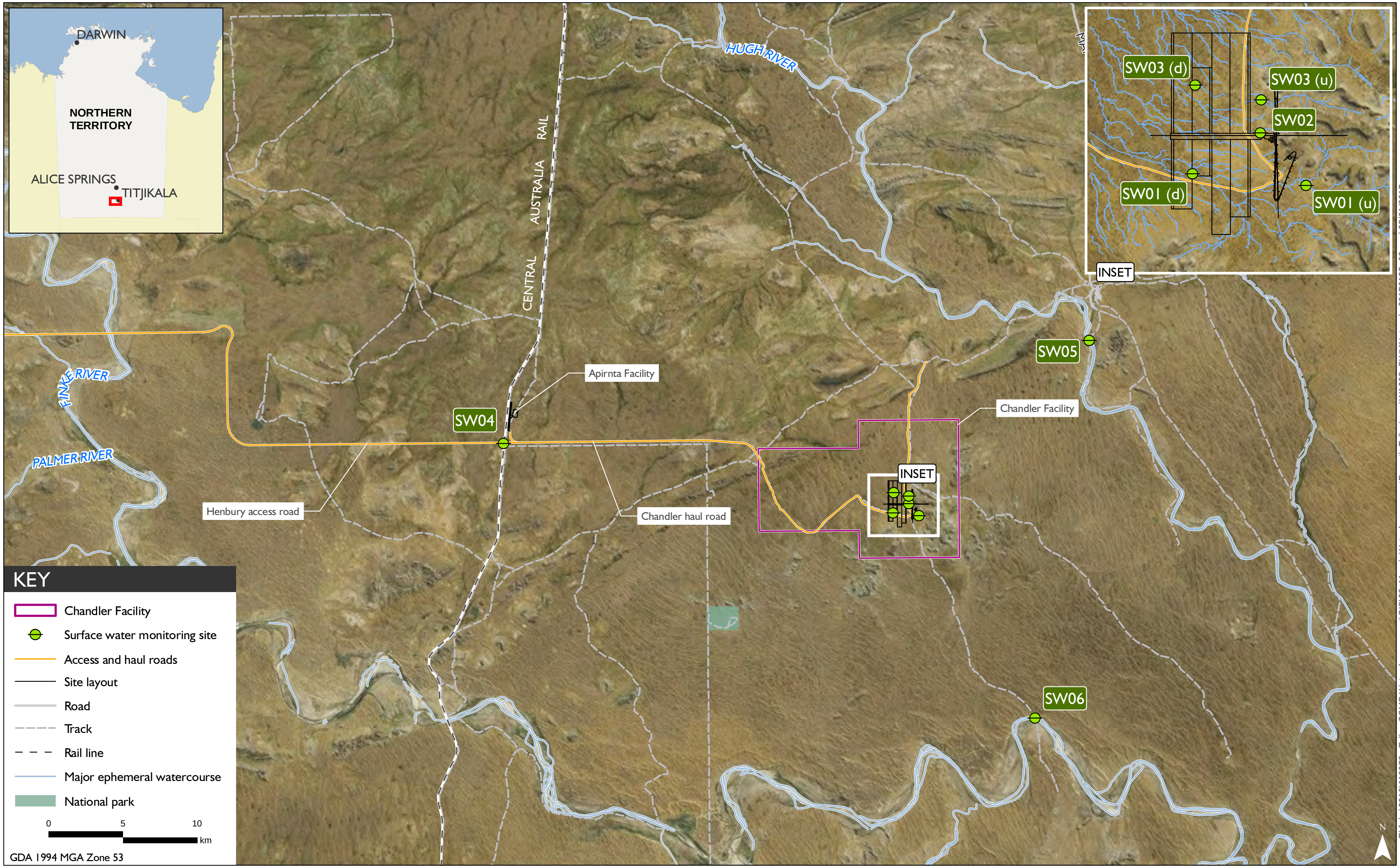
Table 7.2 Groundwater monitoring locations

Site name	Groundwater system	Purpose
WT1	Upper Langra	Chandler Facility abstraction and mine inflow

Table 7.2 Groundwater monitoring locations

Site name	Groundwater system	Purpose
WT2	Horseshoe Bend Shale	Chandler Facility mine inflow
WT3a	Upper Langra	Chandler Facility abstraction and mine inflow
WT3b	Lower Langra	Chandler Facility abstraction and mine inflow
WT4a	Horseshoe Bend Shale	Chandler Facility mine inflow
WT4b	Upper Langra	Chandler Facility abstraction and mine inflow
WT5a	Horseshoe Bend Shale	Chandler Facility mine inflow
WT5b	Horseshoe Bend Shale	Chandler Facility mine inflow
WT6a	Horseshoe Bend Shale	Chandler Facility mine inflow
WT6b	Lower Langra	Chandler Facility abstraction and mine inflow
WT7a[1]	Alluvium	Establishing regional interaction between shallow, deeper systems
WT7b[1]	Upper Langra	Establishing regional interaction between shallow, deeper systems Regional depressurisation from Proposal
WT8a[1]	Alluvium	Establishing regional interaction between shallow, deeper systems
WT8b[1]	Horseshoe Bend Shale	Establishing regional interaction between shallow, deeper systems Regional depressurisation from Proposal
WT8c[1]	Upper Langra	Establishing regional interaction between shallow, deeper systems Regional depressurisation from Proposal
WT9[1]	Stairway Sandstone	Chandler Facility mine inflow
WT10a[1]	Stairway Sandstone	Chandler Facility mine inflow
WT10a[1]	Jay Creek	Chandler Facility mine inflow
WT11[1]	Jay Creek	Chandler Facility mine inflow
WT12[1]	Aeolian sediment	Chandler Facility shallow groundwater quality
WT13a[1]	Aeolian sediment	Apirnta Facility shallow groundwater quality
WT13b[1]	Horseshoe Bend Shale	Apirnta Facility deeper groundwater quality

