

Site Overview	Description
Surface Water Section 3.5	There are no surface water features, including drains or waterways within site. The closest surface waters are Beadon Creek (2.5 km east) and a Salt Lake (0.5 km south), located outside of the site.
Groundwater Section 3.7	<p>The site lies within the Pilbara groundwater area and Ashburton sub-area. Carnarvon superficial aquifer and the Carnarvon Birdrong artesian aquifer are present within site. Water drawn from the Birdrong Aquifer is the primary local bore water source. It is the principal artesian aquifer for the Carnarvon Artesian Basin. The Groundwater Resource Allocation Plan developed by DWER in October 2013 indicated that 1,000,000 kL/year of water were available for allocation and licencing from Ashburton – lower Cane Alluvial.</p> <p>Water level monitoring has been recorded at bores 3/97 and 4/97, located approximately 300 m to the site's southeast. The AAMGL ranged from 0.08 m AHD to 0.81 m AHD.</p> <p>The LWMS reported groundwater salinity to be less than 3,000 mg/L on average, which is considered moderately salty and suggests groundwater is unsuitable for garden bores.</p>
Water Servicing Section 4.0	<p>The Water Corporation has provided support for the site to supply potable water and wastewater disposal.</p> <p>Groundwater for irrigation has not been considered because it has been identified as an unfeasible source in the LWMS (hyd2o, 2012). Alternative sources were assessed, and scheme water is a reliable source for POS irrigation compared to other sources. Other sources can ease the demand but will not suffice the irrigation requirements for the site.</p>
Water Conservation Strategy Section 5.0	<p>Water use within the development will be consistent with the Water Corporation's waterwise land development criteria and Australia's urban water-saving scheme (WELS), including:</p> <ul style="list-style-type: none"> • Use of high-density accommodation pods to reduce the use of water outside of these • Promotion of waterwise practices, including water-efficient fixtures and fittings (taps, showerheads, toilets, waterwise landscaping) within the accommodation pods and administration buildings • Non-structural controls implemented to minimise water evaporation from pools • Use of native plants and natural mosquito repellent trees and vegetation in landscaped areas and hydro zoning as much as possible, including along the edges of the accommodation pods' boardwalks • Maximising on-site retention of stormwater by decreasing the development footprint including protecting the current cultural significance site.
Stormwater Management Strategy Section 6.1	<p>A stormwater management strategy has been developed, which demonstrates that the site can effectively manage stormwater generated during the small, minor, and major rainfall events:</p> <ul style="list-style-type: none"> • All runoff from the roads and car park will be treated at source or as close to the source as possible. • All other runoff from impervious areas within Catchment C (Figure 7) will be directed, via overland flow paths, to Storage C (Figure 9). There will be

Site Overview	Description
	<p>no runoff from pervious areas of Catchment A and B (Figure 7) during the small rainfall event.</p> <ul style="list-style-type: none"> • Minor (20% AEP) and major (1% AEP) rainfall events will be managed via safe overland flow to the natural depressions. Three natural depressions will be used for storage and infiltration.
<p>Groundwater Management Strategy Section 6.2</p>	<p>Imported fill will not be required to raise the site to a minimum elevation of 6.4 m AHD as the development will use elevated boardwalks and accommodation pods. These will be built to provide a minimum clearance to the AAMGL plus sea-level rise of approximately 2.7 m. Therefore, subsoil drainage is not required.</p> <p>The proposed stormwater management practices will ensure that groundwater quality is maintained.</p> <p>The site has been identified as having a moderate to low risk of acid sulfate soils (ASS). Since the natural landform will be used, i.e. no excavation or earthworks will be required around the ASS identified area (Figure 5), an ASS management plan will not be required.</p>
<p>Implementation Plan Section 7.0</p>	<p>A construction and post-development maintenance program has been provided.</p> <p>The operation and maintenance of the stormwater management infrastructure will be the responsibility of the site managers during construction.</p> <p>Post-development, the following measures will be undertaken to ensure the system functions correctly:</p> <ul style="list-style-type: none"> • Ongoing removal of debris and litter from the swales and the natural depressions to guarantee their designed life cycle • Maintaining the landscape feature to ensure effective infiltration and protect the site from erosion.

Table of Contents

1	Introduction	1
1.1	Planning Background	1
1.2	Proposed Development	1
1.3	Guiding Documents	2
2	Design Criteria	3
3	Existing Environment	4
3.1	Existing Land use.....	4
3.2	Current climate.....	4
3.3	Topography	4
3.4	Geology and Soils	4
3.5	Acid Sulfate Soils	5
3.6	Surface Water	5
3.7	Wetland Mapping	6
3.8	Groundwater	6
4	Water Servicing	8
4.1	Potable Water Supply and Wastewater Disposal	8
4.2	Irrigation Water	8
5	Water Conservation Strategy	12
5.1	Proposed Strategy	12
5.2	Water Efficiency and Conservation.....	12
6	Water Management Strategy	14
6.1	Stormwater Management.....	14
6.2	Groundwater Management	16
6.3	Flood Management	17
7	Implementation Plan	18
7.1	Construction Phase.....	18
7.2	Post-Development	18
8	Limitations	20
9	References	21

List of Tables

Table 1: Key UWMP Design Elements	i
Table 2: Design Criteria	3
Table 3: Infiltration Test Result Adjacent to the Site	5
Table 4: Proposed irrigation schedule	9
Table 5: Greywater and blackwater calculations	10
Table 6: Post-development Catchments	15
Table 7: Rainfall runoff storage	16
Table 8: Roles and Responsibilities	19

List of Figures (out of text)

Figure 1: Survey Area

Figure 2: Master Plan

Figure 3: Topography

Figure 4: Geology

Figure 5: Acid Sulphate Soils

Figure 6: Groundwater

Figure 7: Modelled Catchments

Figure 8: 20%AEP Inundation Extent

Figure 9: 1%AEP Inundation Extent

List of Appendices

Appendix A Landscape Plan

Appendix B Engineering Design Plan

1 Introduction

Mineral Resources Limited proposes to develop Lot 300 Back Beach Rd, Onslow (the site). This UWMP has been prepared in accordance with the Better Urban Water Management guidelines (WAPC, 2008) to secure approval for the development of a high-quality 500-person permanent resort-style 'Transient Workforce Accommodation Resort' to cater for the proponent's operations workforce associated with its Onslow Iron Project. The site is set to include recreational facilities, a restaurant and the village operations and administration buildings.

The site is approximately 20.45 hectares (ha) and is located in the Shire of Ashburton, in Onslow. Back Beach Road bounds the site to the south and the Indian Ocean coast to the west. Residential development borders the site to the east and the Onslow Memorial Park to the north (Figure 1).

1.1 Planning Background

The site falls within Unallocated Crown land zoned 'Conservation, Recreation and Nature Landscape' in the Shire of Ashburton Town Planning Scheme No. 7 (TPS7). However, the Onslow Townsite Structure Plan, developed in 2016, identified the area for further development investigation. This plan has been prepared to support the site's development application to be approved via the Regional Joint Development Assessment Panel and the State Development Assessment Unit.

The Residential Design Codes of WA (R-Codes) and Clause 4.1.1 of the Structure Plan apply where the area is found suitable for residential development subject to the approval of the Shire of Ashburton and WAPC.

A Local Water Management Strategy (LWMS) (hyd2o, 2012) was prepared to support the Onslow Townsite Structure Plan.

1.2 Proposed Development

The site's Masterplan is provided in Figure 2 and comprises 500 accommodation pods and communal spaces, including:

- Main Entry gatehouse and car parks
- Administration blocks including a medical centre, restaurants, tavern, and their dedicated alfresco area
- Wellness facilities including gymnasium, outdoor pools, recreation room, driving range, oval and outdoor cricket.

The site will be developed by retaining the current landform. The development footprint will be minimised by providing elevated boardwalks and connecting with, also elevated accommodation pods. The southern portion of the site, ending at Back Beach Road (approximately 6.5Ha), has been preserved for cultural heritage values and will not be developed.

The site will be serviced with roads, car parks, landscape and water and drainage services. The site will be leased to Mineral Resources Limited (MRL) over a period of more than 30 years.

The development proposes to house up to 500 transit workers. However, only around 60% of the site is expected to be occupied in the future due to MRL operations.

1.3 Guiding Documents

This UWMP has been prepared in accordance with the following guidelines, policy documents and previous site investigations:

- Stormwater Management Manual for Western Australia (DoW, 2004-2007)
- State Planning Policy 2.9 Water Resources (WAPC a, 2006)
- Better Urban Water Management (WAPC, 2008)
- State Planning Policy 2.6 State Coastal Planning Policy (WAPC b, 2006)
- Onslow Townsite Development Local Water Management Strategy (hyd2o, 2012)
- Onslow Townsite Development – Development Plan – Engineering Servicing Report (WGE, 2012)
- Decision Process for Stormwater Management in Western Australia (DWER, 2017)
- Desktop Geotechnical Study (Golder Associates, 2011)
- Onslow Townsite Planning Coastal Setbacks and Development Levels (MP Rogers & Associates Pl, 2011).

2 Design Criteria

The site design criteria were adopted from the LWMS (hyd2o, 2012). This plan shows compliance with these criteria as described in sections 4 to 7.

Table 2: Design Criteria

Criteria	Strategy Elements	Criteria
Water Use Sustainability		
CW1	Water Efficiency	Reduce consumptive use through adoption of waterwise practices.
CW2	Water Supply	Develop 'fit for purpose' water supply strategy and minimise potable water use where drinking quality water is not essential.
CW3	Wastewater	Provide a wastewater system that meets agency requirements.
Stormwater		
CS1	Ecological Protection	Maximise the retention of stormwater generated from the site during frequently occurring events. Establishment of storage invert levels no lower than seasonal maximum groundwater levels. Use of infiltration systems for frequently occurring events to minimise mosquito breeding opportunities. Implement non-structural controls.
CS2	Serviceability	Road drainage system to be designed so that roads are passable in the 20% Average Exceedance Probability (AEP) storm event.
CS3	Flood protection	Provide safe conveyance during the 1% AEP storm event from the site. Habitable building floor levels are set at 1% AEP storm surge levels allowing for 1% climate change (or suitable building restrictions where not feasible). Habitable building floor levels are set at 0.5 m above 1% AEP flood levels.
Groundwater		
CG1	Fill Requirement and Subsoil Drainage	Establish development levels with acceptable clearance above post-development groundwater levels. If required, provide subsoil drainage to control any post-development groundwater rise.
CG2	ASS and Contamination	If required, criteria and management of ASS to be handled as a separate process consistent with the Department of Water and Environmental Regulation (DWER) requirements.

3 Existing Environment

3.1 Existing Land use

The site is Unallocated Crown vacant land owned by Western Australia's Government. The land will be ceded to the Aboriginal Corporation, with MRL holding a lease over the land for approximately 30 years. Land negotiations are progressing between MRL, the State Government and the Aboriginal Corporation.

3.2 Current climate

Weather data from 2011 – 2020 were collected from the Onslow Airport weather station (Ref 005017), located approximately 4.1 km south of the site. The annual mean maximum temperature is 32.84 °C, and the annual mean minimum temperature is 21.22 °C. The recorded mean yearly rainfall was 240.92 mm (BoM, 2021).

3.3 Topography

The site gently slopes from the north to the south. The contours indicate that the site elevation is approximately 16 m to the north and 12 m AHD to the south. The site has a steep slope from the northeast to the middle of the site, featuring a low portion (4 m AHD), and then gently slopes towards the southwest of the site (Figure 3) to Back Beach Road, with the lowest ground elevation being 2 m AHD close to Back Beach Road

The site has three natural depressions around its centre:

- A small depression is located to the east
- A medium-size depression around the middle (Storage B in Figure 9)
- A larger depression to the west (Storage C in Figure 9).

Steep slopes are found to the west towards Back Beach. The site features views towards the beach. The eastern portion of the land gently slopes towards exiting housing located on Simpson Street.

The main area to be developed within site has been planned to be at and above 4 m AHD.

3.4 Geology and Soils

3.4.1 Regional Geology

The regional soil mapping indicates the site is located within the Dune System, characterised by dune fields supporting soft and minor hard spinifex grassland and red deep sand (Figure 4).

3.4.2 Soils

Based on the Western Australia Soil Landscape Mapping (DPIRD, 2019), the soils are characterised predominantly by deep red sands. In addition, tidal soils are found to the south and outside the site, within Salt Lake.

3.4.3 Topsoil Condition

Golder Associates Pty Ltd conducted a desktop geotechnical investigation of the site and surrounding region in September 2011 (Golder Associates, 2011).

The geotechnical investigation suggested the beach and coastal dunes (Qs) – light grey sand and unconsolidated and poorly consolidated quartzose calcarenite geological units are present within the site. This unit occurs over the site and may comprise a variable cover of sand over limestone.

The areas are likely to be underlain predominantly by beach and coastal dune deposits. However, the desktop study also concluded a substantial likelihood of limestone units being encountered at shallow depths from the ground level.

3.4.3.1 Infiltration Testing

Hyd2o undertook seven permeability tests on 8 March 2012 to investigate the saturated hydraulic conductivity of the soil across Onslow's townsite area, and the infiltration rates recorded were found to be between 5 m/day and 20 m/day. PM4, a test point, was located on the site's eastern boundary, and a high hydraulic conductivity was observed at this location (16 m/day) (**Table 3**).

Higher rates were observed within Onslow's townsite in lower elevation areas than those conducted within elevated areas. It has been assumed that these rates apply to the site as the site shares the same surface geology as for the LWMS investigation area (hyd2o, 2012).

Stormwater disposal by infiltration is considered suitable for the site, subject to any lower permeability materials such as caprock limestone. Lower infiltration rates may be expected for the elevated area that extends northeast to southwest.

Table 3: Infiltration Test Result Adjacent to the Site

Test Location	Stratigraphy	Average Unsaturated Permeability ¹ k (m/day)		
		Test 1	Test 2	Test 3
PM4	Sand	15.5	18.57	15.2

3.5 Acid Sulfate Soils

Pilbara Coastline ASS mapping (DWER, 2021) indicates the site is mapped as having a moderate to low risk of ASS occurring within 3 m of the natural soil surface from the site centre to Back Beach Road (Figure 5). The rest of the site is classified as no known ASS disturbance risk less than 3 m from the surface.

3.6 Surface Water

The site is located within the Ashburton River surface water area. The Ashburton River is 20 km southwest of the site. The closest surface water features are located approximately 2.5 km east (Beadon Creek) and 0.5 km south (Salt Lake) of the site. There are no surface water features, including drains or waterways within site.

3.7 Wetland Mapping

The Department of Biodiversity Conservation and Attractions (DBCA, 2021) wetland mapping indicates no wetlands on-site.

3.8 Groundwater

3.8.1 Groundwater Resources

The Water Register (DWER a, 2021) indicates that the site lies within the Pilbara groundwater area and Ashburton subarea. Carnarvon superficial aquifer and the Carnarvon Birdrong artesian aquifer are present within site. Water drawn from the Birdrong Aquifers is the principal artesian aquifer for the Carnarvon Artesian Basin, and therefore the primary local water source. The geological units above the Birdrong Aquifer consist of interbedded claystone, siltstones, sandstones, limestones, and dolomite with wide variability in permeability characteristics. The varying permeability characteristics of the interbedded geological units within the overlying layer have most likely resulted in an alternating sequence of aquifers and confining units.

The Onslow townsite is supplied with groundwater from a bore field that draws water from the lower Cane Alluvial. The bore field is owned and operated by Water Corporation and is approximately 40 km to the east of the Onslow townsite. The latest Groundwater Resource Allocation Plan (DWER, 2013) indicated 1,000,000 kL/year of water was available for allocation and licencing from the lower Cane Alluvial. Of this, 550,000 kL/year had been allocated for public water supply and 92,500 kl/year for general licensing (WGE, 2012). Additionally, the DWER has reserved approximately 2,000,000 kL from the Lower Robe Alluvial aquifer for future public water supply. This source is located approximately 70 km east of Onslow.

3.8.2 Groundwater Levels

3.8.2.1 Regional Groundwater Mapping

The historical maximum groundwater levels provided in the Perth Groundwater Map (DWER b, 2021) do not extend to the site.

3.8.2.2 Local Groundwater Monitoring

A search of the Water Information Reporting Database (DWER c, 2021) indicates three WIN groundwater monitoring bores in the vicinity of the site with no valid groundwater readings available.

3.8.2.3 On-site Groundwater Monitoring

Onslow Salt and Water Corporation own five bores, of which two bores are near the site (3/97 and 4/97) (Figure 6). The water levels are monitored bi-monthly within the Onslow area since 1999. The bore records indicated groundwater flowing from south to north, towards the shoreline.

Bore 3/97 and 4/97 are located in the townsite, less than 300 m to the site's southeast. These bores are considered representative of the site groundwater characteristics.

Based on LWMS (hyd2O, 2012), groundwater in the Onslow townsite area ranges from fresh to saline. Freshwater is contained in the Carnarvon superficial aquifer that floats above hypersaline groundwater. The superficial aquifer relies on surface recharge during rainfall events and experiences increases in salinity during periods of low rainfall.

3.8.2.4 Design Groundwater Level

Bore 3/97 and 4/97 were recorded and reported an average annual maximum groundwater level (AAMGL) ranging from 0.08 m AHD to 0.81 m AHD. The bores were drilled at a ground elevation of 5 m AHD (Golder Associates, 2011).

The site's developable area will be located at or above 6.4 m AHD. Therefore, enough clearance to groundwater from the ground surface is expected on site. Additionally, no excavation has been proposed as the development will be built on the pre-development landform.

The lowest ground elevation at the site (2 m AHD) is located within the heritage area, to the south and near Back Beach Road. This area will not be developed.

No groundwater controls (i.e. subsoil drainage) are proposed to be used at the site, satisfying design criteria CG1.

3.8.3 Groundwater Quality

The LWMS (hyd2o, 2012) suggests that the historical salinity within the Onslow townsite reported an annual mean of less than 3,000 mg/L within the existing townsite at bore 3/97, which is considered of low quality to use for POS irrigation.

4 Water Servicing

4.1 Potable Water Supply and Wastewater Disposal

An Engineering Servicing Report was prepared in May 2012 by Wood & Grieve Engineers (WGE, 2012) to support the Onslow townsite development. The investigation extension area covered the site. The report indicated that the Water Corporation supplies the potable water sourced from the Cane River alluvial aquifer located approximately 30 km east of Onslow.

The Onslow Water Supply Scheme is operating close to full capacity with an annual drawing of 0.55 GL/year. Discussions were undertaken between MRL, the project team and Water Corporation on 22 July 2021, suggesting that their current Water Supply Scheme can supply the expected occupancy rate (around 300 workers at one time).

Water Corporation will build a desalination plant to serve the local population growth. The desalination plant has been estimated to provide 1.5 ML/day to cater to population increase for the next 20 years (Water Corporation, 2021). The Water Corporation is currently seeking environmental approvals from the Environmental Protection Authority. It is expected that the desalination plant will be operating in 2024. Therefore, the site will benefit from this source within the next three to five years.

Water Corporation has also provided support to connect to their reticulated sewerage system for an increase of about 125 kL/day of wastewater. This is based on 300 people residing on-site at any one time, satisfying design criteria CW3.

In the coming months, ongoing negotiations will continue between MRL and Water Corporation to finalise approvals for water supply and sewerage connections.

4.2 Irrigation Water

Table 4 highlights the irrigation schedule and worst-case water use scenario. It shows the total water demand during the plants' establishment phase (first 2 years). During this phase more water will be used per day. The water demand decreases by 50% post establishment for garden beds and dune planting.

Groundwater for irrigation has not been considered because it has been identified as an unfeasible source in the LWMS (hyd2o, 2012). Additionally, water quality is poor. The DWER manages allocations from the Carnarvon superficial aquifer and the Carnarvon Birdrong artesian aquifer on a case-by-case basis. This strategy was adopted as actual storage volume within the aquifers are unknown.

An analysis of alternative sources is provided below. It suggests that the only reliable and cost-effective source of irrigation for the site is scheme water.

Greywater and blackwater have been considered as potential sources. Calculated volumes, however, do not significantly reduce the scheme water use demand. When compared to capital costs associated with the systems construction and maintenance and operational costs, these systems become non-cost-effective (compared to scheme water) and unfeasible at this time.