Notes: 1.Stage 2 proposed sites



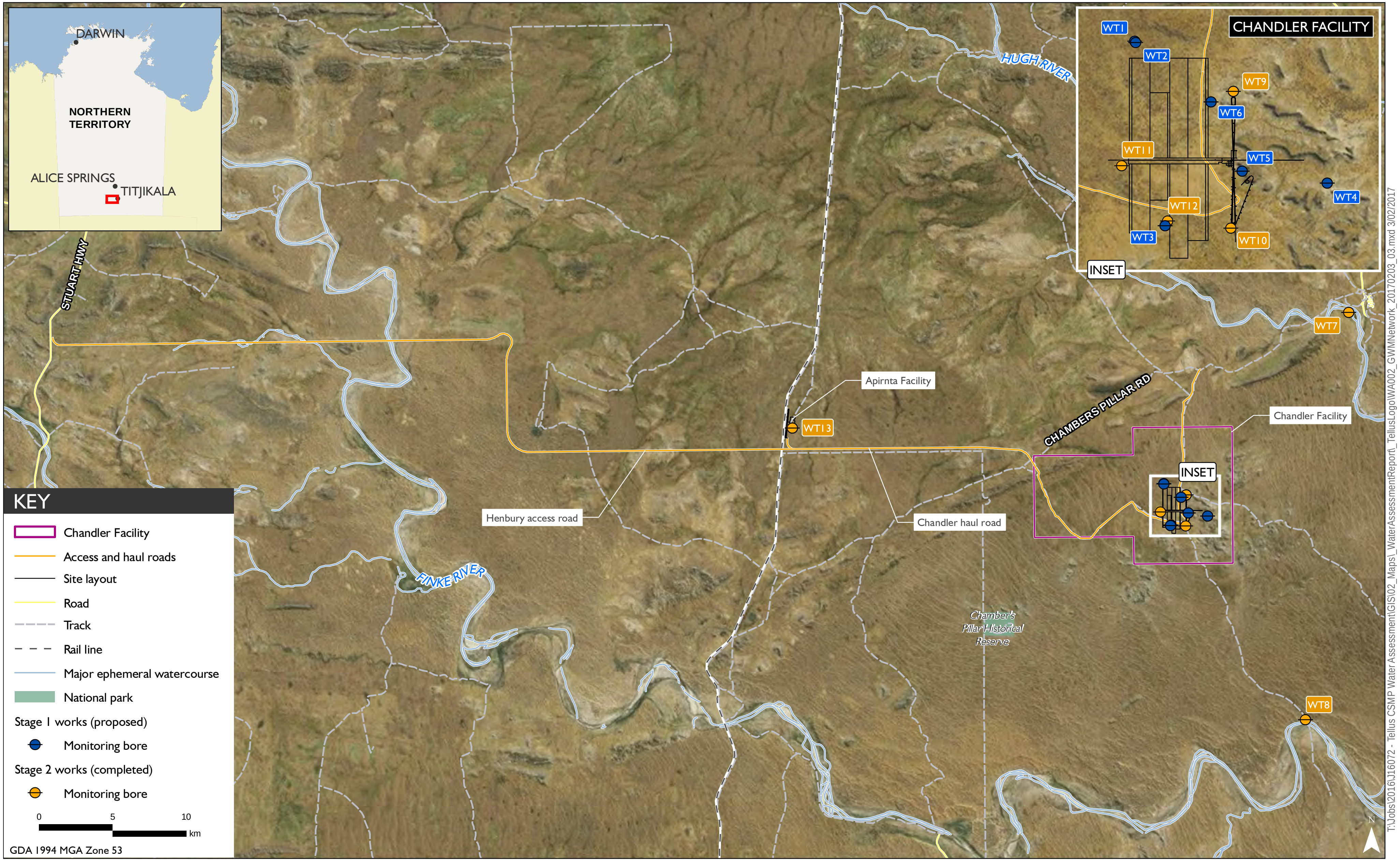
Source: EMM (2017); GeoScience Australia (2016); LPI (2011)

TELLUS

Surface water monitoring network

Chandler facility

Water management plan



Source: EMM (2017); GeoScience Australia (2016); LPI (2011)

TELLUS

Groundwater monitoring network
Chandler facility
Water management plan

7.3 Monitoring parameters

7.3.1 Water quality

In accordance with the requirements of the EIS ToR, the water quality monitoring parameters included in this WMP have been selected based on:

- the *Australian Guidelines for Water Quality Monitoring and Reporting* (ANZECC Monitoring Guideline) (ANZECC/ARMCANZ 2000);
- site-specific baseline data; and
- proposed project waste material to be received by the Proposal.

The physical parameters (i.e. pH and EC) and the major anions and major cations will be used to assess basic water characteristics as they provide good indicators of overall water quality. In addition, Total Suspended Solids (TSS) and turbidity changes will be measured at surface water sites between upstream and downstream locations. This will provide an indication of changes in sediment load potentially caused by Project activities.

Nutrients such as ammonia, nitrates and phosphates provide an indication of the organic load present within the water and can often be linked to anthropogenic activities.

Total petroleum hydrocarbons (TPH) and BTEXN (benzene, toluene, ethyl-benzene, xylene and naphthalene) provide an indication of pollution from hydrocarbons, such as from fuels, oils, solvents and grease.

The dissolved metals listed in Table 7.3 are the common trace constituents measured in groundwater and surface water and generally form a standard suite of analysis for sampling programs. They provide an indicator of rock-water interactions and can demonstrate how the natural environment is influenced by anthropogenic activities within the groundwater and surface water catchments.

An expanded comprehensive analytical suite, targeting key water quality analytes that may be influenced during Proposal Construction, Operational, and Post-closure phases of the Project, through the storage of waste material will also be assessed. This suite will be based on the nature of the waste types that will be received and will focus on the chemistry of the most hazardous materials. A preliminary suite will be identified prior to construction and there will be at least one "pre-construction" sampling event.

Table 7.3 specifies the water quality parameters required for analysis during specified sampling events. A process flow diagram has been developed to demonstrate Tellus' commitment to the ongoing review of the sampling frequency and the analytical suite as the Proposal progresses (see Figure 7.3).

Table 7.3 Monitoring parameters

Analysis/classification	Parameter
In-field analysis	
Chemical properties[1]	pH, dissolved oxygen
Physical properties[1]	temperature, electrical conductivity, total dissolved solids turbidity and TSS [3]
Laboratory analysis	

Table 7.3 Monitoring parameters

Analysis/classification	Parameter
Hydrocarbons[1]	TPH, BTEXN
Dissolved and total metals[1]	aluminium, arsenic, cadmium, chromium, copper, iron, lead, manganese, mercury, nickel, zinc
Major ions[1]	alkalinity, bicarbonate, calcium, carbonate, chloride, hydroxide, magnesium, potassium, sodium, sulfate, fluoride
Nutrients[1]	total nitrogen, total phosphorus, nitrite, nitrate, ammonia
Project waste[2]	To be determined on the basis of the waste that is to be transferred and stored but at a minimum will include PAH, antimony, beryllium, boron, molybdenum, selenium, strontium, radium and uranium

Notes: *1.Standard analytical suite*
2.Comprehensive analytical suite
3.Surface water only

7.3.2 Rainfall records

Rainfall within the catchment can influence the surface water and groundwater quality parameters, as well as surface water flow and groundwater levels. Tellus operates an Automated Weather Station near the proposed Chandler accommodation area, approximately 2 km north-west of the Maryvale Hills. The AWS is programmed to log rainfall on a 15-minute frequency.

Comparisons of rainfall to water quality, flow and groundwater level data will be carried out every 12 months, in line with annual environmental reporting requirements.

7.4 Sampling frequency

The proposed sampling frequencies for surface water and groundwater differ because surface water must consider episodic rainfall events, whereas groundwater is not immediately altered by rainfall. Sampling frequencies will also be modified for the different phases of the project once a satisfactory baseline of water quality and groundwater level data has been obtained.

If sampling frequencies are to be reduced, or individual parameters or sites are to be withdrawn from the program, it will first be demonstrated that there is no longer an impact over three consecutive sampling rounds.

Any proposed alteration to the sampling frequency, individual parameters, or sites would be advised, with supporting evidence to the NT EPA one calendar month prior to the change being implemented.

7.4.1 Surface water sampling frequency

Given the semi-arid to arid environment, and the lack of local surface water features and the ephemeral nature of the rivers skirting the Proposal area, the opportunity to schedule periodic surface water sampling events is limited.

A 3-day (72 hour) rainfall event will be the defined surface water sampling trigger for all local up-stream and down-stream sampling locations. Tellus are committed to sampling all surface water monitoring sites within 24 hours of this rainfall event.

Dependant on rainfall events within the local area, Tellus will undertake surface water sampling events during the pre-construction, construction, and operational phases of the Proposal. Post-closure sampling frequencies will be agreed at a later date under the parameters of an agreed Institutional Control Period.

7.4.2 Groundwater sampling frequency

The sampling frequency for groundwater quality monitoring across the Proposal area will vary dependent on Proposal phase. Table 7.4 outlines the required sampling frequency for groundwater sites across the various phases of the Proposal.

Table 7.4 Groundwater sampling frequency

Proposal phase	Frequency
Pre-construction	Standard suite – quarterly
	Comprehensive suite – annually
Construction	Standard suite – quarterly
	Comprehensive suite – annually
Operation	Standard suite – quarterly
	Comprehensive suite – annually
Post-closure	Comprehensive suite – annually

7.5 Sampling protocol

A project sampling protocol has been developed for the Proposal (see Appendix B). This document will inform field technicians of sampling requirements at each site.

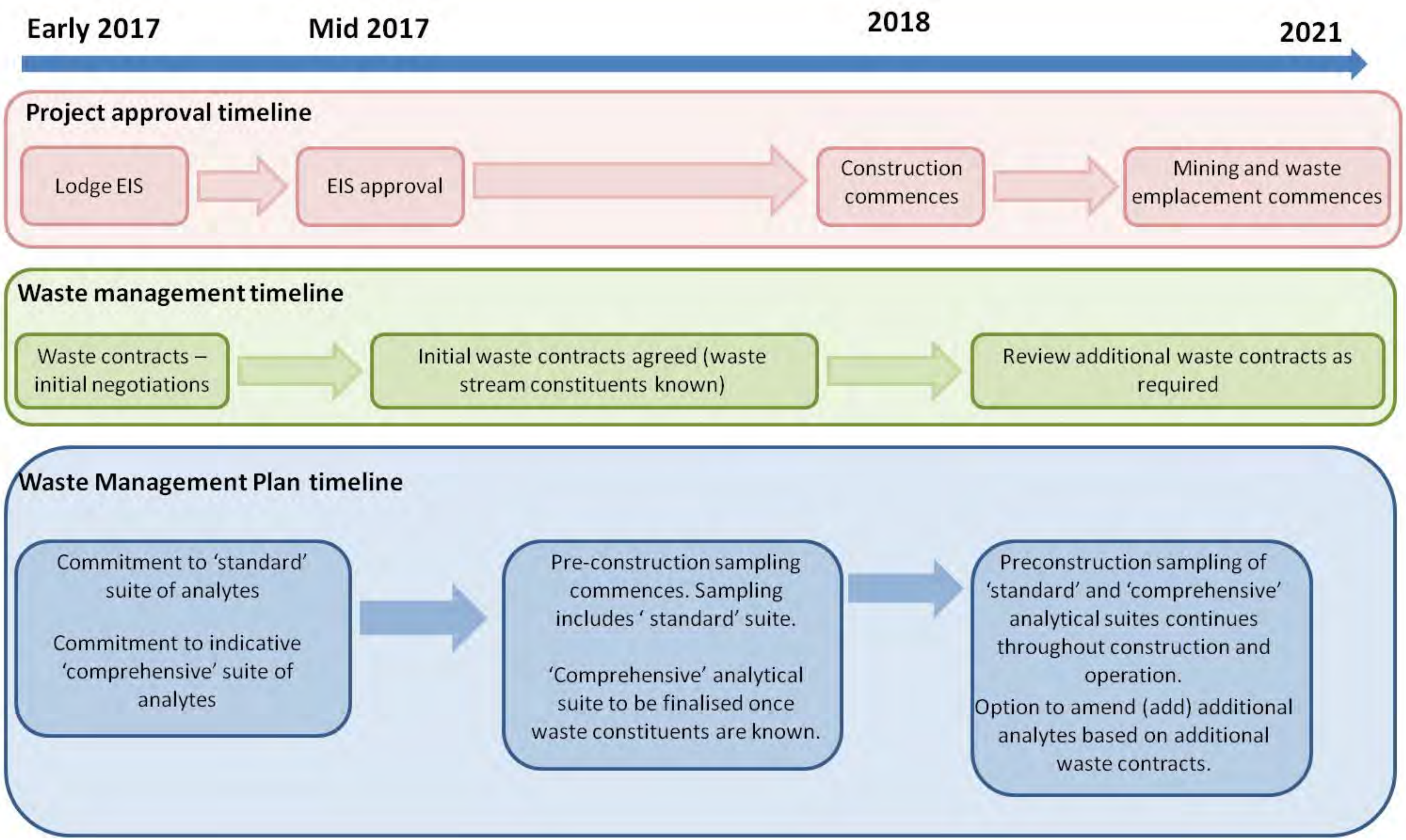


Figure 7.3 Monitoring program process

8 Management and contingency actions

Management goals need to reflect community needs and environmental values. They need to be measurable and relate to potential impacts. Water management goals should reflect the desired levels of protection for resources and ecosystems while also considering economic and social values.

Ongoing water monitoring will be used to identify potential project impacts on the receiving waters and to inform appropriate management and mitigation responses.

Management and mitigation responses apply to Construction, Operational and Post-closure phases of the Proposal. Tellus' approach is outlined in this section, with strategies for management and mitigation developed in accordance with the EIS ToR (see Table 2.1).

8.1 Water quality

For surface water quality, a management response will be triggered if exceedances of any of the water quality criteria listed in Table 6.1 occurs at local monitoring sites as described in the response action process flow diagram presented in Figure 8.1.

For groundwater quality, a management response will be triggered as described in the response action process flow diagram presented in Figure 8.2.