The irrigation costs, if water is sourced from scheme water, is around \$735,000 per year.

Table 4: Proposed irrigation schedule

Landscape	Area (m ²)	Irrigation schedule	Application rate during establishment (mm/day)	Irrigation volume (kL/year)
Managed Native Garden Bed	18,260	5 days a week	5	28,486
Managed Native Dune Planting (Sparse)	31,647	5 days a week	5	41,141
Turf	5,750	5 days a week	8	11,960
Total	55,657			81,587

4.2.1 Estimation of alternative water supplies

4.2.1.1 Groundwater

The licensed aquifers in the Onslow townsite area are the Carnarvon Birdrong artesian and Carnarvon superficial aquifers. The groundwater is described in the LWMS as being of limited and insufficient quantity and marginal quality.

DWER adopts licensing on a case-by-case basis for both aquifers. This is because actual volumes within the aquifers are unknown and the impacts to the aquifers.

Groundwater availability, quantity and quality on-site cannot be ascertained at this time without further investigations, as required by DWER. However, the site is approximately 150 m from the Indian Ocean. Therefore, with a very high likelihood of seawater intrusion occurring.

Additionally, the Birdrong aquifer's water quality is primarily brackish (3,000-10,000 mg/L). It is found over 300 m below ground level in the area. The known presence of gas in the area would also entail additional studies and costs to ensure safe abstraction from this resource.

As groundwater quality is moderately brackish and groundwater volumes from the superficial and the confined aquifer are unknown and unreliable at this time, groundwater has not been further investigated as a source for public open space (POS) irrigation. This is in accordance with the LWMS, suggesting other water sources should be explored.

4.2.1.2 Stormwater/rainwater

Based on the LWMS (hyd2O, 2012), Onslow's limited annual rainfall (240.92 mm) at the same time with episodic cyclonic events makes stormwater and rainwater harvesting schemes problematic and expensive. This is in line with the LWMS recommendations. Furthermore, the use of gutters in cyclonic areas also raises issues concerning potential over-topping, which can be a function of sizing and lack of maintenance/cleaning of gutters. Consequently, stormwater harvesting is not considered a sustainable and steady water source for irrigation.

4.2.1.3 Greywater

Greywater is wastewater from washing machines, showers, baths, washbasins, spa baths, laundry, tubes, and kitchen. Greywater reuse has been considered as a source, and a feasibility analysis has been undertaken. Bathroom's greywater and laundry greywater are the two primary greywater sources at the site, primarily coming from the accommodation pods.

The amount of greywater was calculated based on the Portable Water Calculator for Green Star projects. The water demand from each potable water use is identified to estimate the greywater generated on-site. The calculations assume the maximum number of people at the site (500 people) and accommodation pods and buildings are installed with water efficiency fixtures and fittings, including: Taps – WELS 6 Stars, Toilets – WELS 4 Star (3.5L/min), Urinals – WELS 5 Star (0.8L/flush or water less) and showers – 3 Star (<=7.5 L/min). Washing machines, dishwashers, heat rejection, washdown water, swimming pools and fire system water are excluded from the greywater calculations. The total greywater available for reuse is summarised in **Table 5**. The recycled greywater can only fulfil 13% of the irrigation demand. Other resources will be needed to meet the requirement.

Table 5: Greywater and blackwater calculations

Proposed Building	Water demand (kL/year)	Greywater (kL/year)	Blackwater (kL/year)
Toilets	2,546.9	-	2,546.9
Urinals	138.3	-	138.3
Taps	635.4	635.4	-
Showers – occupants	11,634.4	11,634.4	-
Showers – Sports	3,421.9	3,421.9	-
TOTAL	18,376.9	15,691.6	2,685.2

The kitchen's greywater from the site restaurant has not been considered in the estimation, but this amount is not expected to change the above calculations significantly, and most definitely, will not suffice for irrigation. Additionally, the greywater treatment system will need to be conditioned to receive a more organically loaded wastewater source if this source is used.

In conclusion, the use of greywater minimally reduces the scheme water demand. However, when the small volumes are compared to the high capital costs associated with a greywater system's construction and its associated and stringent maintenance and operational requirements, the source becomes a non-cost-effective solution. Therefore, it has been considered unfeasible for use at this time.

4.2.1.4 Wastewater (Blackwater)

Blackwater is produced from toilets and urinals. The amount of blackwater was calculated based on the Potable Water Calculator developed by Green Building Council of Australia. **Table 5** estimates the blackwater generated on-site. As with greywater, the calculations have been assumed the maximum number of people at the site (500 people), and the use of WELS star rated fittings and fixtures. Again, the estimation of blackwater is lower than greywater, and therefore less water is available to be recycled for POS irrigation.

The Shire of Ashburton has expressed interest in developing a recycled water scheme to irrigate Onslow's existing and proposed future POS areas, thus removing these demands from the drinking water supply. This scheme offers to assist the future growth of the town sustainably and cost-effectively. Water demand and wastewater volumes are expected to increase over a period of 15 years. When the Shire warrants the development of the recycling scheme, this source may assist in reducing or eliminating the use of scheme for POS irrigation at the site in the future. MRL is to initiate discussions with the Shire about the use of this source in the future.

5 Water Conservation Strategy

5.1 Proposed Strategy

Development of the site will lead to an increased demand for potable water use and irrigation of landscaped areas. Water conservation measures will be implemented to reduce the scheme water consumption and satisfy design criteria CW1 and CW2.

Water use within the development will be consistent with the Water Corporation's waterwise land development criteria and Australia's urban water-saving scheme (WELS), including:

- Use of high-density accommodation pods to reduce the use of water outside of these
- Promotion of waterwise practices, including water-efficient fixtures and fittings (taps, showerheads, toilets, waterwise landscaping) within the accommodation pods and administration buildings
- Non-structural controls implemented to minimise water evaporation from pools
- Use of native plants and natural mosquito repellent trees and vegetation in landscaped areas and hydro zoning as much as possible, including along the edges of the accommodation pods and boardwalks
- Minimising turfed areas as much as possible and using eco-zoning
- Maximising on-site stormwater retention by decreasing the development footprint, including not developing the cultural significance area to the south.

5.2 Water Efficiency and Conservation

5.2.1 Buildings

To achieve water efficiency targets, it is envisaged that all accommodation pods and buildings on-site will be built consistent with the current Building Codes Australia energy and water efficiency standards. WELS 3-star (and above) fitting and fixtures are recommended for use. The development footprint will be reduced by building infrastructure that is easily removable such as elevated boardwalks along and connecting the accommodation pods and the accommodation pods.

5.2.2 Landscaped Areas

The Landscape Plan is provided in Appendix A. The following will be implemented to improve water efficiency within landscaped areas. These have been based on benchmarked landscape industry best practices with an emphasis on water efficiency:

- Appropriate species selection and planting of drought-tolerant, dunal and native garden beds plant species and mosquito repellent plant species. Hydro zoning will be implemented.
- Retention of existing vegetation where possible to provide amenity, shade, and landscaping features.

- Mulching to improve moisture and nutrient retention.
- Provide optimal irrigation rates during plant establishment, with irrigation reduced or eliminated at plant maturity.
- Staged irrigation in line with the project's anticipated rate of development.
- The use of a water-efficient sprinkler system and controlled water application rates to suit the water requirement of plants, climate, and rainfall patterns.

The landscape architects estimated the amount of water required for best practice irrigation across the development for garden beds, dunal vegetation, and turfed areas. **Table 4** summarises the water demands for each vegetation type. During the establishment phase, the water requirements can be as much as treble. The application rate in Table 4 is a typical establishment period of up to 2 years. The water demand for native dune planting will be reduced by up to 50% after establishment. Therefore, the approximate establishment rates for garden beds and dunal planting will be 6 mm/day and 5 mm/day, respectively.

Based on the irrigation schedule, approximately 81,587 kL/year of water demand would be required for irrigation. This demand would need to be met entirely through a scheme water supply with the possibility of other sources alleviating the demand. These have been described in Section 4.2 above.

5.2.2.1 Water Efficient Irrigation System

A water-efficient irrigation system will irrigate trees and plants. The irrigation water demand volumes will maintain a constant and uninterrupted supply, especially during dry and hot periods. However, water demand will be minimised as much as possible by, for example, hydro zoning according to water requirements. This allows the reticulation to the endemic plantings to be separately controlled and significantly reduce following their establishment period.

The automated irrigation system will be designed to include monitors to detect malfunctions so that rapid response rectification can be programmed before the planting is detrimentally affected by a disruption of water supply.

6 Water Management Strategy

Stormwater management is proposed to be undertaken consistent with DWER's recommended water sensitive design practices for the northwest of Western Australia and the Onslow Local Water Management Strategy.

The main aim for stormwater management for the site is to mimic, as closely as possible, the pre-development environment post-development. This will be achieved by maintaining, where possible, the natural topography of the site. Runoff throughout the site will be conveyed via overland flow, using the natural topography, to depression storage within site.

6.1 Stormwater Management

A stormwater management strategy has been developed, which demonstrates that the site can effectively manage stormwater generated during minor and major rainfall events and meet design criteria CS1 to CS3.

The drainage design will aim to achieve the following objectives:

- Maximise retention of stormwater generated from the site during frequently occurring events
- Ensure serviceability of the site during the 20% AEP event
- Provide safe conveyance of stormwater during the 1% AEP storm event from the site.

The site will provide permanent resort-style FIFO accommodation with an oval located in the site's northwest corner. The natural landforms of the site will be retained where possible. An engineering design plan has been provided in Appendix B.

The first 10 mm of runoff from roads and car parks will be treated and infiltrated at the source. All other runoff from the site will be conveyed via the natural landforms as overland flow to natural depression storage within site.

6.1.1 Post-development modelling

Post-development stormwater catchments are shown in Figure 7, with the land use breakdown within each catchment summarised in **Table 6**.

For the post-development modelling, only areas of the site that the development has altered have been modelled. The cultural heritage area (to the south of the site) and some of the boundaries of the site where no development is proposed, no runoff from site will be conveyed, or the natural landforms have been maintained, have not been modelled.

Three catchments were developed for the post-development model, each with a natural storage depression. The total area of the catchments is 12.45 ha. The eastern portion of the site drains to a depression (Storage A) with an invert of 7 m AHD. A southern, eastern portion of the site drains to two connected depressions (Storage B) with an invert of 5 m AHD. The remainder of the site, and the total developed area to the north, drains to the largest of the three depressions

(Storage C) to the south, and during major storm events will overflow downstream to further depression storage located within the cultural heritage area.

Australian Rainfall and Runoff Guidelines (ARR) (Geoscience Australia 2019) guide the choice of loss parameters across Australia. There are no recommendations for design losses for arid areas with mean annual rainfalls less than 350 mm.

Infiltration testing, conducted by part of the LWMS (hyd20 2012), indicated infiltration rates across the entire structure plan area ranged from 5 m/day to 20 m/day, with higher rates observed in the lower elevation areas. Infiltration rates on the edge of the site (hyd2o 2021) were recorded as 16.4 m/day.

GHD used a constant rate of 72 mm/hr for modelling in the *Shire of Ashburton Report for Onslow Drainage Assessment, Review of Stormwater Drainage System in Onslow* (GHD 2010).

For consistency with the previous modelling undertaken for the area, a constant rate of 73 mm/hr has been adopted for the natural landforms. In addition, following the recommendation made in the LWMS, a rate of 10 m/day (hyd2o 2012) was adopted for the depression storage.

In accordance with ARR guidelines, all building and hardstand areas were modelled with an initial loss of 1 mm and no continuing losses.

Table 6: Post-development Catchments

Catchment	Land use				Total area (ha)
	Buildings and Hardstand (ha)	Roads (ha)	POS (ha)	Natural ground (ha)	
Catchment A	0.1	na	na	2.9	3
Catchment B	0.1	na	na	2.0	2.1
Catchment C	1.65	0.8	0.8	4.1	7.35

6.1.2 Small Event (63.2% AEP)

The LWMS recommends that the first 10 mm from roads are to be retained and treated. All runoff from the roads and car park will be treated at the source or as close as possible.

All other runoff from impervious areas within Catchment C will be directed, via overland flow paths, to Storage C. The modelling results indicate that there will be 0.14 m of ponding in Storage C during the small event.

Due to the high infiltration rates of the native soils, there will be no runoff from pervious areas of Catchment A and B during the small rainfall event.

6.1.3 Minor Event (20% AEP) and Major Event (1% AEP)

Minor (20% AEP) and major (1% AEP) rainfall events will be managed via safe overland flow to the natural depressions. Three natural depressions will be used for storage and infiltration. Modelling for the site indicates that all Catchments will produce ponding during the 1% AEP event. Catchment C will produce ponding during the 1%, 20%, 63.2% AEP events. Results from the modelling suggest Storage C will overflow during the 1% AEP event to depression storage located downstream in the cultural heritage area.

The extents of inundation in the 20% and 1% AEP events are shown in Figures 8 and 9. The maximum flood depths, storage volumes, topwater levels (TWL), overflow rates and volumes, for the 20% AEP and 1% AEP events are shown in **Table 7**.

Table 7: Rainfall runoff storage

Storage	Depth (m)	Volume (m ³)	TWL (m AHD)	Overflow (m ³ /s)	Overflow Volume (m ³)
20% AEP					
Storage C	1.5	3,172	5.5	na	na
1% AEP					
Storage A	0.3	467	8	na	na
Storage B	0.9	1156	5.9	na	na
Storage C	1.9	4,974	5.9	0.9	8,510

Elevated accommodation pods and boardwalks will be used throughout the site to ensure a minimum 0.5 m clearance from maximum TWLs of flood storage.

Roads have been designed to be passable in the minor events with water flowing to vegetated swales and downstream depressions storage.

6.2 Groundwater Management

6.2.1 Groundwater Levels

Use of fill or excavation will not be undertaken at the site. The site's floor levels will be required to be raised to a minimum elevation of 6.4 m AHD, which will provide enough clearance to the AAMGL plus sea-level rise (approximately 2.7 m). Therefore, subsoil drainage is not proposed.

6.2.2 Groundwater Quality

The proposed stormwater management practices will ensure that groundwater quality will be maintained.

The two key strategies include infiltrating the first flush of rainfall at the source and minimising the development footprint to replicate current (pre-development) conditions and natural groundwater recharge. Other critical strategies for managing groundwater quality at the site include:

- Maximising native and waterwise vegetation within landscaped areas
- Fertiliser and pesticide use on-site to be minimised through waterwise and or native landscaping, minimal community open space and private gardens due to development style.

6.2.3 Acid Sulphate Soil Management

ASS investigations are commonly required as part of the conditions of subdivision application. As moderate to low risk of ASS (Figure 5) have been identified at the site's southern portion, and the natural landform is to be used (i.e. no excavation or earthworks will be required) an ASS management plan will not be required.

6.3 Flood Management

The overland flow will be safely conveyed to the natural depressions, and the site will use natural flow paths.

Figure 9 shows the maximum flood depth for the Storage A, B and C depressions in the 1% AEP storm event. A clearance of 0.5 m to habitable floor levels from the 1% AEP will need to be accounted for to provide the minimum clearance requirement under DWER flood management policy.

Hence, the site's development floor level has been designed to be at a minimum of 8.5 m AHD (at Storage A) and 6.4 m AHD (at Storage B and C). These provide an adequate freeboard to the 1% AEP return period cyclonic storm surge allowing for climate change as specified in the coastal strategy (MP Rogers & Associates Pl, 2011).

7 Implementation Plan

The success of the water management strategy relies on the implementation throughout all stages of development, including construction and post-development.

The commencement of the project construction phase is expected to be in November 2021. The site is scheduled to be completed and ready for use as early as August 2022. Approximately nine months of construction has been proposed, and high-water demand is expected during this phase. However, it has been anticipated that water demand would drop and reach an equilibrium in 2023 when the site's residential condition enters into a steady state. MRL will provide a monthly forecast of water demand to the Water Corporation when construction phasing details, scheduling and implementation are determined. However, the following sections detail implementation practices to be followed during construction and after development completion.

7.1 Construction Phase

During the project's construction phase, water management requires considering direct impacts from any construction activities and maintaining the pre-development hydrological regime at post-development.

7.1.1 Management of Construction Activities

Potential impacts from construction activities related to the water cycle include:

- Dust generation during bulk earthworks and building construction
- Erosion of exposed surfaces.

All of these potential impacts are manageable through appropriate engineering design and site management practices.

Contractors and staff will be notified of the requirement to implement management practices to limit any potential impacts resulting from these activities.

The timing of the construction activities will be dependent on several factors not related to water management. Where possible, the construction schedule should allow for work to be undertaken when impacts on the water cycle are minimised. These include completing civil works during summer or autumn. MRL intends to initiate works in November 2021.

7.2 Post-Development

After completing construction activities, maintenance of any stormwater management infrastructure and assessment of their performance will be required. As there is no drainage pipes and pits system constructed on-site, swales near roads and car parks would be the critical maintenance features.

7.2.1 Maintenance

The operation and maintenance of the stormwater management infrastructure will be the responsibility of the site managers. The stormwater management infrastructure will remain private and will not be ceded to the Shire for management or maintenance. The following measures will be undertaken to ensure the infrastructure functions correctly:

- Street sweeping to reduce the particulate build up on road surfaces
- The ongoing removal of debris and litter from the swales and the natural depressions to guarantee their designed life cycle
- Maintaining the landscape feature to ensure effective infiltration and protect the site from surface erosion.

7.2.2 Roles and Responsibilities

Table 8 details the roles and responsibilities for water management during the construction phase of the development and post-development.

Table 8: Roles and Responsibilities

Role	Responsibility	Description
Construction		
Dust suppression	Site managers	Scheduled water uses for dust suppression with effective watering technique.
Street Sweeping	Site managers	Carry out street sweeping of roads, car parks, and hard surfaces during construction to prevent sediment and other pollutants mobilisation. This is to be carried out as required throughout the construction phase.
Post Construction		
Stormwater infrastructure	MRL	Manage and repair/replace infrastructure as required.
Maintenance	MRL	Undertake maintenance of the stormwater infrastructure (swales), oval and landscaping. Activities include removing sediment build-up, frequent maintenance during the established period of plants. Inspections are to be completed every six months during the first year of operation.

8 Limitations

This report is produced strictly in accordance with the scope of services set out in the contract or otherwise agreed in accordance with the contract. 360 Environmental makes no representations or warranties in relation to the nature and quality of soil and water other than the visual observation and analytical data in this report.

In the preparation of this report, 360 Environmental has relied upon documents, information, data, and analyses ('client's information') provided by the Client and other individuals and entities. In most cases where the Client's information has been relied upon, such reliance has been indicated in this report. Unless expressly set out in this report, 360 Environmental has not verified that the Client's information is accurate, exhaustive, or current, and the validity and accuracy of any aspect of the report including, or based upon, any part of the Client's information is contingent upon the accuracy, exhaustiveness, and currency of the Client's information. 360 Environmental shall not be liable to the Client or any other person in connection with any invalid or inaccurate aspect of this report where that invalidity or inaccuracy arose because the Client's information was not accurate, exhaustive, and current or arose because of any information or condition that was concealed, withheld, misrepresented, or otherwise not fully disclosed or available to 360 Environmental.

Aspects of this report, including the opinions, conclusions, and recommendations it contains, are based on the results of the investigation, sampling and testing set out in the contract and otherwise in accordance with normal practices and standards. The investigation, sampling and testing are designed to produce results that represent a reasonable interpretation of the general conditions of the site that is the subject of this report. However, due to the characteristics of the site, including natural variations in site conditions, the results of the investigation, sampling and testing may not accurately represent the actual state of the whole site at all points.

It is important to recognise that site conditions, including the extent and concentration of contaminants, can change with time. This is particularly relevant if this report, including the data, opinions, conclusions, and recommendations it contains, are to be used a considerable time after it was prepared. In these circumstances, further investigation of the site may be necessary.

Subject to the terms of the contract between the Client and 360 Environmental Pty Ltd, copying, reproducing, disclosing, or disseminating parts of this report is prohibited (except to the extent required by law) unless the report is produced in its entirety, including this page, without the prior written consent of 360 Environmental Pty Ltd.