It is important to note that data generated from environmental sampling are inherently "noisy". The occasional excursion of the data beyond site-specific criteria may be a chance (natural) occurrence, may be due to other land use factors or may indicate a potential issue associated with site activities. The method used to calculate site-specific criteria for the Proposal recognises the inherent variability of natural systems by acknowledging natural and sampling induced variation.

Water quality criteria will be reviewed for appropriateness prior to Project Construction.

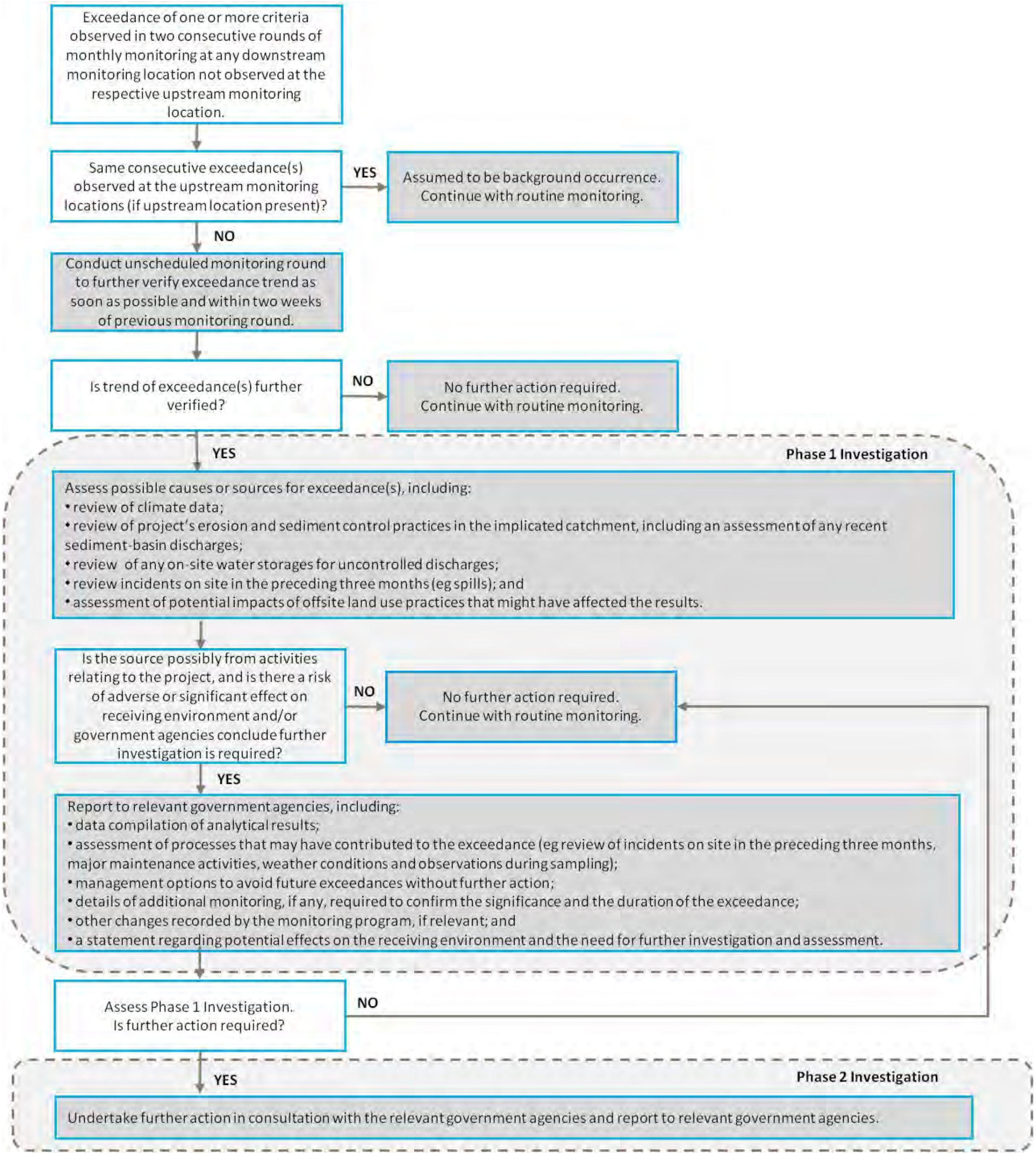


Figure 8.1 Response action process for exceedance of surface water quality threshold

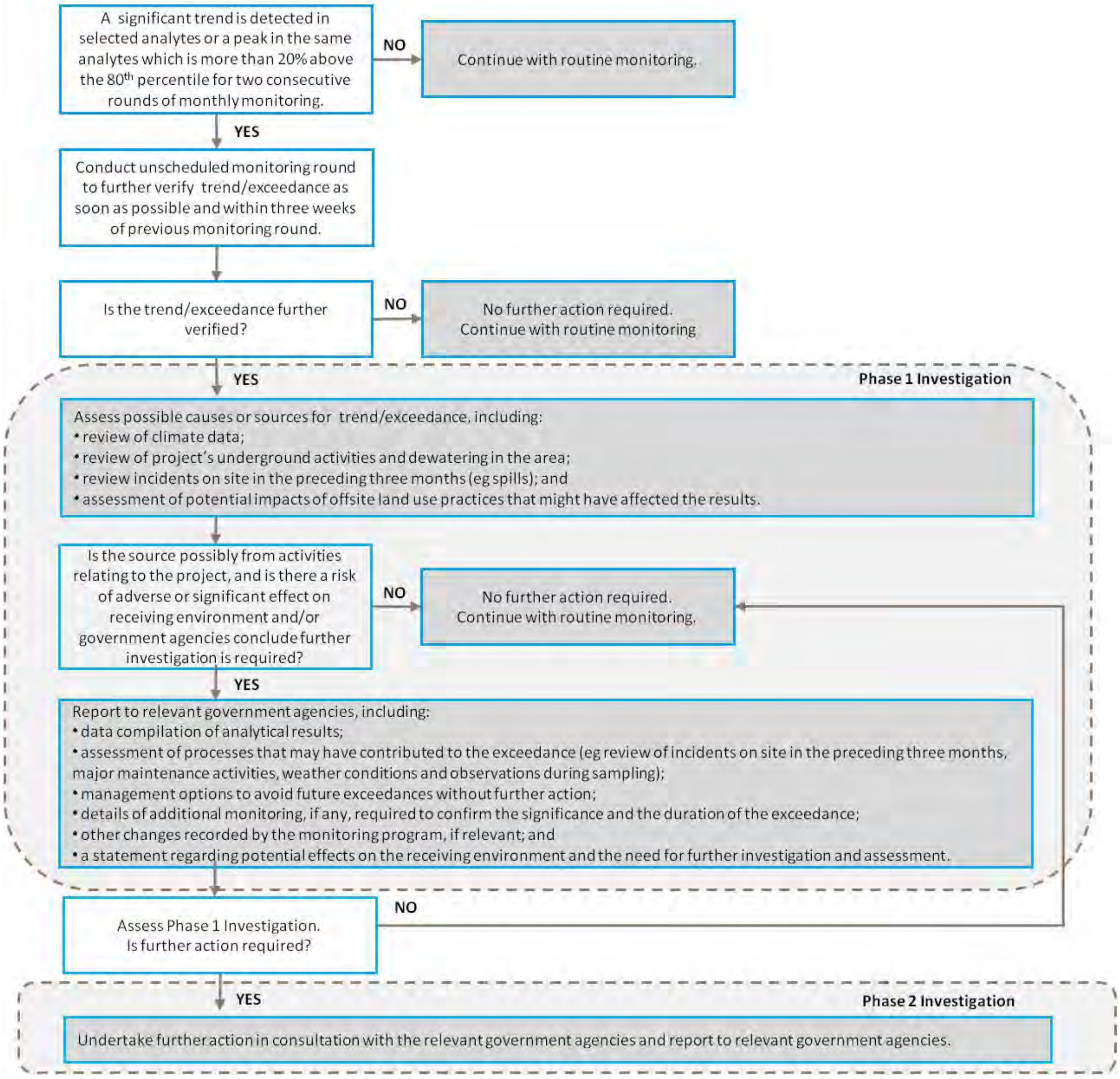


Figure 8.2 Response action process for exceedance of groundwater quality threshold

8.2 Groundwater levels

A management response will be triggered if groundwater level drawdown in existing and proposed Project groundwater monitoring bores exceeds established trigger thresholds (see Section 6.2.3). A management response will be triggered as described in the response action process flow diagram presented in Figure 8.3.

The groundwater level threshold will be reviewed for appropriateness prior to the Construction phase of the Project.

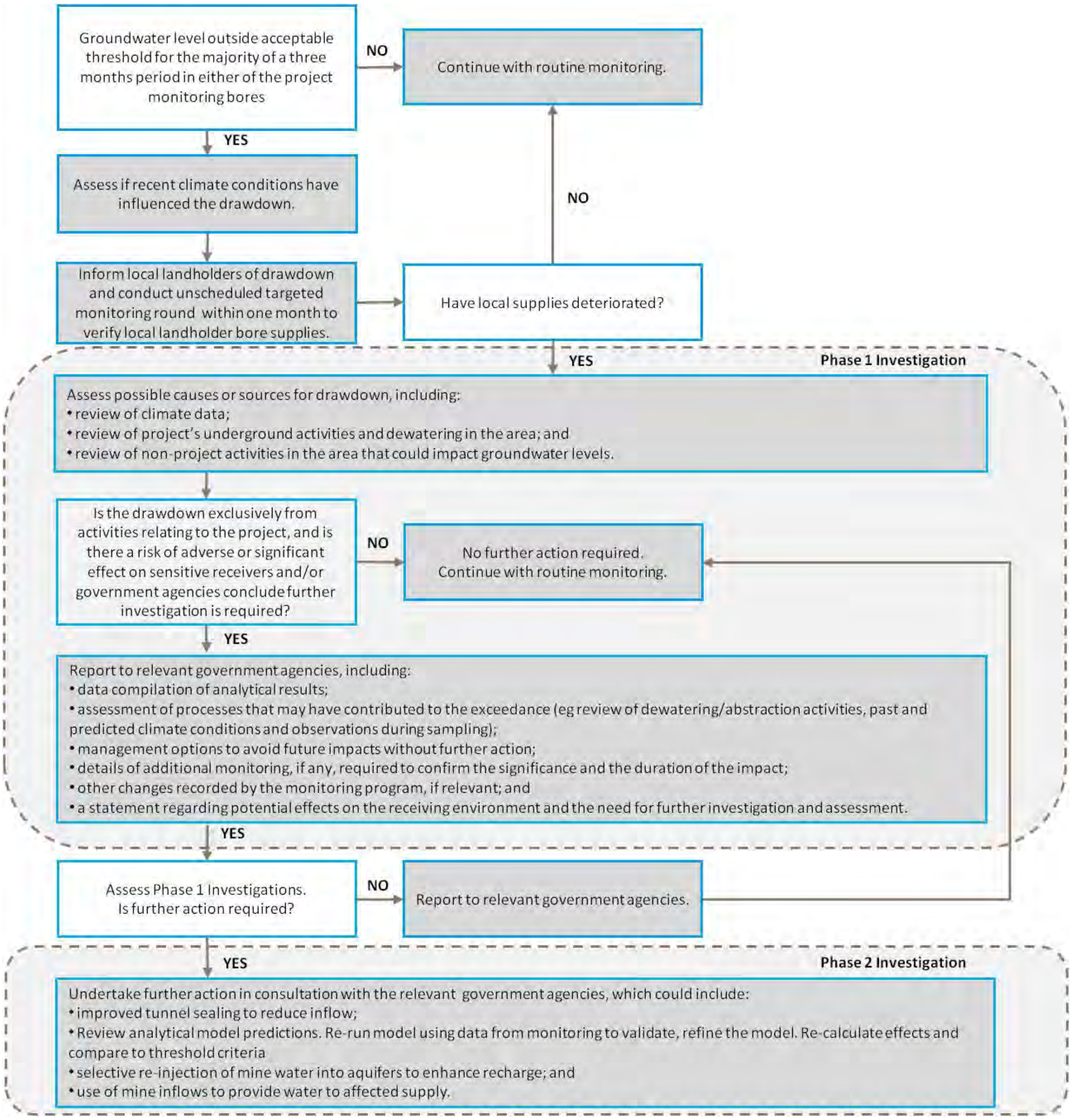


Figure 8.3 Response action process for exceedance of groundwater level threshold

9 Community complaints

If a community complaint relating to surface water or groundwater is received by Tellus, the complaint details are to be circulated and actioned by the responsible party(s). The procedures and protocols to address the relevant community concerns are outlined below.

1. Depending on the nature of the complaint, a revision to the monitoring, reporting and consultation procedures may be required to avoid similar complaints.

2. Actions required in response to complaints are to be effected in a timely manner. The agreed Tellus response shall be communicated effectively to the complainant by the nominated Tellus communications officer via a formal letter.
3. The Tellus Environment and Community Manager is to maintain a register of all complaints, actions and responses.

10 Reporting and document review

10.1 Reporting

Reporting will be required to convey the findings of the program and ensure that project management is responsive to the water quality, groundwater level and flow monitoring results. Groundwater and surface water reporting will be undertaken on an annual basis. Reports will be provided to NT EPA and will be made publically available.