9 References

- DBCA, 2021. *Wetlands Mapping*, Perth: Government of Western Australia Department of Biodiversity, Conservation and Attractions.
- DoW, 2004-2007. *Stormwater Management Manual for Western Australia*, Perth: Department of Water Government of Western Australia.
- DPIRD, 2019. *Western Australia Soil Landscape Mapping*, Perth: Government of Western Australia Department of Primary Industries and Regional Development.
- DWER a, 2021. *Government of Western Australia Department of Water and Environmental Regulation Water Register*. [Online]
Available at: <https://maps.water.wa.gov.au/#/webmap/register>
[Accessed 10 July 2021].
- DWER b, 2021. *Government of Western Australia Department of Water and Environmental Regulation Groundwater Map*. [Online]
Available at: <https://maps.water.wa.gov.au/Groundwater/>
[Accessed 20 July 2021].
- DWER c, 2021. *Government of Western Australia Department of Water and Environmental Regulation Water Information Reporting*. [Online]
Available at: <http://wir.water.wa.gov.au/Pages/Water-Information-Reporting.aspx>
[Accessed 15 July 2021].
- DWER d, N. R. M. O., 2021. *Groundwater licensing in Onslow* [Interview] (20 July 2021).
- DWER, 2017. *Decision Process for Stormwater Management in Western Australia*, Perth: Government of Western Australia Department of Water and Environmental Regulation.
- DWER, 2021. *ASS risk map*, Perth: Government of Western Australia Department of Water and Environmental Regulation.
- Golder Associates, 2011. *Desk Study Assessment - Proposed Residential Subdivisions - Various Sites, Onslow*, Perth: Golder Associates.
- hyd2o, 2012. *Onslow Townsite Development Local Water Management Strategy*, Perth: hyd2o Hydrology.
- MP Rogers & Associates PL, 2011. *Onslow Townsite Planning Coastal Setbacks & Development Levels*, Perth: m p Rogers & associates pl.
- WAPC a, 2006. *State Planning Policy 2.9 Water Resources*. Perth: Western Australia Planning Commission.
- WAPC b, 2006. *State Planning Policy No. 2.6 State Coastal Planning Policy*. Perth: Western Australia Planning Commission.
- WAPC, 2008. *Better Urban Water Management*, Perth: Western Australia Planning Commission.

Water Corporation, 2021. *Onslow Desalination Plant*. [Online]
Available at: <https://www.watercorporation.com.au/Outages-and-works/Ongoing-Works/Onslow-Desalination-Plant>
[Accessed 23 July 2021].

WGE, 2012. *Onslow Townsite Development Development Plan Engineering Servicing Report*.
Perth: Wood & Grieve Engineers.

Figures



Legend

- Survey Area Boundary
- Cadastral Lines

*NOTE THAT POSITION ERRORS CAN BE ± 5M IN SOME AREAS
 -LOCALITY MAP SOURCED LANDGATE 2020
 -AERIAL DATA SOURCED FROM LANDGATE 2020
 -GDA 1984 MGA Zone 50
 -GDA 1984 MGA Zone 50
 (@ Western Australian Land Information Authority 2020)

SLIP ENABLER

360 a 10 Bermiondesy St, West Leederville, 6007 WA
 Environmental
 (08) 9391 2360
 www.360environmental.com.au

0 250 500 750 Meters
 1:20,000 @ A4

LOCALITY MAP



PROJECT ID: 4757
 DATE: 16/07/2021

HORIZONTAL DATUM AND PROJECTION
 GDA 1984 MGA Zone 50

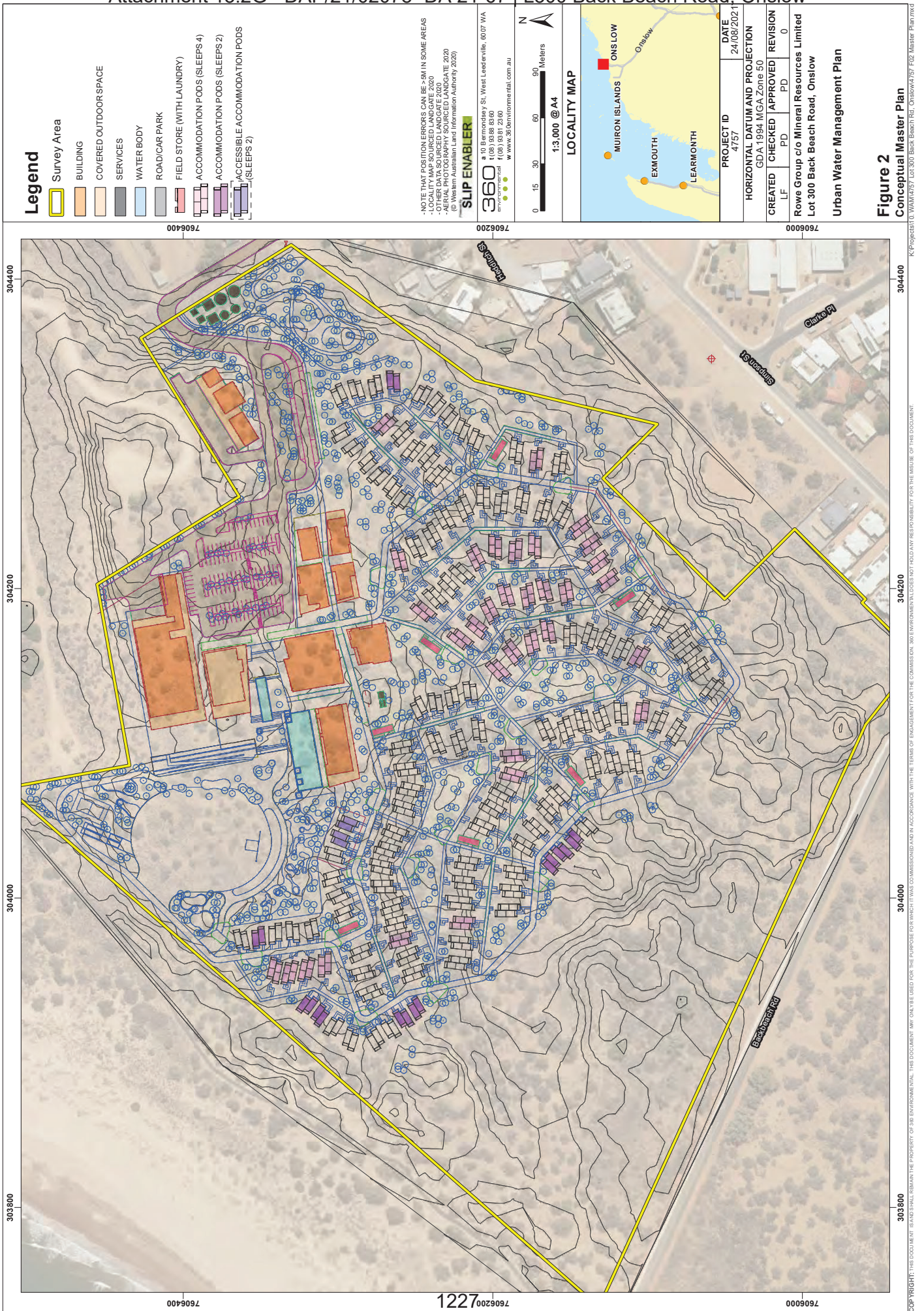
CREATED	CHECKED	APPROVED	REVISION
LF	PD	PD	0

Rowe Group c/o Mineral Resources Limited
 Lot 300 Back Beach Road, Onslow

Urban Water Management Plan




Figure 1
 Survey Area

COPYRIGHT: THIS DOCUMENT IS AND SHALL REMAIN THE PROPERTY OF 360 ENVIRONMENTAL. THIS DOCUMENT MAY ONLY BE USED FOR THE PURPOSE FOR WHICH IT WAS COMMISSIONED AND IN ACCORDANCE WITH THE TERMS OF ENGAGEMENT FOR THE COMPLETION. 360 ENVIRONMENTAL DOES NOT HOLD ANY RESPONSIBILITY FOR THE ABUSE OF THIS DOCUMENT.





Legend

-  Survey Area Boundary
-  Cadastral Lines
-  Topographic Contour (mAHD - 2m Interval)

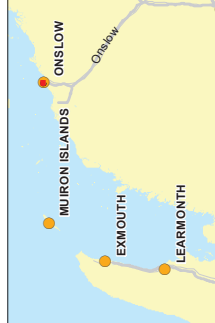
*NOTE THAT POSITION ERRORS CAN BE >5M IN SOME AREAS
 -LOCALITY MAP SOURCED LANDGATE 2020
 -OTHER DATA SOURCED LANDGATE 2020
 -GDA 1984 MGA ZONE 50
 © Western Australian Land Information Authority 2020

SLIP ENABLER

360 Environmental
 a 10 Berronadesy St, West Leederville, 6007 WA
 (08) 9338 8360
 www.360environmental.com.au

0 60 120 180 N
 Meters
 1:5,000 @ A4

LOCALITY MAP



PROJECT ID	DATE
4757	16/07/2021
HORIZONTAL DATUM AND PROJECTION	
GDA 1984 MGA Zone 50	
CREATED	CHECKED
LF	PD
APPROVED	REVISION
PD	0

Rowe Group c/o Mineral Resources Limited
 Lot 300 Back Beach Road, Onslow
 Urban Water Management Plan

Figure 3
 Topography





Legend

- Survey Area
- Cadastral Lines
- Acid Sulfate Soils Risk**
- High to moderate risk
- Moderate to low risk

*NOTE THAT POSITION ERRORS CAN BE ±5M IN SOME AREAS
 -LOCALITY MAP SOURCED LANDGATE 2020
 -GDA DATUM SOURCED LANDGATE 2020
 -GDA DATUM SOURCED GDA 1984 MGA Zone 50
 © Western Australian Land Information Authority 2020

SLIP ENABLER

360 Environmental
 a 10 Bermiondesy St, West Leederville, 6007 WA
 (08) 9338 8360
 (08) 9338 7260
 www.360environmental.com.au

0 60 120 180 Meters
 1:5,000 @ A4

LOCALITY MAP



PROJECT ID	DATE
4757	20/07/2021
HORIZONTAL DATUM AND PROJECTION	
GDA 1984 MGA Zone 50	
CREATED	CHECKED
LF	PD
APPROVED	REVISION
0	0

Rowe Group c/o Mineral Resources Limited
 Lot 300 Back Beach Road, Onslow
 Urban Water Management Plan

Figure 5
Acid Sulfate Soil



Legend

- Survey Area Boundary
- Cadastral Lines
- WIN BORES**
- + Groundwater Bore
- Surface Water Bore

SLIP ENABLER
 360 a 10 Bermiondesy St, West Leederville, 6007 WA
 (08) 9396 2360
 www.slipenabler.com.au

*NOTE THAT POSITION ERRORS CAN BE >5M IN SOME AREAS
 -LOCALITY MAP SOURCED LANDGATE 2020
 -GDA DATUM SOURCED LANDGATE 2020
 -GDA DATUM SOURCED LANDGATE 2020
 (@ Western Australian Land Information Authority 2020)

LOCALITY MAP

Scale: 1:10,000 @ A4

Meters: 0, 125, 250, 375

North Arrow

LOCALITY MAP

Map showing MUIRON ISLANDS, EXMOUTH, LEARMONTH, and ONSLOW.

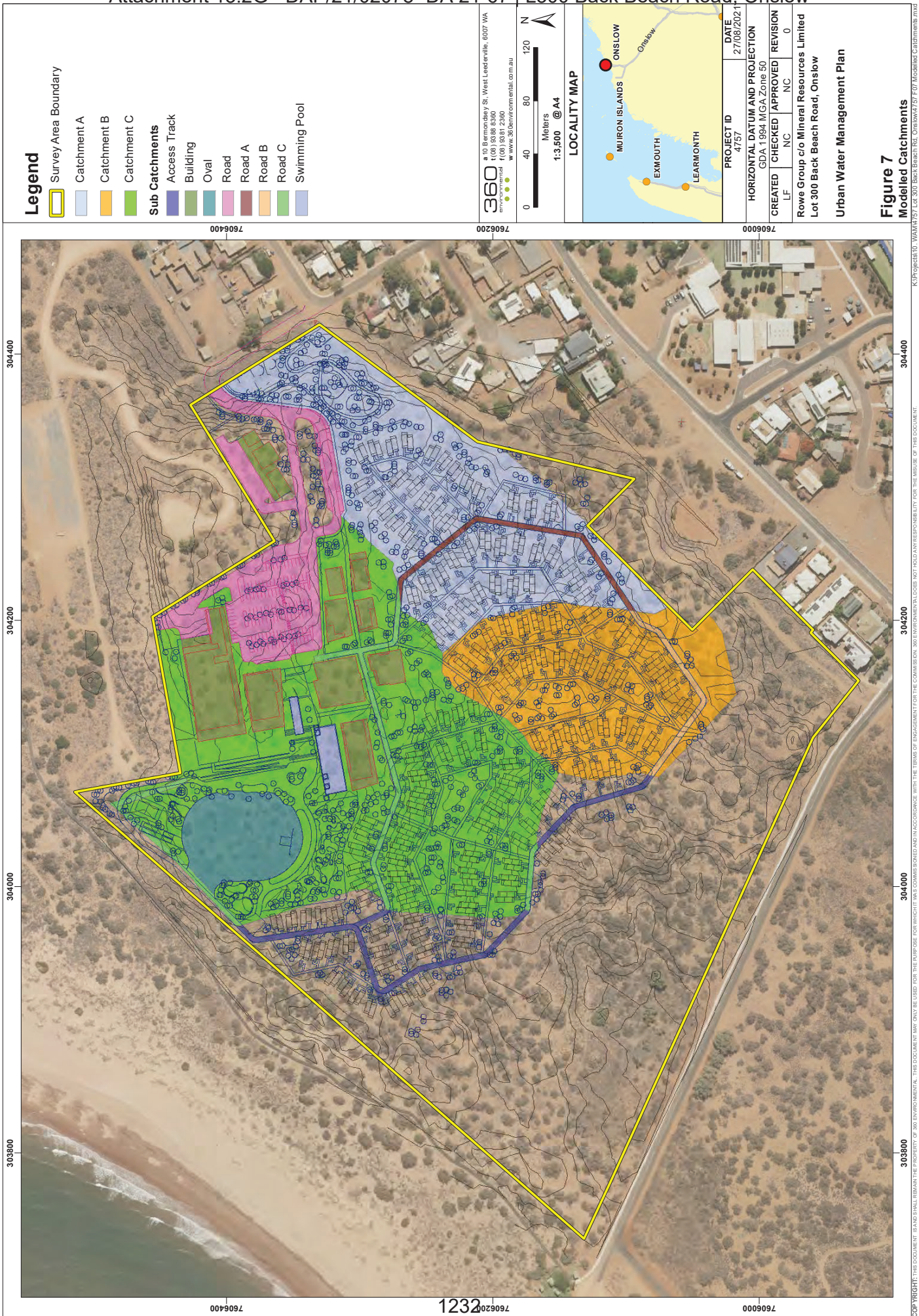
PROJECT ID	DATE
4757	16/07/2021

HORIZONTAL DATUM AND PROJECTION	
GDA 1984 MGA Zone 50	
CREATED	CHECKED
LF	PD
APPROVED	REVISION
	0

Rowe Group c/o Mineral Resources Limited
 Lot 300 Back Beach Road, Onslow

Urban Water Management Plan

Figure 6
Groundwater



Legend

- Survey Area Boundary
- Catchment A
- Catchment B
- Catchment C
- Sub Catchments**
- Access Track
- Building
- Oval
- Road
- Road A
- Road B
- Road C
- Swimming Pool

360 Environmental
 8/10 Bermudez St, West Leederville, 6007 WA
 (08) 9388 8360
 (08) 9391 2360
 www.360environmental.com.au

Scale: 1:3,500 @ A4
 Meters: 0, 40, 80, 120

LOCALITY MAP



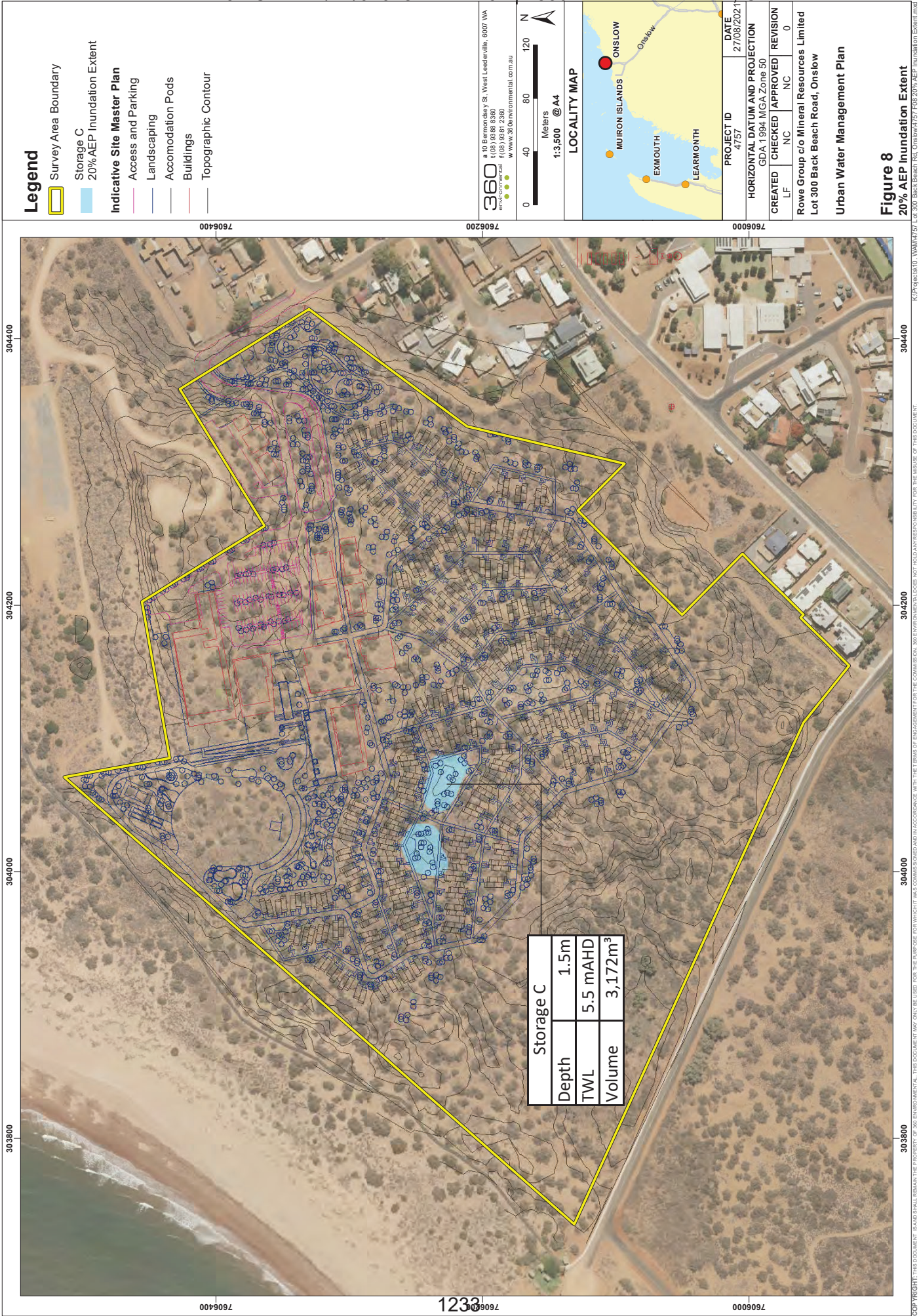
PROJECT ID	DATE		
4757	27/08/2021		
HORIZONTAL DATUM AND PROJECTION			
GDA 1984 MGA Zone 50			
CREATED	CHECKED	APPROVED	REVISION
LF	NC	NC	0

Rowe Group c/o Mineral Resources Limited
 Lot 300 Back Beach Road, Onslow

Urban Water Management Plan

Figure 7
 Modelled Catchments

K:\Projects\10 - WAMW\757_Lot_300_Back_Beach_Rd_Onslow\757_F07_Modelled_Catchments.mxd
 COPYRIGHT: THIS DOCUMENT IS AND SHALL REMAIN THE PROPERTY OF 360 ENVIRONMENTAL. THIS DOCUMENT MAY ONLY BE USED FOR THE PURPOSE FOR WHICH IT WAS COMBINED AND IN ACCORDANCE WITH THE TERMS OF ENGAGEMENT FOR THE COMBINED. 360 ENVIRONMENTAL DOES NOT HOLD ANY RESPONSIBILITY FOR THE ABUSE OF THIS DOCUMENT.