Reporting will include presentation, interpretation and discussion of 12 months of results, noting any exceedances of the trigger values and any incidents. Where applicable, recommended updates to the monitoring program will also be included. The appropriateness of the water balance, and water storage retention dams and spill levels and the adequacy of their design will be reviewed annually.

Field sheets recording field parameters and laboratory results reports will be appended to the reports. At the completion of the Construction, Operational and Post-Closure phases of the Project a detailed report on all water quality, groundwater level and flow data will be prepared. This will state whether revisions to the water monitoring program are required.

10.2 Document review

This WMP has been developed based on the concept Proposal design, and limited baseline information. Tellus are committed to reviewing this WMP following detailed design and the collection of additional baseline information. The review will ensure defined environmental triggers and management measures are consistent with detailed design and the ambient environment.

The WMP will be reviewed in response to major incidents where environmental management responses are initiated in the event of a trigger value exceedance, or in response to environmental audits. This WMP will be adapted and ongoing throughout the Construction, Operational, and Post-Closure phases of the Proposal.

11 Consultation

As required by Project EIS ToR, the draft WMP has been prepared in consultation with the NT EPA and has been through a process of Independent Peer Review. Feedback received through Independent Peer Review is appended to this document (see Appendix A).

This WMP is considered a working document and should be periodically reviewed as additional data becomes available. All revisions to this WMP will be undertaken in consultation with the NT EPA.

12 References

Agriculture and Resource Management Council of Australia and New Zealand and the Australian and New Zealand Environment and Conservation Council (ANZECC/ARMCANZ) 2000 Australian and New Zealand guidelines for fresh and marine water quality

ANZECC/ARMCANZ 1995, Guidelines for Groundwater Protection in Australia–end-user analysis report, Department of Resources, Energy and Tourism

ANZECC/ARMCANZ 2000, National water quality management strategy guidelines for groundwater protection in Australia

Australian Standard 5667.11 Water Quality Sampling Part 11: Guidance on sampling of Groundwaters. Australian/ New Zealand Standard 5667.11:1998

Duguid, A., Barnetson, J., Clifford, B., Pavey, C., Albrecht, D., Risler, J. and McNellie, M. (2005). Wetlands in the arid Northern Territory. A report to the Australian Government Department of the Environment and Heritage on the inventory and significance of wetlands in the arid NT. Northern Territory Government Department of Natural Resources, Environment and the Arts. Alice Springs

EMM 2016, *Chandler Facility Groundwater Assessment.* Tellus Holdings Limited

Lloyd J.W. and Jacobson G. 1987, *The Hydrogeology of the Amadeus Basin, Central Australia.* Journal of Hydrology 93(1987):1-24

NHMRC 2011, National Water Quality Management Strategy: Australian Drinking Water Guidelines 6: Volume 1

Northern Territory Environment Protection Authority 2013, Final Guidelines for the preparation of an

Appendix A

Independent Peer Review - feedback

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INDEPENDENT REVIEW STATEMENT

ATTENTION:	Richard Phillips, Environment and Approvals Manager, Tellus Holdings Ltd	
CC:	Sean Cassidy, Senior Hydrogeologist, EMM Consulting	
FROM:	Hugh Middlemis, Principal Groundwater Engineer, Hydrogeologic Pty Ltd	
REFERENCES:	**6 February 2017**	Project ref: Chandler Facility Salt Project Water Management Plan
	HGL job#: 61.044	HGL doc#: Middlemis_2017_Chandler_WMP_review.docx
SUBJECT:	**Independent review of Chandler Facility Water Management Plan**	

This memo summarises the outcomes of an independent review of the Chandler Facility Water Management Plan (WMP) that was developed by EMM Consulting (EMM) on behalf of Tellus Holdings Ltd. The Chandler Salt Project site is about 120 km south of Alice Springs in the Northern Territory (and about 130 km north of the South Australian border).

The WMP describes specific water management strategies, procedures, controls and monitoring programs that are to be implemented in the Construction, Operational and Closure phases to address potential impacts to surface water, groundwater, and erosion and sediment control.

The Chandler WMP (EMM, 2017) demonstrates a high degree of compliance with Condition 4.5.3 of the Environmental Impact Statement (EIS) Terms of Reference (ToR).

Appropriate site-specific trigger values have been developed for surface water and groundwater management, making best of the baseline data available (around 13 months of record) and adapting recommendations from the best practice guidelines (ANZECC/ARMCANZ, 2000) for the *South Australia low area rainfall* conditions. Commitments are made to periodically update the WMP in response to changes to construction, operations, water requirements and water monitoring responses. The monitoring network and program, including proposed staged expansions, are designed to provide data for the stated management purposes and to allow updates to the trigger values and response actions as data is acquired.

Yours sincerely, **Hydrogeologic Pty Ltd**

Hugh Middlemis (Principal Groundwater Engineer)

References

EMM Consulting (2017). Chandler Facility Salt Project Water Management Plan. Prepared for Tellus Holdings Ltd. February, 2017.