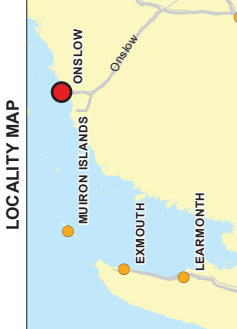


Legend

- Survey Area Boundary
- Storage C
- 20% AEP Inundation Extent
- Indicative Site Master Plan
- Access and Parking
- Landscaping
- Accommodation Pods
- Buildings
- Topographic Contour

360 Environmental
 8/10 Bermansley St, West Leederville, 6007 WA
 (08) 9388 8360
 www.360environmental.com.au

Scale: 1:3,500 @ A4
 Meters: 0, 40, 80, 120



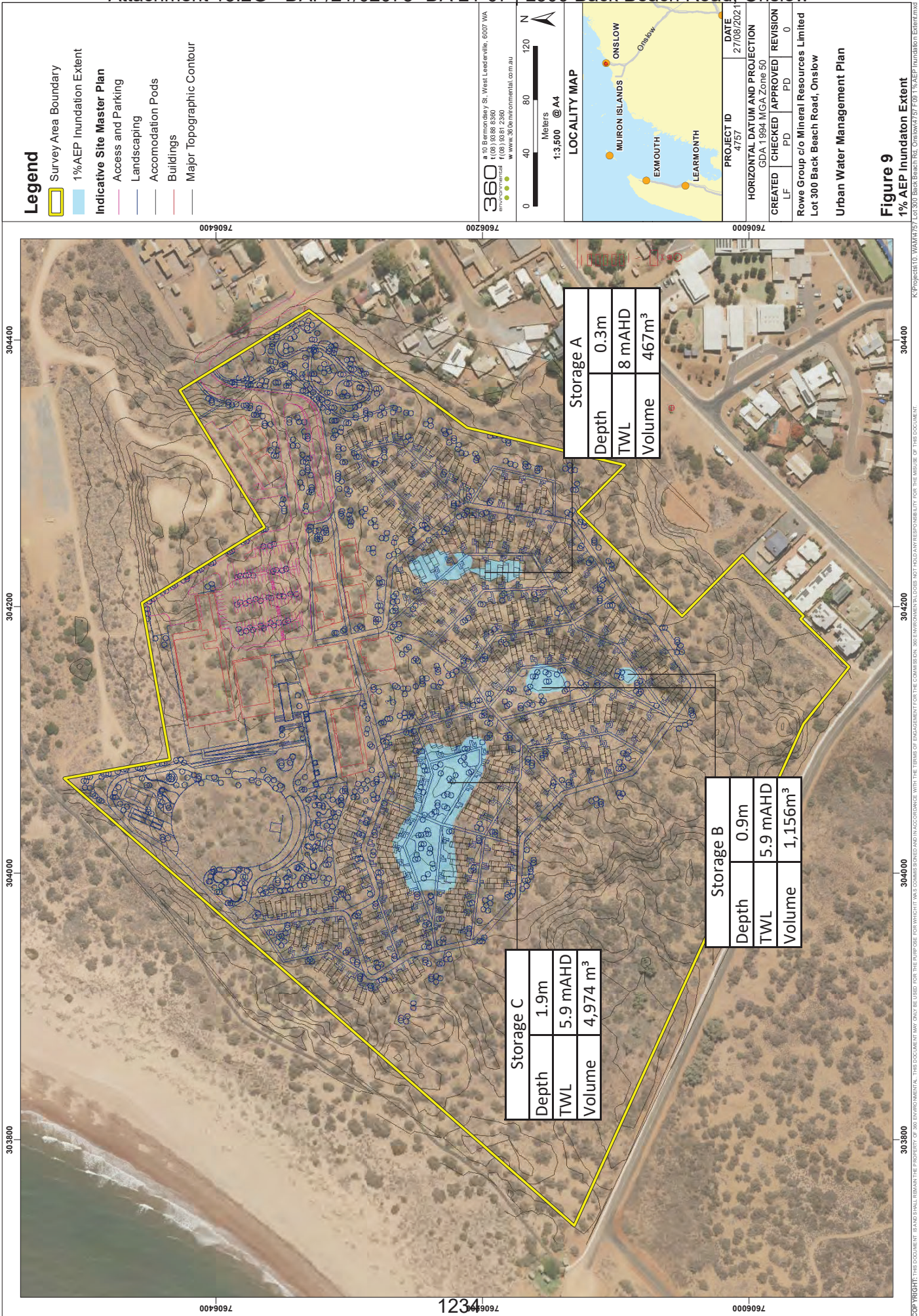
PROJECT ID: 4757
 DATE: 27/08/2021
 HORIZONTAL DATUM AND PROJECTION: GDA 1984 MGA Zone 50

CREATED: LF
 CHECKED: NC
 APPROVED: NC
 REVISION: 0

Rowe Group c/o Mineral Resources Limited
 Lot 300 Back Beach Road, Onslow

Urban Water Management Plan

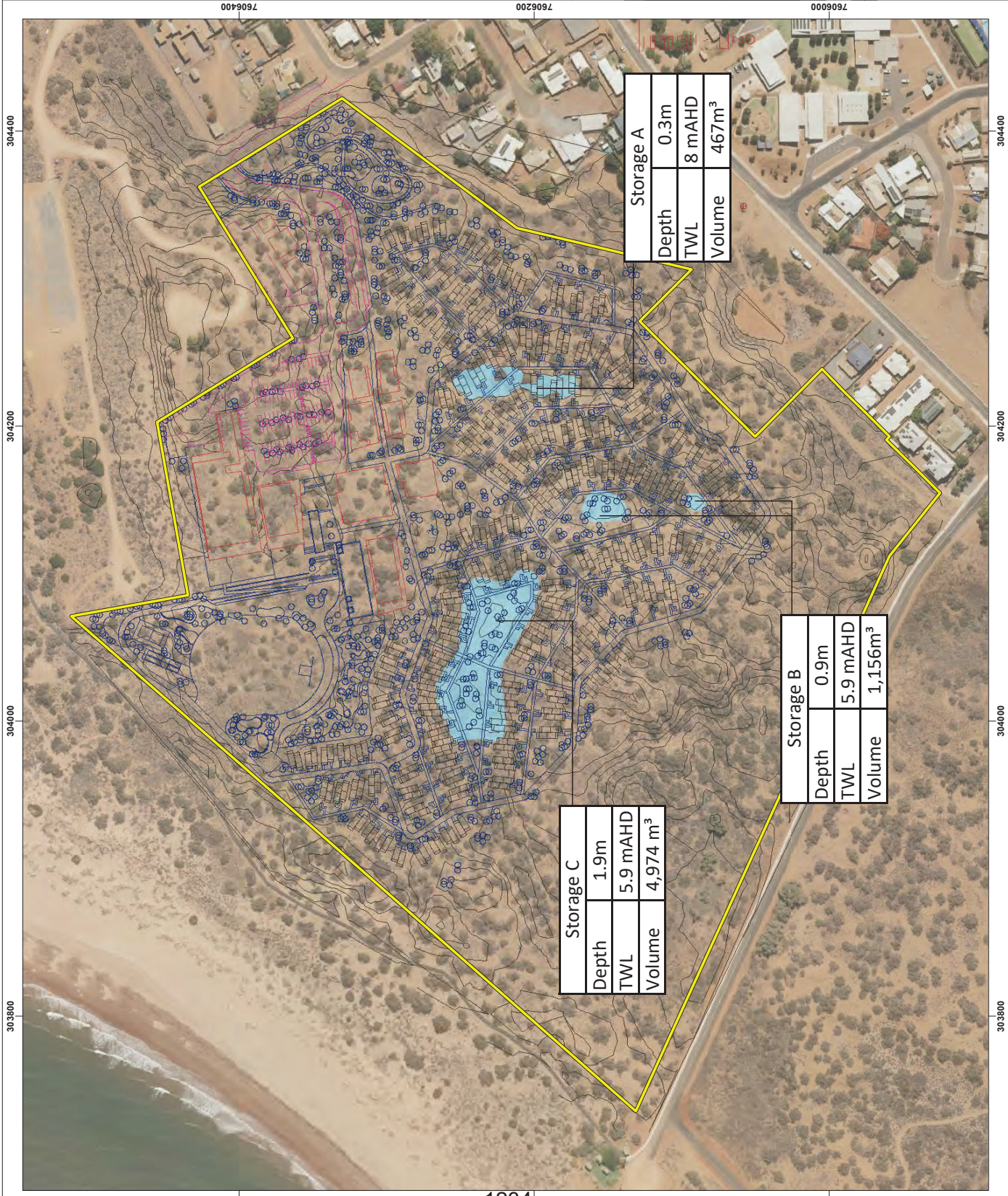
Figure 8
 20% AEP Inundation Extent



Storage C	
Depth	1.9m
TWL	5.9 mAHD
Volume	4,974 m ³

Storage B	
Depth	0.9m
TWL	5.9 mAHD
Volume	1,156m ³

Storage A	
Depth	0.3m
TWL	8 mAHD
Volume	467m ³



Appendices

Appendix A Landscape Plan

ONSLOW TOWNSHIP VILLAGE LANDSCAPE



Mineral Resources Limited
PER21030.00



ON SLOW TOWNSHIP VILLAGE

Prepared by:
ASPECT Studios
L1 / 191 St Georges Tce
Perth, WA, 6000

Prepared with:
Millieu Creative
L1 / 488 Stirling Highway
Peppermint Grove, WA, 6011

Prepared for:
Mineral Resources Limited
1 Sleaf Rd,
Applecross WA 6153

Document Control

Job Number: PER21030.00
Report Title: Onslow Iron Ore Project
Revision: B
Date Issued: 24.08.2021

ASPECT Team

Nicola Marunczyn
Tom Lucey
Jonathon Marshall
Tom Griffiths
Michael Rowlands

**‘We design
places where
people want
to be.’**

Contents

- 01. Introduction
- 02. Landscape Plans
- 03. Landscape Quality - Materials and Finishes
- 04. Planting Strategy



1.0 Introduction

The landscape design for the Onslow Township Village, has been prepared by ASPECT Studios in collaboration with Milieu Creative. The design responds to the scale, form and function of the architecture and local context in order to create a dynamic and engaging sequence of landscape spaces.

With the striking Pilbara landscape as a backdrop, the landscape design will showcase a mix of natives, exotic, and sensory plant species to support the proposed accommodation, sports fields, play, recreation and amenity spaces.

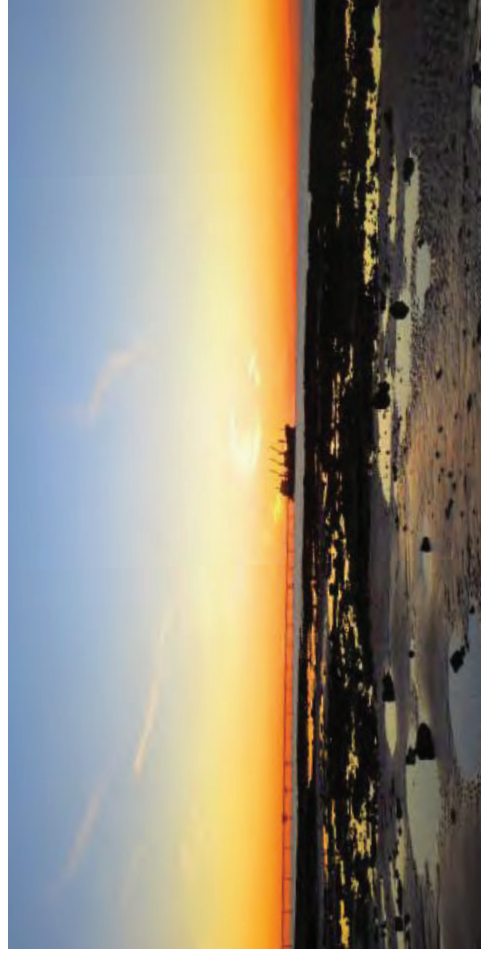
The landscape concept responds to the site's larger contextual relationship to the coastal landscape situated adjacent to Onslow Township, celebrating the vibrant, textured tones and layered vegetation.

The public landscape spaces have been designed to provide a place where the community can gather for play and recreation catering for the needs of residents, visitors and the broader community.

The following general principles form the landscape approach to the site:

- Use high quality landscape design to integrate the proposed sporting development with broader active and passive recreational offerings;
- Develop a legible network of spaces that fully integrate with and connect to the surrounding context;
- Create spaces with varying characters and identities.
- Design spaces that will become activated and vital.
- Maximise opportunities for social interaction through arrangement of seating and views.
- Create a robust landscape made from proven materials and planting species, integrating bold forms that can be managed and maintained.
- Selection of local and native plant species that benefit surrounding ecologies.
- Ensure structural elements read as an extension of the architectural material palette and are integrated with the planting compositions.

The design of landscape considers the architectural design by Milieu Creative in both concept and materiality, with the intention of creating a cohesive transition from internal to external spaces.

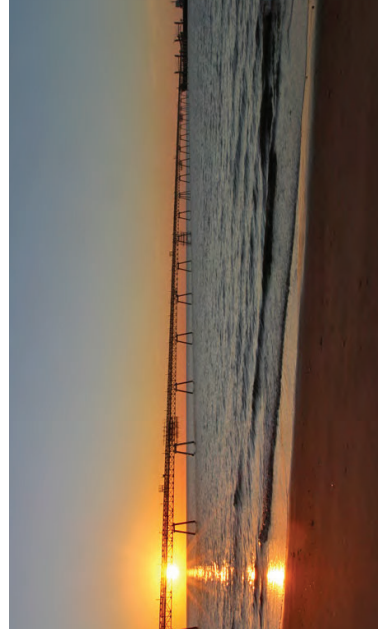
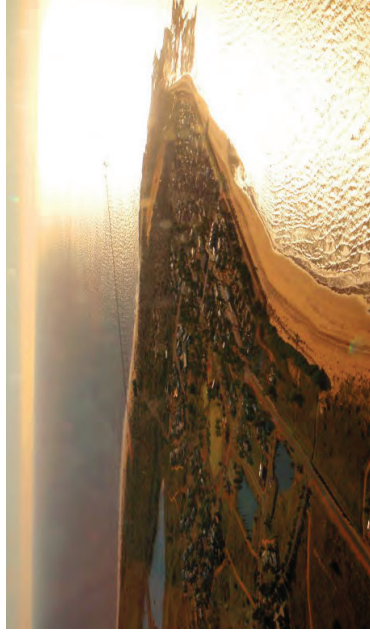
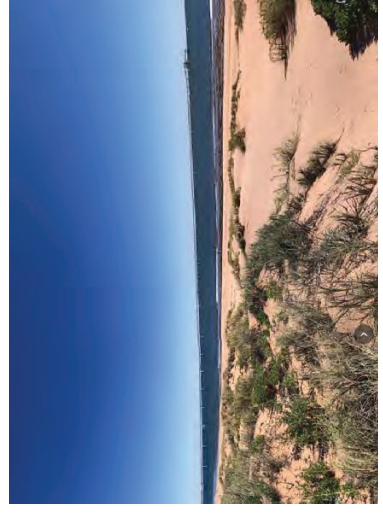
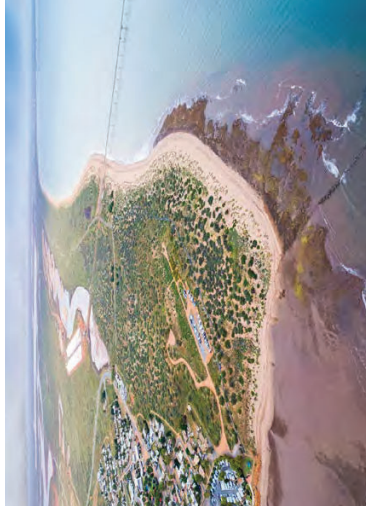


1.1 Vision

Set on the western edge of Australia, Onslow Township Village will be a world class accommodation facility that contributes to the community and economic growth of the region.

The village will be designed as a high quality facility that sets a new benchmark for accommodation that promotes a healthy, active and sustainable lifestyle for workers and the local community.

Inspired by the unique coastal landscape and sense of place the village will be designed to respond to the future vision of Onslow Town Centre and leave a lasting legacy for future generations.



1.3 Landscape Principles

The following design principles have been developed to guide the design of the village and surrounding landscape. Throughout the design process these principles will continue to inform and develop the landscape response.



- Celebrate the unique character of the site.
- Maximise visual, physical and symbolic connectivity to the local context.
- Touch the ground lightly



- Create strong connections to community and the environment.
- Design to support social interaction and relationship building.



- Design comfortable and safe connections to promote incidental physical activity and access to nature.
- Provide formal or informal, natural and man-made landscape areas to support recreational, sporting and social activities.



- Contribute to the " ... Community vision that Onslow be a vibrant, sustainable and prosperous place for work, living and leisure - for both residents and visitors."
- Future proof the site for the next generation of users.

1.4 Landscape Approach

The landscape approach responds to the immediate context of the development area. A series of strategies have been developed that focus the development of the landscape design around key views, local character, the existing topography and integrating the architecture into the landscape.

Celebrate the Views

- Maximise the sites' existing topography to retain the best views out to the horizon.
- Develop a strategy to ensure the accommodation and the common-use amenity retain views to significant vistas

Respond to the Local Character

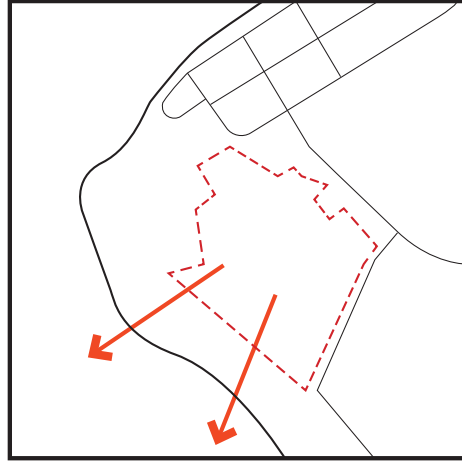
- Respond to the immediate social and environmental influences surrounding the site. Including the beach, Onslow townsite and cultural histories.

Touch the ground lightly

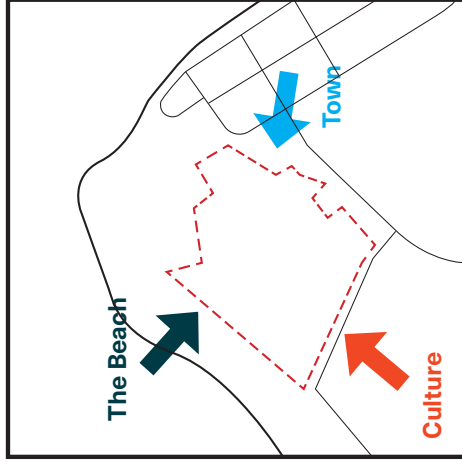
- Develop a strategy for pedestrian networks, accommodation pods and built amenity to minimize disturbance to the existing natural topography and ecologies of the site.

Integrate Landscape and Architecture

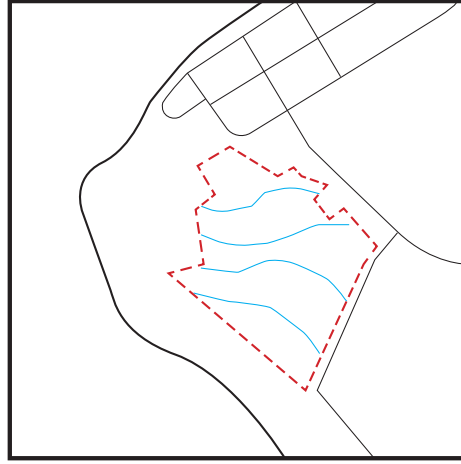
- Create a landscape-driven site response that informs the siting and location of proposed built infrastructure within the site.



Celebrate the views



Respond to local character



Touch the ground lightly



Integrate landscape and Architecture



2.0 Landscape Plan

PROGRAM	
1	Bus Stand (Pickup/Dropoff)
2	Sheltered Community Playground
3	Dedicated Dropoff (Small Vehicles, Short Term)
4	Terraced Entry Plaza
5	Water Feature
6	Recreation Turf
7	Outdoor Gym
8	Cricket Nets & Beach Volley Ball
9	Relax Zone (BBQ, Hammocks, Furniture, Shade Structure)
10	Mini Golf
11	Alfresco Deck With Terraced Embankment
11	Pedestrian / Maintenance Vehicle Access (with shade structures and comfort nodes)
12	Pedestrian Access (Boardwalk with shade structures and comfort nodes)
13	Security Fence
14	Entry Statement Wall

GENERAL	
	Site Boundary

SURFACES	
	Pedestrian Access Paving
	Plaza Paving
	Asphalt (Carpark)
	Asphalt (Maintenance Access)
	Composite Timber Boardwalk
	Fibre Reinforced Plastic Boardwalk
	Stabilised Gravel
	Pool

PLANTING	
	Lawn
	Native Dune Mix Planting - Managed Sparse
	Native Swale Mix - Managed Sparse
	Native Shrub Mix - Managed
	Proposed Native Tree

- Refer to Civil Engineers drawings for grading plan

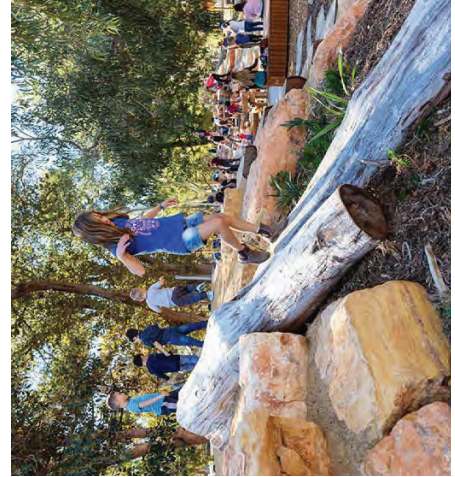
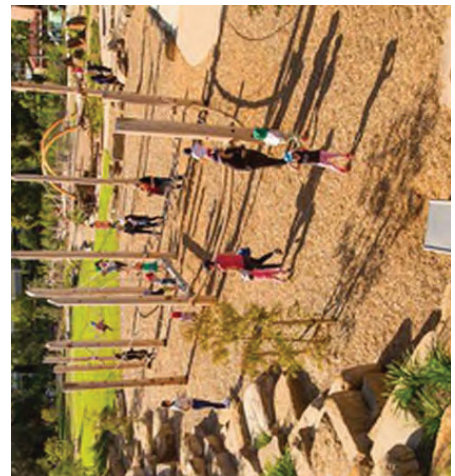
2.1 Community Playground & Entry

The entry road to the Onslow Township Village provides staff and guests with a high quality landscaped experience as they enter through a tree lined road. Water Sensitive Urban Design (WSUD) principles are incorporated into the design of the entry landscape, capturing water runoff into the filtration garden beds and surrounding landscape.

South of the entry road and interfacing with the Onslow Townsite is the Community Playground. This space provides a publicly accessible parkland within the Onslow townsite. The park provides shaded recreation and play opportunities for locals and visitors to enjoy.

LEGEND

1	Treed Arrival Plaza With Furniture
2	Universal Access Ramp
3	Footpath
4	Play Area
5	Entry Statement
6	Security fence / Entry Wall

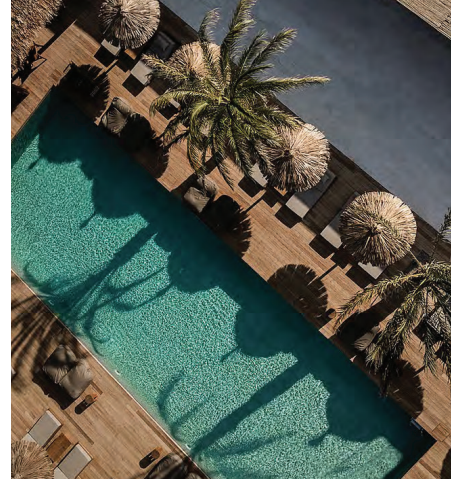
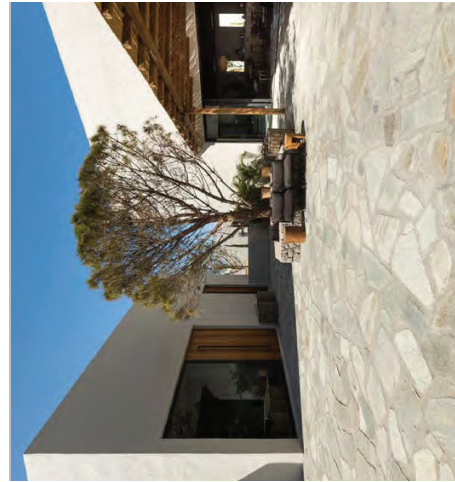
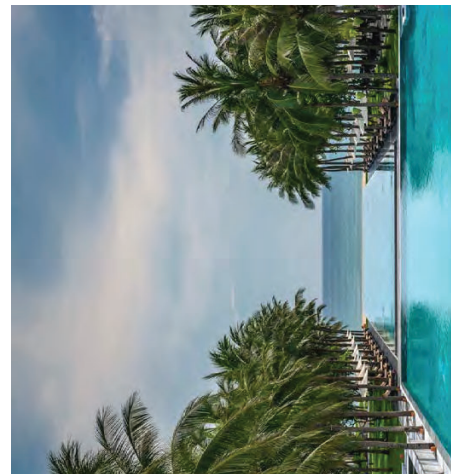


2.2 Amenity and Recreation Areas

The Amenity and Recreation Areas are characterised by a mix of high quality landscape surface treatments and softscape palette that lead guests and staff through the main amenities areas. Key vistas out to the ocean are celebrated through elevated landscape terracing, alfresco areas and the entry plaza. The design of the carpark, incorporates WSUD principles to ensure large planted areas with tree planting occurs.

LEGEND

1	Carpark (Designed to Water Sensitive Urban Design principles)
2	Dropoff/Pickup Bays
3	Entry Plaza With Water Feature
4	Pool
5	Terraced Embankment With Universal Access
6	Alfresco Dining
7	Access To Accommodation



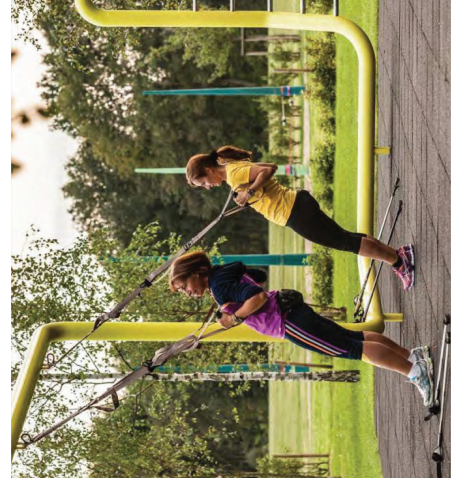
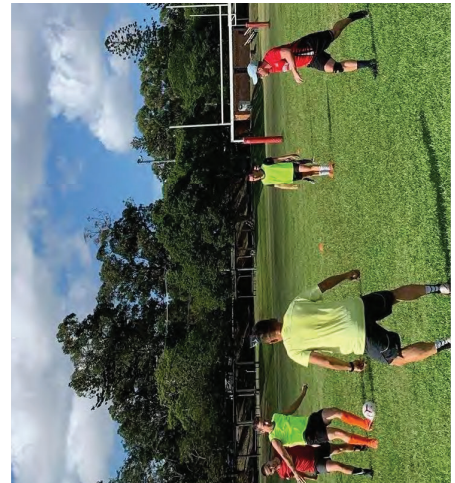
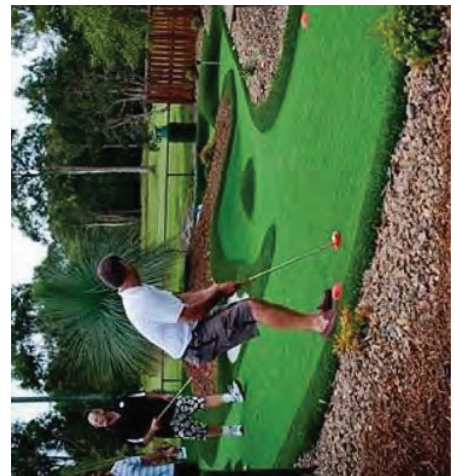
2.3 Outdoor Amenity Areas

The outdoor amenities area provides guests and staff with a range of health and fitness opportunities in an outdoor setting. Universal access is provided through a network of high quality paved surfaces that link to the accommodation and administration areas.

The landscape design provides the following list of outdoor amenity:

LEGEND

- 1 Outdoor Gym
- 2 Beach Volley Ball
- 3 Relax Zone (including hammocks and furniture in a garden setting)
- 4 BBQ and Shade Structures
- 5 Turf Kick-About Area
- 6 Cricket Nets
- 7 Mini-Golf
- 8 Pool



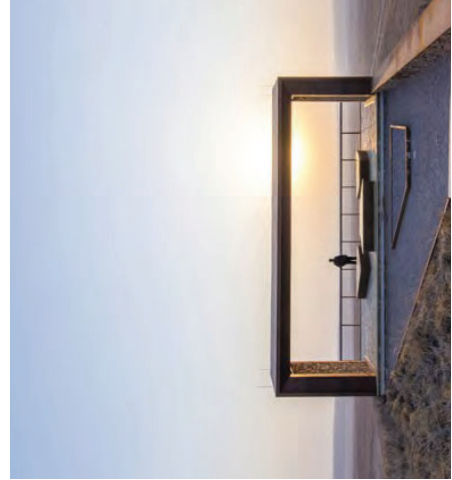
2.4 Accommodation Areas

The accommodation area has been designed to respond to the existing topography and ecology of the site. Minimising disturbance to the existing levels through a considered architectural and landscape response. An elevated boardwalk system extends through the area forming pedestrian circulation route that touches the ground lightly. Along the boardwalk network a series of comfort nodes are included to provide social spaces to experience the raw landscape in comfort. A hierarchy of boardwalks are achieved through primary access routes that provide direct linkages to the key extents of the accommodation, Secondary boardwalks provide more intimate linkages to guests accommodation.

A service and maintenance track doubles as a fitness and well-being loop for guests and staff to exercise by running or walking through the landscape.

LEGEND

- 1 Pod Accommodation
- 2 Primary Boardwalk With Shade Structures (3m wide)
- 3 Secondary Boardwalk With Shade Structures (2.5m wide)
- 4 Comfort Node with Furniture and Shade Structure
- 5 Laundry Service dropoff/pickup
- 6 Maintenance / Exercise Loop



3.1 Landscape Materials

Materials Strategy

A refined palette of robust and low maintenance materials are proposed that are in keeping with the project context and Architecture. The proposed landscape scheme will use a palette of high quality materials, selected to reinforce the identity of the spaces.

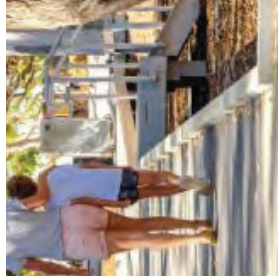
Materials have been selected that are sympathetic to the local context and are appropriate to their location and use. The materials detailed here form a structured palette that are coordinated to create visual unity and integrity within the landscape and the surrounding the Onslow neighbourhood.

The Material strategy will:

- Use materials that are sympathetic to the local context and are appropriate to their location and use.
- Create visual unity and integrity within the landscape but allow for variations in texture and colour that can be used to define function and character.
- Give consideration to long-term performance, durability and maintenance requirements.
- Consider impact on the environment and sourcing, cost and project sustainability.



Large format stone paver



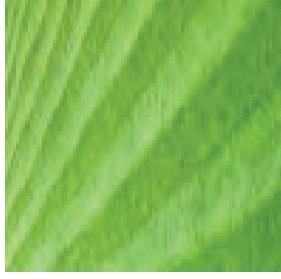
Composite timber



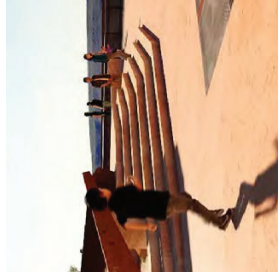
Concrete paving



Stone boulders



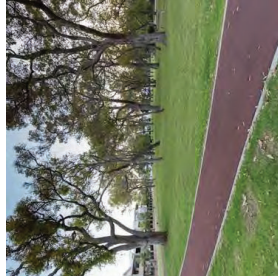
Turf



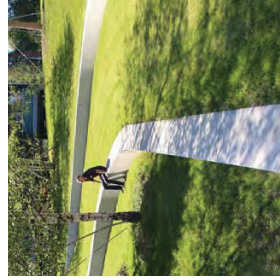
Concrete steps



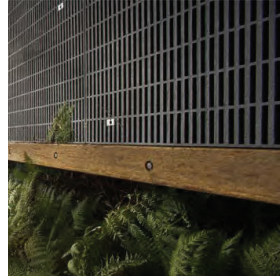
Stabilised pindan gravel



Asphalt



Concrete walls



RFP mesh boardwalk



Concrete inlay



Informal Seating

3.2 Planting Strategy

Planting Strategy

The planting scheme for the project is designed to add a strong well-vegetated character to the site and present a response that interfaces with neighbouring frontages and contributes to greater site ecologies. Landscape will be used to create identity through a series of contextually appropriate planting palettes. Guests and Staff will be able to experience the harshness and fragility of the Pilbara Coastal landscape through considered planting design.

Endemic plants will feature throughout the village which will help to restore and improve the health of degraded landscape areas within the development.

Entry and Recreation Areas

As guests enter the village they will be greeted with a tree lined access route that leads them to the arrival point at the administration and recreation area. Water Sensitive Urban Design principles are used throughout the entry and Recreation Areas and will feature low water demanding irrigated landscape areas. Bush fire Asset Protection Zones are strategic placed around the perimeter of the site with densities of trees, shrubs and ground covers in the locations designed to reduce the effect of bush-fires.

Accommodation Areas

The Accommodation areas are characterised by a mix of dunal vegetation that is characteristic of the immediate ecologies of the site. The planting intent is to restore the local vegetation complexes that exist within the dunal systems surrounding Onslow. This area will be irrigated with a mix of drip and spray irrigation. Other incentives within the accommodation areas include swale planting within the low points of

the site to maximise the filtration of overland water-flows

Low to mid-level planting to the perimeter of the site within the bush fire Asset Protection Zone will be designed to reduce the effect of bushfires while also blending the visual appearance between the development and the surrounding vegetation.

Water Efficient Irrigation System

Trees and plants will be irrigated by a water efficient irrigation system. The irrigation water demand volumes will not be excessive, however, a constant and uninterrupted supply must be maintained especially during dry and hot periods.

Where possible, plants will be hydro-zoned according to water requirements. This allows the reticulation to the endemic plantings to be separately controlled and greatly reduced following their establishment period. The automated irrigation system can be designed to include monitors to detect malfunctions so that rapid response rectification can be programmed before the planting is detrimentally affected by a disruption to water supply.

A holistic irrigation strategy will be prepared for the project that aims to include the following initiatives:

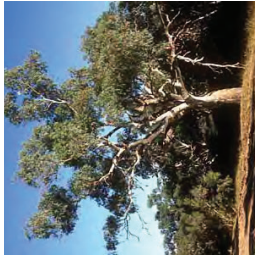
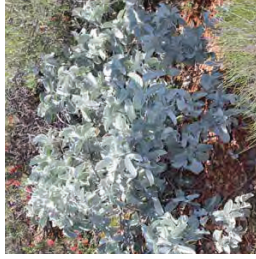
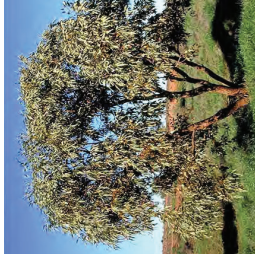
- Aqua monitoring to record and display water usage
- Hydro-zoning of plants
- Watertwise planting and use of local species
- High quality and improved soils with good moisture and nutrient holding capacity



3.3 Planting

Indicative Species List

Endemic Key	Botanical Name	Common Name	
TREES Taller than 10m	<i>Acacia conracea</i>	Wirewood	
	<i>Adansonia gregorii</i>	Boab	
	<i>Brechychiton obtusifolia</i>	River Gum	
	<i>Eucalyptus camadulensis</i>	Smooth Bark Coolbarr	
	<i>Eucalyptus virix</i>		
TREES Up to 10m	<i>Eucalyptus xerodermica</i>		
	<i>Acacia ampliceps</i>	Salt Wattle	
	<i>Acacia citrinoviridis</i>	Mulga Tree	
	<i>Bauhinia cunninghamii</i>	Jigal Native Bauhinia	
	<i>Grevillea wickhamii</i>	Wickham's Holly Grevillea	
LARGE SHRUBS Up to 4m	<i>Pitsopterum phyllaeroides</i>	Native Olive	
	<i>Acacia anictrocarpa</i>	Fitzroy Wattle	
	<i>Acacia bivenosa</i>	Two Vein Wattle	
	<i>Acacia dictyophleba</i>	Sandpaper Wattle	
	<i>Acacia trachycarpa</i>	Minni Ritchi	
	<i>Capparis lasiantha</i>	Spat Jack	
	<i>Capparis spinosa</i>	Caper Bush	
	<i>Crotalaria cunninghamii</i>	Green Bird Flower	
	<i>Eremophila fraseri</i>	Vanish Bush	
	<i>Eremophila maculata</i>	Spotted Emu Bush	
	SMALL SHRUBS Less than 2m	<i>Acacia hilliana</i>	Tabletop Wattle
		<i>Acacia gregori</i>	Gregory's Acacia
<i>Eremophila cuneifolia</i>		Phyruu	
<i>Eremophila microtheca</i>		Heath-like Eremophila	
<i>Indigofera monophylla</i>		Indigo Plant	
<i>Ipomoea yendensis</i>		Yardie Morning Glory	
<i>Philotus exaltatus</i>		Tall Mulla Mulla	
<i>Philotus obovatus</i>		Cotton Bush	
<i>Scaevola crassifolia</i>		Thick leaved Fan Flower	
<i>Solanum lasiophyllum</i>		Bush Tomato/ Flannel Bush	
<i>Senna notabilis</i>		Cockroach Bush	
GROUND COVERS Less than 600mm		<i>Gomphrena canescens</i>	Bachelors' Buttons
		<i>Ipomoea pes-caprae</i>	Coastal Morning Glory
		<i>Erchyliana tomentosa</i>	Baner Saltbush
		<i>Philotus clementi</i>	Tassel Top
	<i>Solanum horridum</i>	Wild Gooseberry	
	<i>Suaresonia formosa</i>	Sturt Desert Pea	
	<i>Suaresonia maccullochiana</i>	Ashburton Pea	
	<i>Canavalia rosa</i>	Wild Jack Bean	
	<i>Ipomoea costata</i>	Bush Potato	
	<i>Ipomoea pes-caprae brasiliensis</i>	Goat's Foot Morning Glory	
Grasses	<i>Ipomoea muelleri</i>	Poison Morning Glory	
	<i>Aristida contorta</i>	Wind Grass	
	<i>Pennisetum decompositum</i>	Native Millet	