Appendix B

Project sampling protocol

Appendix B

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6 February 2017

Groundwater Monitoring Protocol

Chandler Facility, Northern Territory

Tellus Holdings Limited

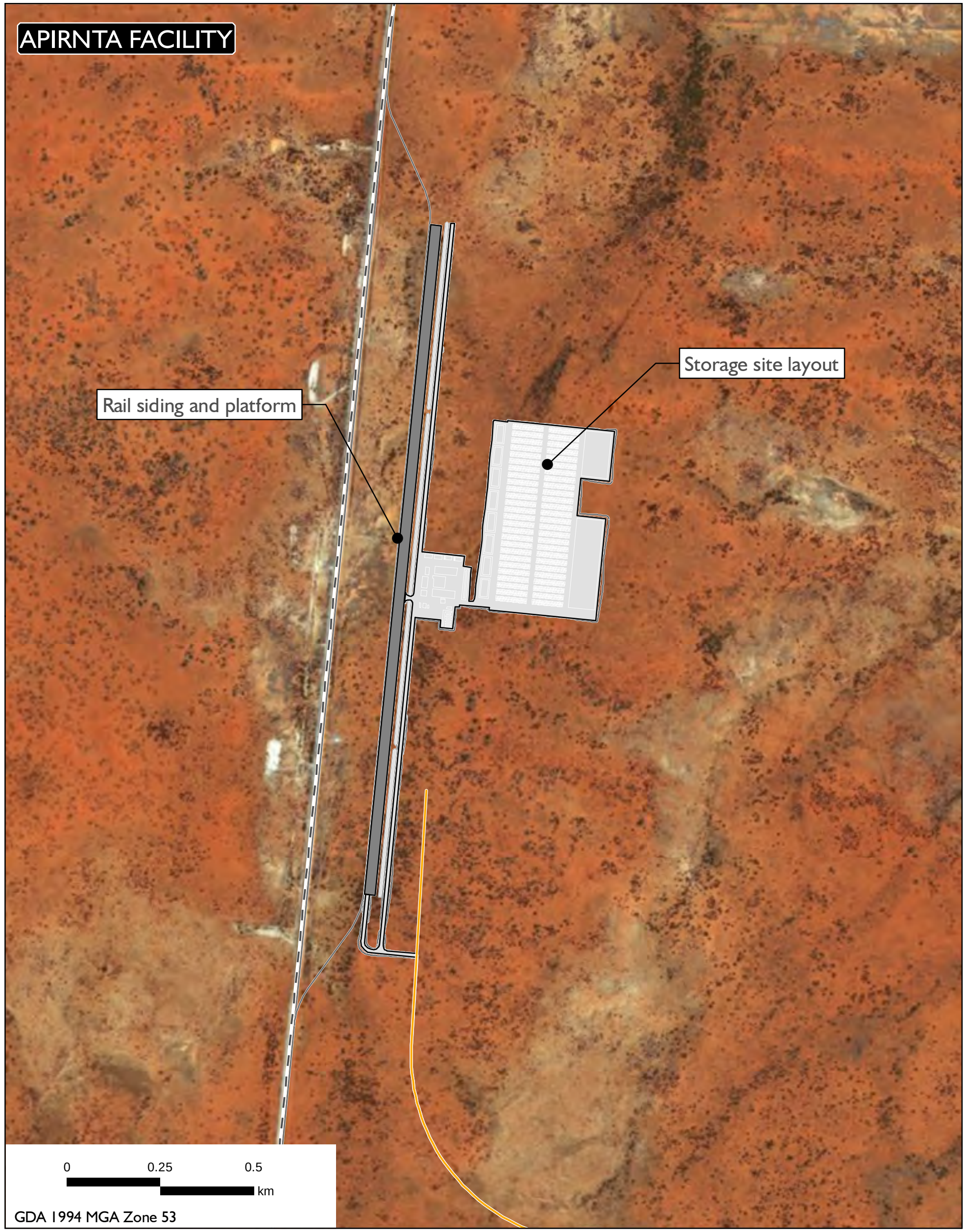
1 Introduction

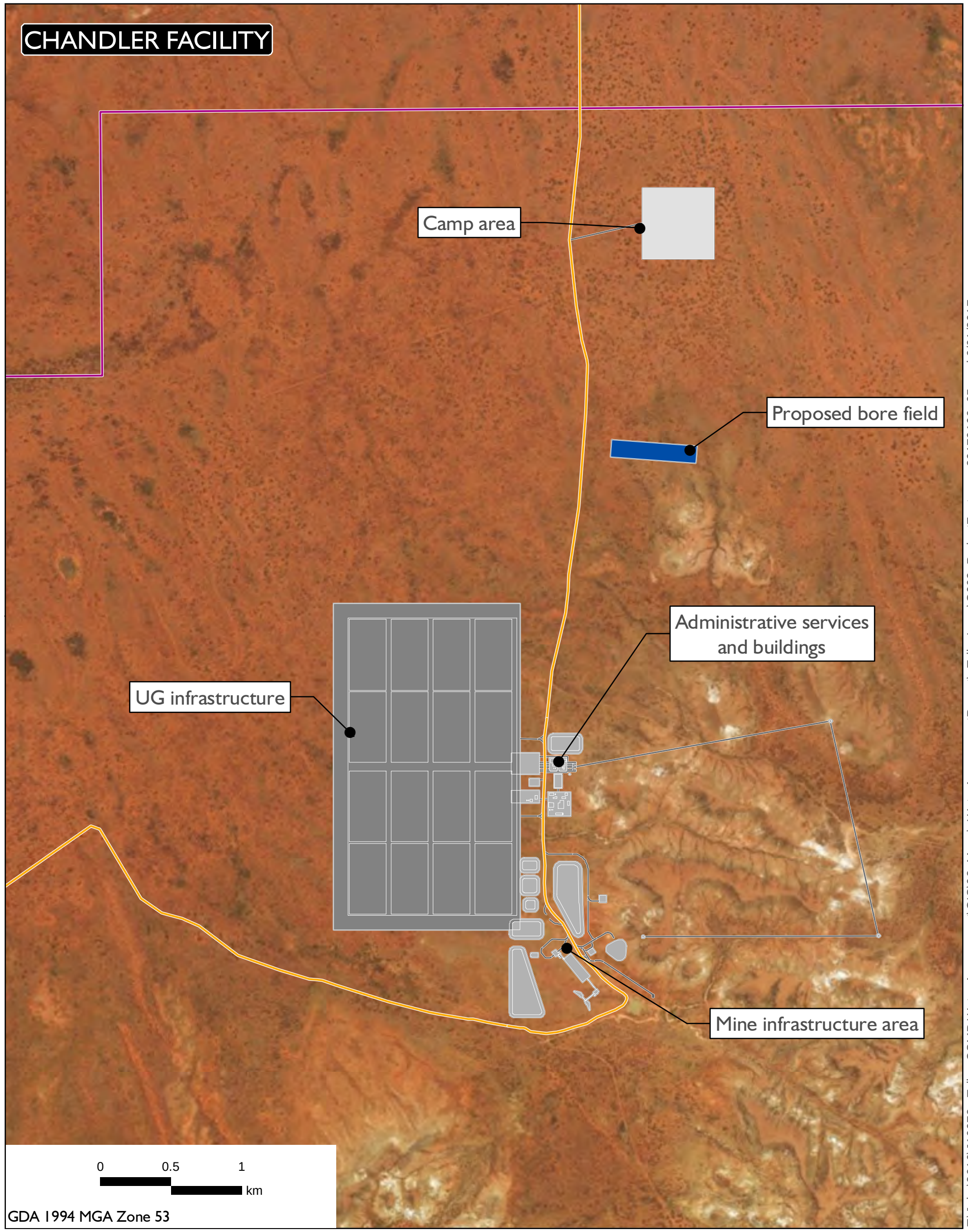
This memorandum summarises the Chandler Facility sampling protocol for the proposed groundwater monitoring network. This document is designed to be read in conjunction with the Chandler Facility Water Management Plan (WMP).

The Project groundwater monitoring network is designed to strategically target water bearing zones intercepted through the construction, operation and closure of the Project. The network serves multiple purposes, including:

- continued establishment of a groundwater quality, level baseline on a local and regional scale;
- monitoring of water quality, level and pressure changes associated with the construction, operation and closure of the Project; and
- monitoring of the local and regional groundwater systems, with respect to key sensitive environmental receivers identified in the Project EIS.