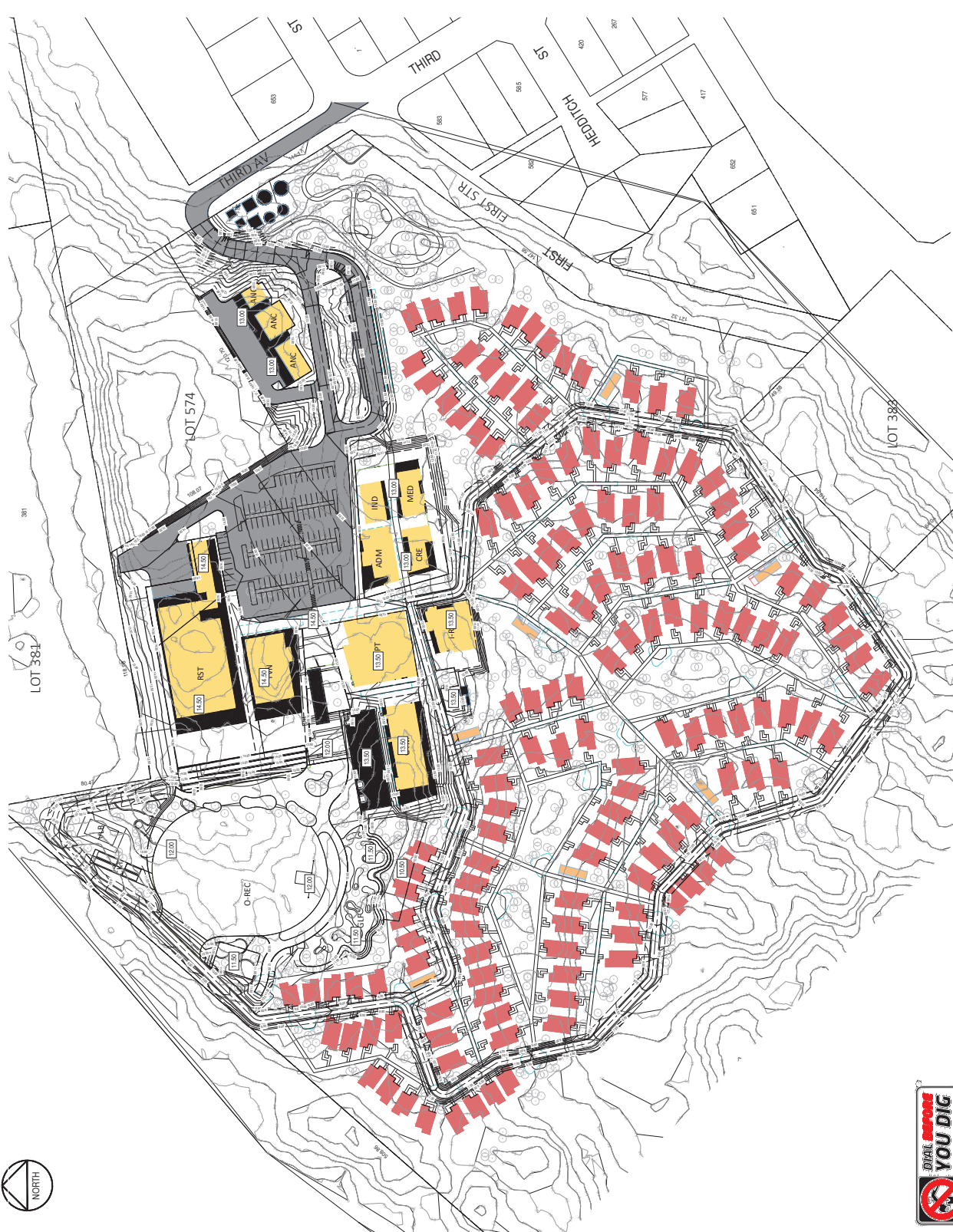


Appendix B Engineering Design Plan

NOTES

1. ALL DIMENSIONS SHOWN ARE IN METRES (U.S.O.)
2. ALL COORDINATES AND LEVELS SHOWN ON THIS DRAWING SHALL BE REFERRED BY THE SURVEY POINTS AND LEVELS SHOWN ON THIS DRAWING. SURVEY POINTS SHALL BE REPORTED TO THE SUPERINTENDENT WITH INSTRUCTIONS.
3. SURVEY INFORMATION SUPPLIED BY BENCHMARK SURVEYS (M.A.)
4. ALL BENCHMARKS ARE TO BE PROTECTED AND PRESERVED UNLESS NOTED OTHERWISE.
5. ALL BENCHMARKS ARE TO BE PROTECTED AND PRESERVED UNLESS NOTED OTHERWISE.
6. ALL BENCHMARKS ARE TO BE PROTECTED AND PRESERVED UNLESS NOTED OTHERWISE.
7. ALL CONSTRUCTION SHALL BE ACCORDANCE WITH THE SPECIFICATION AND ALSO THE REQUIREMENTS OF THE SHEET OF SUBMITTALS.
8. THE CONTRACTOR SHALL BE RESPONSIBLE FOR OBTAINING ALL NECESSARY PERMITS AND EXISTING SERVICES WITHIN THE CONTRACT AREA PRIOR TO THE COMMENCEMENT OF WORK. COMPLETE WORKING DRAWINGS ON THE WORKS AND THE ONLY VARIATION TO BE TAKEN AND SUPPLIED TO THE SUPERINTENDENT IMMEDIATELY.
9. COMMENCEMENT OF WORK SHALL BE APPROVED BY THE SUPERINTENDENT PRIOR TO COMMENCEMENT OF WORK.
10. CONTRACTOR SHALL NOTE THAT NON-TREFFICABLE SUBTERRANEAN STRUCTURES AND OTHER SUBTERRANEAN STRUCTURES, THESE MATERIALS AND STRUCTURES ARE TO BE PROTECTED AND PRESERVED UNLESS NOTED OTHERWISE.
11. THE CONTRACTOR SHALL TAKE ALL NECESSARY PRECAUTIONS TO PROTECT ALL UTILITIES AND OTHER SUBTERRANEAN STRUCTURES. THESE MATERIALS AND STRUCTURES ARE TO BE PROTECTED AND PRESERVED UNLESS NOTED OTHERWISE.
12. THE CONTRACTOR SHALL TAKE ALL NECESSARY PRECAUTIONS TO PROTECT ALL UTILITIES AND OTHER SUBTERRANEAN STRUCTURES. THESE MATERIALS AND STRUCTURES ARE TO BE PROTECTED AND PRESERVED UNLESS NOTED OTHERWISE.
13. ALL TREES TO BE RETAINED SHALL BE FENCED OFF FOR THE DURATION OF THE PROJECT FOR THE REMOVAL OF THE TREE AS NOTED.
14. THE CONTRACTOR SHALL TAKE ALL NECESSARY PRECAUTIONS TO PROTECT ALL UTILITIES AND OTHER SUBTERRANEAN STRUCTURES. THESE MATERIALS AND STRUCTURES ARE TO BE PROTECTED AND PRESERVED UNLESS NOTED OTHERWISE.
15. ALL ROOTS, BOLLERS AND ANY OTHER DESTRUCTIVE MATERIAL SHALL BE TOTALLY REMOVED AND DISPOSED OF IN ACCORDANCE WITH THE SPECIFICATION AND AS NOTED ON THE DRAWINGS.
16. ALL ROOTS, BOLLERS AND ANY OTHER DESTRUCTIVE MATERIAL SHALL BE TOTALLY REMOVED AND DISPOSED OF IN ACCORDANCE WITH THE SPECIFICATION AND AS NOTED ON THE DRAWINGS.
17. WHICH AGREEMENTS TO THE EVENT OF EARTHWORKS MAY OCCUR TO PRESERVE IDENTIFIED TREES.
18. ALL MATERIAL SHALL BE PLACED IN A SINGLE LAYER UNLESS SHOWN OTHERWISE ALSO.
19. ALL FILL SHALL BE CLEAN AND BE FREE FROM DEBRIS AND ORGANIC MATERIAL.
20. FILL MATERIAL TO BE TESTED BY A REGISTERED MATERIALS TESTING LABORATORY AND RESULTS REPORTED TO THE SUPERINTENDENT PRIOR TO THE INCEPTION AND PLACEMENT OF MATERIAL.
21. PROFORMERS USED FOR TESTING MUST BE CALIBRATED FOR SITE AND RECALIBRATED TO AGENCY NOT LESS THAN 99% M.M.D. REFER TO SPECIFICATION FOR COMPACT TO COMPLETE ALL BACKFILLING AND EARTHWORKS REQUIRED TO ACHIEVE LEVELS SHOWN ON THIS DRAWING.
22. CONTRACTOR TO COMPLETE ALL BACKFILLING AND EARTHWORKS REQUIRED TO ACHIEVE LEVELS SHOWN ON THIS DRAWING.
23. TO BE LEFT CLEAN AND FREE OF RUBBISH UPON COMPLETION OF WORKS.
24. THE INTO ADJACENT BOUNDARIES AND FEATURES TO BE SHOWN WITH THE SPECIFICATION AND PROVIDED TO THE SUPERINTENDENT PRIOR TO PROCEEDING TO THE NEXT STAGE OF WORKS.

LEGEND



<p>450 Adelaide Street Substation WA 6000 Perth WA 6000 Telephone (08) 9442 0111 www.pritchardfrancis.com.au</p>		<p>NOT FOR CONSTRUCTION</p>	<p>DATE: AUGUST 2021</p>	<p>SCALE: 1:1000</p>	<p>PROJECT: 21195-C9-SK-05</p>
<p>pritchard francis civil and structural engineering consultants</p>		<p>MINERAL RESOURCES ONSLOW VILLAGE</p>	<p>EARTHWORKS CONCEPT OPTION 2</p>	<p>DATE: 21/08/21</p>	<p>PROJECT: 21195-C9-SK-05</p>
<p>C. 24/08/21</p>	<p>MINOR UPDATE</p>	<p>DL AT</p>	<p>DATE</p>	<p>BY</p>	<p>SCALE</p>
<p>B. 08/08/21</p>	<p>CONOURS REVISED TO SUIT ARCHITECT COMMENTS</p>	<p>JS AT</p>	<p>DATE</p>	<p>BY</p>	<p>SCALE</p>
<p>A. 04/08/21</p>	<p>INITIAL ISSUE</p>	<p>JS AT</p>	<p>DATE</p>	<p>BY</p>	<p>SCALE</p>

Attachment 4.0
Desktop Contamination Assessment Report



Lot 300 Back Beach Road, Onslow WA

Desktop Contamination Assessment

**Prepared for
Mineral Resources Limited (MRL)**

July 2021

● people ● planet ● professional

Document Reference	Revision	Prepared by	Reviewed by	Admin Review	Submitted to Client	
					Copies	Date
4756AA_Rev0	Internal Draft	DO	RB	-		20/7/21
4756AA_Rev1	Client Draft	DO	RB	LI	1 x electronic	21/7/21
4756AA_Rev2	Client Final	DO	RB	LI	1 x electronic	27/7/21

Disclaimer

This report is issued in accordance with, and is subject to, the terms of the contract between the Client and 360 Environmental Pty Ltd, including, without limitation, the agreed scope of the report. To the extent permitted by law, 360 Environmental Pty Ltd shall not be liable in contract, tort (including, without limitation, negligence) or otherwise for any use of, or reliance on, parts of this report without taking into account the report in its entirety and all previous and subsequent reports. 360 Environmental Pty Ltd considers the contents of this report to be current as at the date it was produced. This report, including each opinion, conclusion and recommendation it contains, should be considered in the context of the report as a whole. The opinions, conclusions and recommendations in this report are limited by its agreed scope. More extensive, or different, investigation, sampling and testing may have produced different results and therefore different opinions, conclusions and recommendations. Subject to the terms of the contract between the Client and 360 Environmental Pty Ltd, copying, reproducing, disclosing or disseminating parts of this report is prohibited (except to the extent required by law) unless the report is produced in its entirety including this cover page, without the prior written consent of 360 Environmental Pty Ltd.

© Copyright 2021 360 Environmental Pty Ltd ACN 109 499 041

Executive Summary

360 Environmental Pty Ltd (360 Environmental) was commissioned by Mineral Resources Limited (MRL) to complete a desktop contamination assessment of the proposed development site located at Lot 300 Back Beach Road in Onslow, Western Australia.

The primary objectives of this desktop assessment are to identify areas of potential concern (AOPC) associated with onsite or offsite contamination, identify data gaps associated with contamination, and to provide advice on potential future works to address those data gaps.

Based on the findings of this desktop assessment and review of available information, it is concluded that there have been no significant historical contaminating activities at the site, as the site has been vacant and undeveloped. However, six (6) AOPC were identified, namely:

- AOPC 1 – Part of the site located adjacent to the former furnace oil aboveground storage tanks (ASTs) to the north of the site, and associated fuel pipelines and pumps (the offsite former furnace oil AST area was formerly classified as Contaminated – remediation required)
- AOPC 2 – Part of the site located adjacent to the former historical bulk fuel storage to the east (dieseline) of the site, and associated fuel pipelines and pumps
- AOPC 3 – Part of the site located adjacent to the former historical bulk fuel storage to the south (aviation spirit) of the site, and associated fuel pipelines and pumps
- AOPC 4 - Part of the site with a moderate to low risk of acid sulfate soils (ASS) being present within 3 metres of the soils surface
- AOPC 5 - Potential unexploded ordnance (UXO) from activities during WWII (whole of site and Onslow Townsite)
- AOPC 6 - Potential asbestos from illegal fly-tipping or associated with offsite sources (whole of site).

The following data gaps were identified associated with the above AOPCs:

- There have been no soil or groundwater investigations undertaken at the site however it is understood offsite contamination (and possible remediation) associated with former fuel infrastructure located to the north has previously occurred. Reports presenting details of investigation(s) and/or remediation offsite have not been identified and as such the specific scope and/or effectiveness of any remediation works is not well understood. In this regard the nature and extent of existing and/or residual contamination in soil or groundwater is not known. The risk to the site is considered to be LOW.
- It is not known if the soils in the area marked as having a moderate to low risk of ASS being present are potential or actual ASS. The requirement to investigate is dependent on whether development plans for the site involve disturbance of potential ASS material or if dewatering may be required. Management measures, such as development of an ASS management plan (ASSMP) or dewatering management plan (DMP), would be

dependent on the findings of any ASS investigation. The risk to the site is considered to be LOW.

- Onslow Townsite (including the site) is listed on the Department of Defence (DoD) UXO Mapping Application as having a Slight Potential for the presence of UXO. It is not known if a detailed UXO survey has been undertaken at the site, or if records exist of any historical UXO searches or recovery operations in relation to the site. Information on possible UXO presence in AECOM (2010) was anecdotal in nature. The risk to the site is considered to be LOW to MODERATE.
- Without a hazardous materials (HAZMAT) survey of the site or previous site investigations, it is not known if asbestos containing materials (ACM), asbestos fines (AF) or fibrous asbestos (FA) are present at the site. If these are present, they may be a source of potential contamination for onsite and offsite, current and future, receptors (human health). The risk to the site is considered to be LOW to MODERATE.

Based on the data gaps identified, the following recommendations are made:

- A UXO survey of the site should be considered prior to any site works commencing.
- A HAZMAT site survey should be considered to evaluate the potential presence of asbestos at the site.
- Conduct a review of any available contamination investigation and/or remediation reports describing works associated with former bulk fuel infrastructure (i.e. AOPC 1, AOPC 2 and AOPC 3) to determine the requirement for investigation onsite.
- Site development plans should be reviewed to determine if ASS may be disturbed by development activities or if dewatering is to occur, and thereby determine the requirement for an ASSMP/DMP.
- Depending on the findings of the above, consideration should be given to intrusive site investigations to:
 - Investigate the contamination status of soils (and potentially groundwater) onsite at AOPC 1, AOPC 2 and AOPC 3, to confirm there are no hydrocarbon impacts.
 - Assess the potential presence of asbestos (ACM, AF or FA) in soils at the site. If identified to be present, asbestos remediation should be undertaken in accordance with Department of Health guidelines.
 - In the absence of any site investigations associated with AOPC 1, AOPC 2 or AOPC 3, an unexpected finds protocol (UFP) is recommended to be developed prior to site development works. The protocol should detail the management requirements should any of the contaminants of potential concern (COPCs) for the site be encountered during site development works.

Table of Contents

1	Introduction.....	1
1.1	Objectives	1
1.2	Scope of Works.....	1
1.3	Information Sources.....	1
1.4	Regulatory Guidelines.....	2
2	Site Information and Setting.....	3
2.1	Site Identification.....	3
2.2	Surrounding Land Uses	3
2.3	Environmental Setting.....	4
2.4	Heritage Sites.....	8
3	Site History.....	10
3.1	Historical Aerial Review	10
3.2	Previous Environmental Investigations	11
4	AOPC and Data Gaps	12
4.1	AOPCs	12
4.2	Potential Receptors.....	13
4.3	Potential Migration Pathways.....	14
4.4	Source-Pathway-Receptor Linkages	15
4.5	Data Gaps	16
5	Conclusions and Recommendations.....	17
6	Limitations	19
7	References	20

List of Figures

Figure 1: Site Location

Figure 2: Areas of Potential Concern

List of Tables

Table 1: Databases and Information Sources	1
Table 2: Site Identification.....	3
Table 3: Surrounding Land Uses.....	4
Table 4: Environmental Setting.....	5
Table 5: Aboriginal Heritage Locations	8
Table 6: Other Heritage Locations.....	8
Table 7: Historical Aerial Photographs	10
Table 8: Previous Reports	11
Table 9: AOPC and COPC.....	12
Table 10: Potential Receptors	13
Table 11: Potential Migration Pathways.....	14
Table 12: Data Gaps	16

List of Appendices

Appendix A Basic Summary of Records Results

Appendix B Historical Aerial Photographs

1 Introduction

360 Environmental Pty Ltd (360 Environmental) was commissioned by Mineral Resources Limited (MRL) to complete a desktop contamination assessment of the proposed development site located at Lot 300 Back Beach Road in Onslow, Western Australia (herein referred to as the site).

1.1 Objectives

The primary objectives of this desktop assessment are to identify areas of potential concern (AOPCs) associated with onsite or offsite contamination, identify data gaps associated with contamination, and to provide advice on potential future works to address those data gaps.

1.2 Scope of Works

360 Environmental undertook the following scope of works as part of the desktop contamination assessment:

- Desktop review of publicly available information (online databases, websites, etc.)
- Desktop review of relevant client-provided investigation reports and design drawings
- Consideration of potential sources of contamination and identification of AOPCs
- Identification of data gaps associated with the potential contamination
- Provision of recommendations for further works to address data gaps.

1.3 Information Sources

The following information sources were utilised for the desktop review to identify critical environmental aspects relevant to the project.

Table 1: Databases and Information Sources

Aspect	Database Searches/Relevant Literature
Tenure and Land Uses	
Land Uses	<ul style="list-style-type: none"> • Department of Planning, Lands and Heritage (DPLH) PlanWA Interactive Map, https://espatial.dplh.wa.gov.au/PlanWA/Index.html?viewer=PlanWA (accessed online 15 July 2021) (DPLH 2021).
Aboriginal Heritage/Native Title	<ul style="list-style-type: none"> • Aboriginal Heritage Inquiry System, https://espatial.dplh.wa.gov.au/AHIS/index.html?viewer=AHIS (accessed online 16 July 2021) (DPLH 2021).
European Heritage	<ul style="list-style-type: none"> • Shire of Ashburton Local Government Heritage Inventory, October 2019 (Shire of Ashburton 2019). • inherit Heritage register (accessed online 15 July 2021) (HCWA 2021).
Reserves/Conservation Areas/ESAs	<ul style="list-style-type: none"> • Perth Regional Ecological Linkages, GIS Dataset. Perth Biodiversity Project (2008). • Bush Forever Sites, GIS Dataset. Department of Planning (2014). • Clearing Regulations - Environmentally Sensitive Areas, GIS Dataset. Department of Water and Environmental Regulation (2018a).

Aspect	Database Searches/Relevant Literature
Physical and Hydrological Aspects	
Acid Sulfate Soils	<ul style="list-style-type: none"> • Acid Sulfate Soils, Swan Coastal Plain, GIS Dataset. Department of Water and Environmental Regulation (2019a).
Contamination and Hazardous Substances	<ul style="list-style-type: none"> • Contaminated Sites DWER Records, GIS Dataset. Department of Water and Environmental Regulation (DWER) (accessed online 15 July 2021). • Department of Defence (DoD) UXO Mapping Application, https://www.whereisuxo.org.au/ (accessed online 17 July 2021).
Groundwater	<ul style="list-style-type: none"> • Water Register, https://maps.water.wa.gov.au/#/webmap/register. Department of Water and Environmental Regulation (accessed online 15 July 2021).
Surface Water/Drainage	<ul style="list-style-type: none"> • Hydrography – Swan Coastal Plain (Detailed Mapping) GIS Dataset, Department of Water and Environmental Regulation (2019b) • Hydrography Linear (Hydrography), GIS Dataset, Department of Water and Environmental Regulation (2018c).