The groundwater monitoring network comprises Stage 1 sites (completed) and Stage 2 sites (proposed). Figure 1 shows the location of the Stage 1 and 2 sites with respect to the concept Proposal features.





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TELLUS

Project features

Chandler Facility
Water Assessment

Figure 3.1

2 Sampling methodology

Representative sampling and preservation are the critical components and considerations given to developing a sampling rationale for a groundwater monitoring program. Consideration must be given to the local hydrogeology, location, accessibility and bore construction need when designing a comprehensive, project-specific methodology.

2.1 Groundwater monitoring network

Groundwater monitoring bores have been selected for their appropriateness in terms of gathering relevant spatial and temporal scale data. Bores targeting the alluvium/aeolian sediment, Horseshoe Bend Shale, Langra Formation, Stairway Sandstone, and the Jay Creek Limestone Formations have been selected across the Proposal area as a means to capture groundwater level behaviour within the these groundwater systems. Most locations are sited at the Chandler facility, surrounding the mine site. Nested sites targeting discrete zones within the different groundwater systems provide information on potential vertical gradients between shallower and deeper formations. This is important for the ongoing conceptualisation of the groundwater environment, including recharge and discharge characteristics in the deeper groundwater systems.

Table 1 lists the locations, bore depths, screen depths and screened lithology of each of the groundwater monitoring bores. The table has been broken up into Stage 1 (completed) and Stage 2 (proposed) sites. This document will be updated following installation of the Stage 2 sites.

Table 1 Groundwater monitoring network

Bore ID	Elevation (m AHD)	Total depth (m BGL)	Screen interval (m BGL)	Target formation	Lithology
Stage 1 (completed sites)					
WT1	410.3	201	126-201	Upper Langra	Sandstone
WT2	410.2	120	90-102	Horseshoe Bend Shale	Sandstone
WT3a	422.5	222	192-216	Upper Langra	Sandstone
WT3b	422.5	328	298-322	Lower Langra	Sandstone
WT4a	445.9	234	210-228	Horseshoe Bend Shale	Sandstone
WT4b	445.9	287	281-287	Upper Langra	Sandstone
WT5a[2]	439.5	134	5.7-134	Horseshoe Bend Shale	Sandstone
WT5b	439.5	180	168-174	Horseshoe Bend Shale	Sandstone
WT6a	426.2	194	170-188	Horseshoe Bend Shale	Sandstone
WT6b	426.2	306	237-252	Lower Langra	Sandstone
Stage 2 (proposed sites)					
WT7a	367.4	20	16-19	Alluvium	Unconsolidated surficial deposits
WT7b	367.4	100	93-99	Horseshoe Bend Shale	Sandstone
WT8a	332	20	16-19	Alluvium	Unconsolidated alluvium
WT8b	332	80	73-79	Horseshoe Bend Shale	Sandstone
WT8c	332	150	143-149	Upper Langra	Sandstone
WT9a	424.1	450	443-449	Stairway Sandstone	Sandstone
WT10a	423.1	450	443-449	Stairway Sandstone	Sandstone
WT10b	423.1	530	523-529	Jay Creek	Limestone
WT11	423.8	530	523-529	Jay Creek	Limestone

Table 1 Groundwater monitoring network

Bore ID	Elevation (m AHD)	Total depth (m BGL)	Screen interval (m BGL)	Target formation	Lithology
WT12	422.6	10	6-9	Aeolian sediment	Unconsolidated surficial deposits
WT13a	428.4	20	16-19	Alluvium	Unconsolidated surficial deposits
WT13b	428.4	100	93-99	Horseshoe Bend Shale	Sandstone

2.2 Groundwater level monitoring

Groundwater level monitoring will be automated through the installation of dedicated Solinst pressure transducing data loggers. Data loggers will be installed approximately 20 metres (m) below the standing water level (SWL) in each groundwater monitoring bore. Data loggers will be connected to direct-read cables and a download interface. The download interface will be accessible at surface, allowing for *in-situ* remote downloads, negating the need for logger removal.

Following logger download, the standing groundwater level will be measured manually using an electronic dip meter prior to any purging or sampling. The measurement will be read from the same surveyed reference point on the casing to be related back to metres Australian Height Datum (mAHD). Recorded groundwater levels will be tabulated in both metres below top of casing (mbTOC) and then converted to mAHD.

The total depth of the borehole will be measured periodically to ensure there has not been a build-up of fines in the slotted screen interval.

2.3 Groundwater quality sampling

All groundwater monitoring bores will have dedicated micropurge 'low flow' pumps installed. This type of sampling installation negates the need for excessive purging, and therefore the production and surface management of wastewater. Installations target the screened sections of monitoring bores, thereby sampling discrete inflows at depth.

The sampling method will observe the following quality assurance / quality control (QA/QC) requirements:

- disposal nitrile gloves will be worn;
- the water quality meter will be calibrated prior to use;
- field equipment will be decontaminated before use each day and rinsed between sampling locations;
- electrical conductivity, pH, dissolved oxygen and oxidation reduction potential (redox) will be measured in the field as they can change rapidly following sampling. Turbidity (NTU) will also be measured in the field for surface waters to enable timely management responses should trigger values be exceeded, rather than waiting for laboratory results to be returned.
- appropriate sample bottles with suitable preservation will be used (i.e. containers supplied by the laboratory);
- sample bottles will be labelled with client reference, sampler initials, site ID and the date and time;
- sample bottles will adhere to laboratory instructions (e.g. no headspace for TPH);
- samples are to be kept chilled whilst in transit to the laboratory, and will be delivered within holding periods and under chain of custody protocols;

- inclusion of trip spikes and blanks for TPH analytes of known concentration to assess potential contamination of the sample during transport;
- collection of duplicate samples (two samples collected simultaneously, one being a ‘blind’ sample). One in every ten samples collected should be a duplicate sample. The blind sample will be submitted without any indication of the sample it replicates; and
- assessment of laboratory repeatability and precision by calculating the relative percentage difference (RPD) between the duplicate and primary samples.

The RPD is calculated by:

$$\mathrm{RPD} = \frac{(C1 - C2)}{\left(\frac{C1 + C2}{2}\right)}\, x100\%$$

where C1 is the primary sample concentration and C2 is the duplicate sample concentration

According to Australian Standard AS4482.1-2005, typical RPD values for soils range from 30 to 50% while an RPD within the range of 50% is considered to show acceptable agreement. Conversely, data is considered to have poor agreement where an RPD is outside this 50% range.

In instances where either the primary or duplicate sample results were below the laboratory limit of reporting (LOR), half the LOR was applied.

3 Preservation and transport methodology

Water quality samples will be stored on ice whilst in the field. Samples will then be couriered from Alice Springs to a NATA accredited laboratory. Samples will be delivered to the analytical laboratory within the laboratory-specified holding time.