1.4 Regulatory Guidelines

In Western Australia, suspected or known contamination is legislatively addressed under the Contaminated Sites Act and regulated by the DWER Contaminated Sites Branch. This PSI follows the approach to reporting, investigating and remediating suspected or known contaminated sites as guided by the assessment protocols defined in the revised (2013) *National Environmental Protection Measure (Assessment of Site Contamination)* [2013 NEPM ASC] schedules, the DWER *Assessment and Management of Contaminated Sites Guidelines*, dated December 2014 (DER, 2014) [AMCS Guideline] and Department of Health (2009) *Assessment, Remediation and Management of Asbestos-Contaminated Sites in Western Australia*.

2 Site Information and Setting

2.1 Site Identification

Site identification and land use information is summarised in **Table 2**.

Table 2: Site Identification

Aspect	Detail		
Primary address	Lot 300 Back Beach Road, Onslow WA 6710		
Lot Details	Lot 300 on Deposited Plan 067927		
Current Owner	Unallocated Crown Land		
Property details (Vol/Fol)	3160/90		
Local Government Authority	Shire of Ashburton		
Zoning	Conservation, Recreation and Nature Landscape		
Local Planning Scheme	Shire of Ashburton Scheme No. 7		
Regional Planning Scheme	None		
Structure Plans	Onslow Townsite Expansion Structure Plan		
State Planning Policies	3.7 – Planning in Bushfire Prone Areas		
Boundary Coordinates [Geographic Datum Australia (GDA 1994 MGA Zone 50)] (refer Figure 1)	Reference	Easting (mE)	Northing (mN)
	1	303735	7606131
	2	304071	7606513
	3	304422	7606330
	4	304154	7605925
Site Area	20.4485 hectares (ha)		
Current Land Use	Vacant, undeveloped		
Proposed Land Use	500 (TBC) resort-style fly-in fly-out accommodation facility		
Contaminated Sites Status	The site is not shown as classified on the Contaminated Sites Database (CSD) (accessed online 15 July 2021). A Basic Summary of Records (BSR) search was undertaken with the results indicating that as of 27/07/2021 the site has not been reported as a known or suspected contaminated site, either prior to or after the commencement of the <i>Contaminated Sites Act 2003</i> . The BSR response is provided in Appendix A .		

2.2 Surrounding Land Uses

Identified land uses in each direction from the site as identified during this desktop assessment are summarised in **Table 3**.

Table 3: Surrounding Land Uses

Direction from site	Current land use(s)
North	The site is immediately abutted by the former location of the furnace oil above ground storage tanks (ASTs), now vacant land used for tourism purposes (i.e. Lookout Point and Onslow Memorial Park), then beach followed by waters of the Indian Ocean.
East	Some residential properties are located to the east of the site and bordering First St, Third Ave or Simpson St. Also to the east are community facilities including Onslow Primary School, the Onslow Community Garden, a church and police station. The location of the former diesel/water storage AST is vacant.
South	The site is bound by Back Beach Rd and small area of residential development, followed by a vacant portion of the site operated by Onslow Salt, then infrastructure of Onslow Salt.
West	The site is immediately abutted by vacant land with a memorial boardwalk, then Sunset Beach and the Indian Ocean (with a loading jetty associated with Onslow Salt). The former aviation spirit AST is still present, approximately 210m to the south of the site, having been converted to residential use.

2.3 Environmental Setting

2.3.1 Environmental Setting

The environmental setting of the site is summarised within **Table 4**.

Table 4: Environmental Setting

Attributes	Detail	Onsite	Offsite
Topography		The site has a low point of approximately 6 m above Australian Height datum (mAHD) in the southwest corner and rises to a high of approximately 16 mAHD near the northeast corner, before falling to 9 mAHD near Third Ave. The site tends to undulate gently from southeast to southwest through the centre of the site, before again falling away along the northwest boundary (GoogleEarthPro, accessed online 15 July 2021).	The ground level generally fluctuates around the dunal areas around the site and drops down towards beach areas. Salt mining areas to the southwest are topographic lows.
Geology and Soils	Regional geology	Onslow is located in the Carnarvon Geological Region and within the Exmouth Province of the Western Coastlands Physiographic Region (AECOM, 2010). The Exmouth Province is characterised by sandy or alluvial plains associated with drainage systems such as the Ashburton River. Coastland adjacent to the river is characterised by sandy beaches and dunal systems of the Quaternary shoreline and coastal eolian deposits. Onslow is situated on a large sandy island, with the most seaward point located over an old coral reef, forming Beadon Point (AECOM 2010). Regional soils are predominantly red sands in the dune fields and red soils in the plains (AECOM 2010).	
	Local geology	No site investigations are understood to have been undertaken. Based on the aerial photographs and the site location, the site is expected to reflect the regional geology and comprise coastal dunes, being calcareous and siliceous sands, locally shelly and/or cemented (beach rock).	
	Acid sulfate soils	Part of the site (central portion running to the southwest site boundary at Back Beach Rd) is mapped as having a moderate to low risk of acid sulfate soils (ASS) occurring within 3m of the natural soil surface but high to moderate risk of ASS below 3 m of the natural soil surface (ASS Risk Map, Pilbara Coastline, DWER-053).	
Hydrogeology	Regional hydrogeology	There is limited hydrogeological information for the site and Onslow area. AECOM (2010) notes that Onslow is located within the Ashburton Sub-Area of the Pilbara Groundwater Area. The freshwater aquifer beneath the townsite is understood to be of limited supply and is not extracted for human consumption, with town potable supplies sourced from bores approximately 30 km to the east (AECOM 2010)	
	Local hydrogeology	No groundwater investigations are understood to have been conducted at the site.	No nearby offsite groundwater investigations were identified in this investigation.
	Groundwater quality and protection	Groundwater is anticipated to range from fresh to saline. Potable water is sourced from approximately 30 km to the east and a large salt lake is present to the southwest of the site. Given the proximity of the site close to the Indian Ocean, groundwater beneath the site is likely to be saline. No groundwater investigation reports associated with the site were identified.	
	Groundwater abstraction licence(s)	There are no abstraction licences associated with the site.	A search of the Water Register indicates one groundwater abstraction licence within 500m of the site. The licence (181614) is registered to Onslow Development and applies to the property to the immediate north of the site (Lot 381 on Plan 205465) and has an annual allocation of 16,000kL. The use of this abstraction (and whether the allocation is utilised) is not provided.

Attributes	Detail	Onsite	Offsite
	Registered bores	A search of the Water Information Reporting (WIR) and the Australian Groundwater Explorer indicate there are no registered or licensed groundwater wells at the site.	<p>A search of the WIR database identified three (3) registered bores while a search of the Australian Groundwater Explorer identified a total of four (4) sites within 500m of the site. The sites are summarised as follows:</p> <ul style="list-style-type: none"> 70610006 – Onslow Artesian No. 2, drilled in 1899, with a measured static water level in 1899 of 6 mbgl. 70610297 – Onslow Oval 70612248 – monitoring well installed in 1997 to a depth of 12.7 mbgl. 70612247 – monitoring well installed in 1997 to a depth of 9.1 mbgl.
	Surface water protection	The site and surrounds are not located within any surface water protection area.	
Surface Water	Ambient surface water bodies, wetlands and flood plains	No natural, constructed water bodies or wetlands exist on the site.	A natural lake area, visible in the earliest aerial photograph, is present approximately 200m to the southwest and is associated with the Onslow Salt site and operations (i.e. it is assumed to be saline).
Contaminated Sites	Contaminated Sites Database (CSD)	The site is not a listed on the CSD and there are no classified properties adjoining the site. Note that it is possible properties classified as “possibly contaminated – investigation required” (PCIR) may be near the site. PCIR sites are not listed on the CSD.	There are currently no classified sites listed within 1 km of the site, with the nearest being more than 2 km to the southeast. 360 Environmental notes that AECOM (2010) reported nearby Lot 381, the site of the former 2,300KL furnace oil ATSS adjacent to the northern site boundary, as being classified as Contaminated – remediation required. That report noted the ASTs had been installed on an oil-saturated sand bed, and that anecdotal evidence indicated pipes containing oil had been uncovered during installation of a sewer pit. Those pipes were presumably associated with the tanks and may have run out to the former jetty to the north. Remediation was noted to be occurring in 2010 (AECOM 2010), the outcomes of which are not known. A search of the CSD in July 2021 did not identify the site as classified and the BSR search determined the site has not been reported as known or suspected contaminated site (refer Appendix A).
Environmental Protection	Environmental Sensitive Areas (ESA)	The site is not located in an ESA.	There are no ESAs located within a 500m radius of the site.

Attributes	Detail	Onsite	Offsite
Heritage	Aboriginal heritage	There are three (3) registered heritage sites associated with the site (Place IDs 6617, 6618 and 8920). These are described in Section 2.4.1.	There is one (1) registered heritage site within 500m of the site (Place ID 6575). This is described in Section 2.4.1.
	European heritage	There are no registered Historical Heritage locations at the site.	There are six (6) registered heritage locations within 500m of the site (and a further two (2) reported in Shire of Ashburton (2019)). These are further described in Section 2.4.2.

2.4 Heritage Sites

2.4.1 Aboriginal Heritage

A search of the AHIS identified three (3) listed heritage locations associated with the site and one (1) additional location within 500m of the site. These are described in **Table 5**.

Table 5: Aboriginal Heritage Locations

ID	Name	Type / Description
Onsite		
6617	Burubarladji	Mythological; not a protected area
6618	DEW TALU	Ceremonial, Water Source; not a protected area
8920	Onslow 1	Artefacts / Scatter, Midden / Scatter; not a protected area
Offsite		
6575	Jinta 1 Midden	Artefacts / Scatter, Midden / Scatter; not a protected area

2.4.2 Other Heritage Sites

A search of state and local government heritage databases and available reports identified several heritage locations within 500m of the site. These are further described in **Table 6**.

Table 6: Other Heritage Locations

HCWA No.	Name	Type / Description
Heritage Council of WA Website (inHerit)		
15366	Police Residence (fmr)	3 First St, Onslow. The former police residence has aesthetic, historic, social and representative cultural heritage significance and is a relic of Onslow's early settlement
15392	St Nicholas Church	19 Third Ave, Onslow. St Nicholas Church has significant aesthetic, historic, social and rarity heritage value.
15377	Residence - Sweeting	18 Third Ave, Onslow. The residence on Lot 326 has historic cultural heritage significance, being a remnant of the Old Onslow town site that has survived numerous storms.
15376	Residence	26 Third Ave, Onslow. The residence has aesthetic, historic and representative cultural heritage significance.
15367	Onslow Post Office & Residence	19-21 Second Ave, Onslow. The former Post Office and residence have aesthetic, historic and representative cultural heritage significance
15364	Beadon Hotel	22-26 Second Ave, Onslow. The Beadon Hotel has significant aesthetic, historic, social and rarity cultural heritage value.
Shire of Ashburton Local Government Heritage Inventory		
-	Fuel Storage Tanks	Includes the former Aviation Spirit tank, dieseline tank and furnace oil tanks 1 and 2, and the pump outstation and hose locker. These were present across several lots, with several (furnace oil tanks, dieseline tank and pump stations) immediately adjacent to the site. These were

HCWA No.	Name	Type / Description
		listed as having heritage value based on their physical form and their role in defence activities in World War II.
26612	Beadon Point Rear Navigational Leading Light	2 Second Ave, Onslow. Cultural significance as provided evidence of when Onslow was the major port for the Ashburton district. Demolished in 2019.

3 Site History

3.1 Historical Aerial Review

A review of publicly available online historical aerial imagery (dating back to 1970) was undertaken on 15 July 2021. Observed changes to the site and surrounding area are described in **Table 7**. Copies of the historical aerial imagery reviewed are provided in **Appendix B**.

Table 7: Historical Aerial Photographs

Year	Photograph Description	
	Onsite	Offsite
1970	The site is undeveloped with natural ground cover.	<ul style="list-style-type: none"> Fuel storage infrastructure is visible to the north [two furnace oil above ground storage tanks (ASTs)], east (dieseline AST and pump station) and south (aviation pump station and aviation spirit AST). Residential properties are present to the east and southeast of the site and the jetty is present to the north at Beadon Point. Land to the west is undeveloped.
2001	The site appears similar to the 1970 aerial photograph and remains undeveloped with natural ground cover.	<ul style="list-style-type: none"> Most of the fuel storage infrastructure remains and appears generally similar to the 1970 aerial photograph. Additional residential properties are present to the immediate east and south of the site, including across Simpson St. The jetty to the north is no longer present however a jetty associated with Onslow Salt, present to the southwest of the site, is now present to the west of the site.
2010	The site appears similar to the 2001 aerial photograph and remains undeveloped with natural ground cover.	<ul style="list-style-type: none"> The two furnace oil ASTs to the north have been removed and some bioremediation of impacted soil occurred. Other fuel infrastructure in the vicinity appears similar to the 2001 aerial photograph. Minor changes are evident among the residential properties east and southeast of the site.
2017	The site appears similar to the 2010 aerial photograph and remains undeveloped with natural ground cover.	<ul style="list-style-type: none"> The remaining small AST to the north of the site has been removed, as has the former dieseline AST east of the site (which historically had been converted to a water storage tank for the town). The remainder of the area appears generally similar to the 2010 aerial photograph.
2020	The site appears similar to the 2017 aerial photograph and remains undeveloped with natural ground cover.	<ul style="list-style-type: none"> Much of the surrounding area appears similar to the 2017 aerial photograph.

3.2 Previous Environmental Investigations

Relevant investigation reports sighted for this investigation (or referenced within signed reports) are identified and summarised in **Table 8**, noting no environmental investigations specifically targeting the site were identified

Table 8: Previous Reports

Report	Report Summary	Relevance to Site
AECOM (2010) Environmental Due Diligence	<p>AECOM completed an environmental due diligence (EDD) on behalf of LandCorp as part of preparatory works in support of the expansion of the townsite as part of the Onslow Townsite Strategy</p> <p>A limited Preliminary Site Investigation (PSI) was completed as part of the EDD and included identification of potentially contaminating activities, industries or land uses relevant to the site and subsequent development of a conceptual site model for the site.</p> <p>The Limited PSI identified a number of potentially contaminating land uses on and in vicinity of the development area and associated recommended actions should the townsite expansion occur.</p>	<p>The EDD investigation area incorporates part of the site as defined in this investigation. Some of the associated potentially contaminating activities, industries and land uses of AECOM (2010) are relevant to the site, including:</p> <ul style="list-style-type: none"> • Old furnace oil tank, Lot 381 • Old diesel AST, Lot 383 • Old aviation spirit tank, Lot 385 • Diesel (Lot 651) and aviation spirit (Lot 658) pumping stations • Fuel pipeline. <p>AECOM (2010) summarises key areas of potential concern, some of which that are relevant to the site, including potential hydrocarbon contamination associated with the bulk storage facilities, the likely presence of fuel/oil in the pipeline on decommissioning and possible product loss from the pipeline, and the possible effects of inundation on contamination migration.</p>
Kelsall (1995) Bulk Fuel Installation, Onslow	<p>Referenced within AECOM (2010), this report described the installation and history of the bulk fuel installation facilities, as described by the engineer who designed the facilities.</p> <p>The report notes that cyclone damage occurred to the fuel installation throughout its history, and that sections of the pipeline were removed by Medalia and Benn Pty Ltd, but further information on the removal is not known.</p>	<p>Parts of the bulk fuel installation facilities were located immediately adjacent the site and are known to have been contaminated (e.g. the furnace oil tank on Lot 381). The locations of former fuel pipelines from the tanks to pump out stations are indicated to be close to the eastern boundary of the site.</p>
Department of Maritime Archaeology (1995) Port Related Structures on the Coast of Western Australia	<p>The Department of Maritime Archaeology (DMA) of the Western Australian Maritime Museum reported on port-related structures in Western Australia. The report notes that the new Onslow jetty at Beadon Point was built in 1923 and was subsequently used for resupplying fuel to naval and other ships during World War (WW) II. The township and port were also the headquarters for nuclear bomb tests in the Montebello Islands in 1952-1956.</p>	<p>Describes the use of the jetty for fuel resupply, and the damage and destruction to the jetty from cyclones in 1953, 1958, and three cyclones in 1961.</p> <p>The report also notes that asbestos from Wittenoom Gorge was exported from a land-backed wharf in Beadon Creek between 1943 and 1966. The nature of the asbestos exported and the exact location of the wharf are not known.</p>

4 AOPC and Data Gaps

4.1 AOPCs

AOPCs are those areas on a site that may have potentially polluting activities, industries and land uses that could result in contamination of surficial and subsurface media. For purposes of this report, AOPCs are generally characterised as areas where:

- Sources from which potential releases of contaminants of potential concern (COPCs) to the environment either currently exist, or have historically existed
- Operational processes, such as storage, handling, and transport of hydrocarbons or other COPC could result in releases to the environment
- Potential polluting activities, such as illegal dumping of asbestos waste, of a scale sufficient to adversely impact surficial and/or subsurface conditions.

360 Environmental have identified six (6) AOPCs at or within the vicinity of the site, and associated COPC) based on the findings of the desktop assessment, including review of the site history and available information. These are summarised in **Table 9** with AOPCs depicted on **Figure 2**.

Note that there is no direct evidence of potential offsite sources impacting the site, as no investigations have been completed at the site and a site inspection was not undertaken as part of the desktop assessment.

Table 9: AOPC and COPC

AOPC	Area / Details	COPC
1	<p><u>Area adjoining the former furnace oil ASTs and associated fuel infrastructure to the north</u></p> <p>Based on the previous classification of Lot 381 to the north as Contaminated – remediation required in accordance with the Contaminated Sites Act 2003. The site was classified in January 2007 on the basis of total petroleum hydrocarbons (TPH) and polycyclic aromatic hydrocarbons (PAHS) in soil at the site. Contamination was associated with the storage and use of fuels associated with the former refuelling station for submarines during World War II (AECOM, 2010).</p> <p>Based on review of AECOM (2010) it is understood remediation was being undertaken in 2010. However the specific activities and outcomes are not known as no investigation or remediation reports have been sighted to confirm the nature and extent of any remediation activities.</p>	Hydrocarbons, polyaromatic hydrocarbons, heavy metals
2	<p><u>Area adjoining the former dieseline AST to the east and associated pipeline</u></p> <p>Based on the previous use of Lot 383 to the immediate east of the site for the storage of dieseline. AECOM (2010) notes that the AST historically sat on a bed of oil-saturated sand and the underground pipe from the AST to the pump out station north of the site was wrapped in bitumen-soaked hessian and buried at a depth of approximately 0.6 mbgl. The AST is understood to have been decommissioned and then re-engineered by Water Corporation for use as a water supply storage tank, receiving water from the Cane River borefield east of Onslow.</p> <p>The use of the former AST for dieseline storage, the bitumen-saturated bed on which it sat, the bitumen-soaked hessian wrap of the pipeline have the potential to be sources of contamination through spillage or product loss from damage to fuel infrastructure.</p>	Hydrocarbons, polyaromatic hydrocarbons, heavy metals

AOPC	Area / Details	COPC
3	<p><u>Area adjoining or near the former aviation spirit pump station to the south and associated pipeline</u></p> <p>Based on the previous use of Lot 658 (as reported in AECOM 2010) as a pump out station for the aviation spirit tank to the south of the site at Lot 385, and the pipeline route from the tank to the station and down towards the former jetty location to the north of the site.</p> <p>The use of the former AST for aviation spirit storage, the bitumen-saturated bed on which it sat, and the likely bitumen-soaked hessian wrap of the pipeline are potential sources of contamination.</p>	Hydrocarbons, polyaromatic hydrocarbons, heavy metals
4	<p><u>Part of the site with a moderate to low risk of ASS being present</u></p> <p>Based on the identification of part of the site as having a moderate to low risk of ASS being present at less than 3 m depth and high to moderate risk of ASS being present beyond 3 m depth. Site redevelopment works may disturb and/or expose ASS. ASS may impact construction materials and exposed ASS has the potential to produce acidic leachate or groundwater.</p>	Acidic soils and/or leachate
5	<p><u>Entire site</u></p> <p>Onslow Town Site (which includes the site) is listed within the Department of Defence (DoD) Unexploded Ordnance (UXO) Mapping Application (accessed online 17 July 2021) as having a Slight Potential for the presence of UXO. The description provided is as follows: "Anti-aircraft artillery live firing practices using high explosive ammunition during WW (World War) II. Aerial bombing also highly likely. For land use planning advice contact the WA Department of Fire and Emergency Services (advice@dfes.wa.gov.au) and quote location number N26 and page number C-275. Where a Defence report is available, it will be listed below and can be found on the Defence UXO Website". Note that no report was listed in the mapping application.</p> <p>AECOM (2010) noted that although at the time of reporting Onslow was not considered to have a slight or substantial risk of UXO potential, Onslow was subject to an air raid on 15 September 1943 during which bombs were dropped. It was not clear how many bombs had been dropped or whether all exploded on impact (AECOM 2010).</p>	UXO
6	<p><u>Entire site</u></p> <p>360 Environmental notes that although there is no evidence of historical development at the site, asbestos containing materials (ACM) or potential ACM (PACM) may be present as a result of illegal fly-tipping of waste materials at the site, the effects of cyclonic activity, or historical exporting of asbestos from a wharf in Beadon Creek.</p> <p>It is noted that several large cyclones have impacted Onslow, including three in 1961 that damaged buildings and destroyed the jetty to the north of the site. Such events have the potential to transport building materials some distance and therefore may have resulted in ACM or PACM being present at the site.</p>	Asbestos [ACM sheeting, asbestos fines (AF), fibrous asbestos (FA)]

4.2 Potential Receptors

Potential receptors to the AOPC are described in **Table 10**.

Table 10: Potential Receptors

Potential Receptor	Relevant AOPC
Onsite human health (including future site workers, future site residents and intrusive maintenance workers)	AOPC 1, AOPC 2, AOPC 3, AOPC 4, AOPC 5, AOPC 6
Offsite human health (current/future workers and residents in the vicinity of the site)	AOPC 1, AOPC 2, AOPC 3, AOPC 4, AOPC 5, AOPC 6

4.3 Potential Migration Pathways

The potential migration pathways between AOPCs and potential receptors both onsite and offsite are described in **Table 11**.

Table 11: Potential Migration Pathways

Migration Pathway	Detail
Exposure to impacted soils via direct contact (i.e. by dermal contact, inhalation and accidental ingestion) from AOPC 1, AOPC 2 and AOPC 3.	<p><u>Onsite</u></p> <p>The site is vacant, undeveloped and has natural surface cover. It is considered unlikely that offsite residents or workers would be exposed to onsite soils. Future site workers involved in the development of the site may be exposed to contaminated soils if present. Fauna, if present, are unlikely to contact impacted soils, given the likely depth of impact if present. Flora types are currently not known, therefore the risks associated with contaminant uptake are unknown.</p> <p><u>Offsite</u></p> <p>Residents or maintenance workers are more likely to be exposed to offsite soils potentially impacted by AOPC 1, AOPC 2 and AOPC 3, but these sources are not directly associated with the site.</p>
Volatilisation and subsequent migration of hydrocarbon vapour (potentially present in hydrocarbon impacted sands associated with AOPC 1, AOPC 2 and AOPC 3)	<p><u>Onsite</u></p> <p>There are no man-made surface coverings or structures at the site, thus if impacted onsite soils were present there is no risk of migration of vapours into aboveground structures. Future site residents, workers and maintenance workers may be exposed to hydrocarbon vapour in the event soil contamination is present at the site and structures are built.</p> <p><u>Offsite</u></p> <p>Residents in properties adjacent AOPC 1, AOPC 2 or AOPC 3 are at higher risk of exposure to hydrocarbon vapours, although there is no current evidence of actual contamination associated with these AOPC and AOPC 1 is understood to have been remediated.</p>
Abstraction of COPC in groundwater	<p><u>Onsite</u></p> <p>There are no groundwater abstraction bores at the site and it is not known if future development of the site will include groundwater abstraction. The facilities requirements indicate a potable water treatment plant, but it is not indicated if water will be sourced from the site.</p> <p><u>Offsite</u></p> <p>One groundwater abstraction licence is associated with the property to the north of the site, although the ultimate use of this groundwater (and whether the allocation is utilised) is not known. As most water used in the Onslow Town site is sourced from abstraction bores east of the town, exposure to potential contaminants is unlikely.</p>
Disturbance of ASS resulting in the development of acidic leachates and acidification of groundwater and/or effects on construction materials	<p><u>Onsite</u></p> <p>ASS pose a risk to future site development works if soils are determined to be ASS and development activities disturb those materials. If present, ASS could affect the integrity and longevity of construction materials.</p> <p><u>Offsite</u></p> <p>Not relevant to offsite receptors unless disturbed onsite and stockpiles of ASS material develop leachate which runs off the site.</p>

Migration Pathway	Detail
Direct contact with UXO associated with AOPC 5	<p><u>Onsite</u></p> <p>The site is currently vacant and undeveloped however it is not known if the site is fenced/access is restricted. Although the likelihood of UXO being present is given as Slight, potential risk of exposure is possible. Risk to future site workers involved in site development are higher, as site works involving machinery and excavations are likely to occur and could contact UXO, if present.</p> <p><u>Offsite</u></p> <p>Risks to current and future offsite residents and workers is considered low, given the level of development in the surrounding area.</p>
Inhalation of asbestos fibres from AOPC 6	<p><u>Onsite</u></p> <p>The site is vacant and undeveloped with no current site users. If present onsite, ACM, AF or FA could pose a risk to future site users. Although there is no current evidence of asbestos being present at the site [a hazardous materials (HAZMAT) survey has not been undertaken at the site] asbestos building products were likely historically used in nearby properties and asbestos products were historically exported from a wharf on Beadon Creek. Damage during cyclonic activities (building products) or demolition and potential losses during transport (asbestos export), exacerbated by potential wind-blown transport during cyclonic activity, may have occurred (although considered unlikely).</p> <p><u>Offsite</u></p> <p>Given the age of the Onslow Town site, it is likely that asbestos building products (such as in asbestos fencing or cladding) were historically used. These materials may have been damaged in historical cyclone activity or site redevelopment/demolition works and therefore pose a risk to current offsite residents and workers.</p>

4.4 Source-Pathway-Receptor Linkages

For a particular contaminant to present a risk to receptors, three components must be present:

- **Source** - A potentially hazardous substance that has been released into the environment
- **Pathway** - A mechanism by which receptors can become exposed to the source or derivatives of the source
- **Receptors** - The human or ecological component potentially at risk of experiencing an adverse response following exposure to the source or derivatives of the source.

If one of these three components (referred to as SPR linkages) are missing from an exposure scenario, then there can be no risk. Following the desktop assessment the following SPR linkages were identified as having the potential to be complete at the site if the site is redeveloped:

SPR 1: UXO are potentially present at the site and pose a risk to potential future onsite workers involved in site development works. Although the likelihood of their presence is listed as Slight, the potential human health impacts of exposure for future site workers are high, thus the overall risk associated with UXO (AOPC 5) is considered **LOW to MODERATE**.

SPR 2: Asbestos materials may be present at the site and no HAZMAT survey has been undertaken. Although the likelihood of these being present onsite is low, the potential human

health impacts of exposure for future site workers or residents are high, the overall risk associated with asbestos (AOPC 6) is considered **LOW to MODERATE**.

SPR 3: The potential presence of onsite soil or groundwater contamination associated with offsite bulk fuel infrastructure is not known and no previous onsite investigations have been identified. Although the adjoining site to the north has previously been classified as Contaminated – remediated required, remediation is understood to have occurred, the likelihood of impacts to future site workers or residents is considered low. The overall risk from AOPC 1, AOPC 2 and AOPC 3 is considered **LOW**.

SPR 4: Part of the site is listed as having a moderate to slight risk of ASS being present, although no ASS investigations have been undertaken and specific site development plans (i.e. areas of excavation, the requirement for dewatering) are not known. If present, the risk of ASS to future site workers and the groundwater receptor is considered **LOW**.

4.5 Data Gaps

The identification of data gaps supports determination of information necessary to meet the objectives for completing the desktop contamination assessment. Data gaps relevant to the project are summarised in **Table 12**.

Table 12: Data Gaps

Data Gap	AOPC(s)	Description
1	AOPC 1, 2, 3	There have been no soil or groundwater investigations at the site, however it is understood contamination (and remediation) associated with former fuel infrastructure offsite to the north has previously been identified (AECOM 2010). Reports presenting details of investigation(s) and/or remediation offsite have not been identified and as such the specific scope and/or effectiveness of any remediation works is not well understood. In this regard, the nature and extent of existing and/or residual contamination in soil or groundwater is not known.
2	AOPC 4	It is not known if the soils in the area marked as having a moderate to low risk of ASS being present are potential or actual ASS. The requirement to investigate is dependent on whether development plans for the site involve disturbance of potential ASS material or if dewatering may be required. Management measures, such as development of an ASS management plan (ASSMP) or dewatering management plan (DMP), would be dependent on the findings of any ASS investigation.
3	AOPC 5	Onslow Townsite is listed on the DoD UXO Mapping Application as having a Slight Potential for the presence of UXO. It is not known if a detailed UXO survey has been undertaken at the site, or if records exist of any historical UXO searches or recovery operations in relation to the site. Information on possible UXO presence in AECOM (2010) was anecdotal in nature.
4	AOPC 6	Without a HAZMAT survey of the site or previous site investigations, it is not known if ACM, AF or FA are present at the site. If these are present, they may be a source of potential contamination for: current offsite residents and workers through wind-blown transport of fibres; future site workers involved in the development of the site through ground disturbance activities; or potential future site residents and site workers post development through wind-blown transport of fibres.

5 Conclusions and Recommendations

Based on the findings of this desktop assessment and review of available information, it is concluded that there have been no significant historical contaminating activities at the site, as the site has been vacant and undeveloped. However, six (6) AOPC were identified, namely:

- AOPC 1 – Part of the site located adjacent to the former furnace oil ASTs to the north of the site, and associated fuel pipelines and pumps [the offsite former furnace oil AST area was formerly classified as Contaminated – remediation required (AECOM 2010)].
- AOPC 2 – Part of the site located adjacent to the former historical bulk fuel storage to the east (dieseline) of the site, and associated fuel pipelines and pumps.
- AOPC 3 – Part of the site located adjacent to the former historical bulk fuel storage to the south (aviation spirit) of the site, and associated fuel pipelines and pumps.
- AOPC 4 - Part of the site with a moderate to low risk of acid sulfate soils (ASS) being present within 3 metres of the soils surface.
- AOPC 5 - Potential UXO from activities during WWII (whole of site and Onslow Townsite).
- AOPC 6 - Potential asbestos from illegal fly-tipping or associated with offsite sources (whole of site).

The following data gaps were identified associated with the above AOPCs:

- There have been no soil or groundwater investigations undertaken at the site however it is understood offsite contamination (and possible remediation) associated with former fuel infrastructure located to the north has previously occurred. Reports presenting details of investigation(s) and/or remediation offsite have not been identified and as such the specific scope and/or effectiveness of any remediation works is not well understood. In this regard the nature and extent of existing and/or residual contamination in soil or groundwater is not known. The risk to the site is considered to be **LOW**.
- It is not known if the soils in the area marked as having a moderate to low risk of ASS being present are potential or actual ASS. The requirement to investigate is dependent on whether development plans for the site involve disturbance of potential ASS material or if dewatering may be required. Management measures, such as development of an ASSMP or DMP, would be dependent on the findings of any ASS investigation. The risk to the site is considered to be **LOW**.
- Onslow Townsite (including the site) is listed on the DoD UXO Mapping Application as having a Slight Potential for the presence of UXO. It is not known if a detailed UXO survey has been undertaken at the site, or if records exist of any historical UXO searches or recovery operations in relation to the site. Information on possible UXO presence in AECOM (2010) was anecdotal in nature. The risk to the site is considered to be **LOW to MODERATE**.
- Without a HAZMAT survey of the site or previous site investigations, it is not known if ACM, AF or FA are present at the site. If these are present, they may be a source of potential contamination for onsite and offsite, current and future, receptors (human health). The risk to the site is considered to be **LOW to MODERATE**.

Based on the data gaps, the following recommendations are made:

- A UXO survey of the site should be considered prior to any site works commencing.
- A HAZMAT site survey should be considered to evaluate the potential presence of asbestos at the site.
- Conduct a review of any available contamination investigation and/or remediation reports describing works associated with former bulk fuel infrastructure (i.e. AOPC 1, AOPC 2 and AOPC 3) to determine the requirement for investigation onsite.
- Site development plans should be reviewed to determine if ASS may be disturbed by development activities or if dewatering is to occur, and thereby determine the requirement for an ASSMP/DMP.
- Depending on the findings of the above, consideration should be given to intrusive site investigations to:
 - Investigate the contamination status of soils (and potentially groundwater) onsite at AOPC 1, AOPC 2 and AOPC 3, to confirm there are no hydrocarbon impacts.
 - Assess the potential presence of asbestos (ACM, AF or FA) in soils at the site. If identified to be present, asbestos remediation should be undertaken in accordance with Department of Health guidelines.
- In the absence of any site investigations associated with AOPC 1, AOPC 2 or AOPC 3, an unexpected finds protocol (UFP) is recommended to be developed prior to site development works. The protocol should detail the management requirements should any of the COPCs for the site be encountered during site development works.

6 Limitations

This report is produced strictly in accordance with the scope of services set out in the contract or otherwise agreed in accordance with the contract. 360 Environmental makes no representations or warranties in relation to the nature and quality of soil and water other than the visual observation and analytical data in this report.

In the preparation of this report, 360 Environmental has relied upon documents, information, data and analyses (“client’s information”) provided by the client and other individuals and entities. In most cases where client’s information has been relied upon, such reliance has been indicated in this report. Unless expressly set out in this report, 360 Environmental has not verified that the client’s information is accurate, exhaustive or current and the validity and accuracy of any aspect of the report including, or based upon, any part of the client’s information is contingent upon the accuracy, exhaustiveness and currency of the client’s information. 360 Environmental shall not be liable to the client or any other person in connection with any invalid or inaccurate aspect of this report where that invalidity or inaccuracy arose because the client’s information was not accurate, exhaustive and current or arose because of any information or condition that was concealed, withheld, misrepresented, or otherwise not fully disclosed or available to 360 Environmental.

Aspects of this report, including the opinions, conclusions and recommendations it contains, are based on the results of the investigation, sampling and testing set out in the contract and otherwise in accordance with normal practices and standards. The investigation, sampling and testing are designed to produce results that represent a reasonable interpretation of the general conditions of the site that is the subject of this report. However, due to the characteristics of the site, including natural variations in site conditions, the results of the investigation, sampling and testing may not accurately represent the actual state of the whole site at all points.

It is important to recognise that site conditions, including the extent and concentration of contaminants, can change with time. This is particularly relevant if this report, including the data, opinions, conclusions and recommendations it contains, are to be used a considerable time after it was prepared. In these circumstances, further investigation of the site may be necessary.

Subject to the terms of the contract between the Client and 360 Environmental Pty Ltd, copying, reproducing, disclosing or disseminating parts of this report is prohibited (except to the extent required by law) unless the report is produced in its entirety including this page, without the prior written consent of 360 Environmental Pty Ltd.

7 References

AECOM (2010). *Environmental Due Diligence, Onslow Townsite Strategy*. Report prepared for LandCorp. 4 October 2010.

Department of Aboriginal Affairs (2021). Aboriginal Heritage Inquiry System (AHIS), <https://espatial.dplh.wa.gov.au/AHIS/index.html>, accessed online 16 July 2021.

Department of Defence (2021). UXO Mapping Application, <https://www.wherisuxo.org.au/>, accessed online 17 July 2021.

Department of Environment Regulation (2014). Assessment and Management of Contaminated Sites (AMCS), Contaminated Sites Guidelines, Department of Environment Regulation, Government of Western Australia, December 2014.

National Environment Protection Council (2013). National Environmental Protection (Assessment of Site Contamination) Amendment Measure 2013 (No. 1) schedules, Office of Parliamentary Council, Canberra, Australia, May 2013.

Department of Marine Archaeology (1995). *Port Related Structures on the Coast of Western Australia*. Western Australian Maritime Museum, October 1995.

Department of Planning, Lands and Heritage (2021). PlanWA Interactive Map, <https://www.dplh.wa.gov.au/planwa>, accessed online 15 July 2021.

Department of Water (2021). Water Information Reporting database, <http://wir.water.wa.gov.au/Pages/Water-Information-Reporting.aspx>, accessed online 15 July 2021.

Department of Water (2021). Water Register, <http://maps.water.wa.gov.au/#/webmap/register>, accessed online 15 July 2021.

Department of Water and Environmental Regulation (2021). Contaminated Sites Database, <https://dow.maps.arcgis.com/apps/webappviewer/index.html>, accessed online 15 July 2021.

Enviro Map (2021). <https://360enviro.maps.arcgis.com/apps/webappviewer/index.html>, accessed online 15 July 2021.

Heritage Council of Western Australia (2021). inHerit register, <http://inherit.stateheritage.wa.gov.au/Public/>, accessed online 15 July 2021.

Kelsall, K. J. (1995). *Bulk Fuel Installation, Onslow*. June 1995.

Shire of Ashburton (2019). Local Government Heritage Inventory, October 2019.

Figures



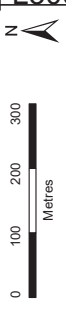
Legend

Approximate Site Boundary

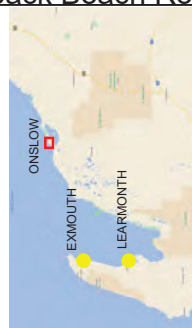
Site Coordinates GDA94 MGA50			
Point ID	Easting	Northing	
1	303735	7606131	
2	304071	7606513	
3	304422	7606330	
4	304154	7605925	

- NOTE THAT POSITION ERRORS CAN BE ±5M IN SOME AREAS
 - THIS DATA IS FOR INFORMATION ONLY
 - OTHER DATA SOURCED LANDGATE 2020
 - AERIAL PHOTOGRAPHY SOURCED LANDGATE 2020
 © Western Australian Land Information Authority (2021)

360 Environmental
 10 Bermondsey St, West Leederville, 6007 WA
 (08) 9388 8360
 www.360environmental.com.au



LOCALITY MAP



PROJECT ID	DATE
4754	15/7/2021
HORIZONTAL DATUM AND PROJECTION	
GDA 1984 MGA Zone 50	
CREATED	CHECKED
DO	TS
APPROVED	REVISION
TS	1

Mineral Resources Limited
 Lot 300 Back Beach Rd, Onslow

Desktop Contamination Assessment

Figure 1
 Site Location



Appendices

Appendix A

Basic Summary of Records Results

Your ref: Onslow BSR
Our ref: DMO 7279
Enquiries: Registrar
Phone: 1300 762 982
Fax: (08) 6364 7001
Email: info@dwer.wa.gov.au

Dion Mark Oulton
360 Environmental
57A Shearn Cres
Doubleview WA 6018

Dear Sir/Madam

BASIC SUMMARY OF RECORDS REQUEST

Thank you for your Basic Summary of Records request for the site consisting of the following parcel(s) of land:

- LOT 300 ON PLAN 67927 as shown on certificate of title LR3160/90 known as 300 Back Beach Rd, Onslow WA 6710

which Department of Water and Environmental Regulation (the department) received on 15/07/2021.

A search of the department's records of known and suspected contaminated sites was undertaken however, our records indicate that as of 27/07/2021 this site has not been reported to the department as a known or suspected contaminated site either prior to or after the commencement of the *Contaminated Sites Act 2003*.

For general enquiries, please contact the Registrar on 1300 762 982.

Yours sincerely



Michelle Brierley, A/Manager

CONTAMINATED SITES REGULATION
Delegated Officer under section 91
of the *Contaminated Sites Act 2003*

27/07/2021

Enc. Receipt Number RR023087

Appendix B

Historical Aerial Photographs

Historical Aerial Imagery	
Image	Image Date
	September 1970
	September 2001

Historical Aerial Imagery	
Image	Image Date
	September 2010
	May 2017

Historical Aerial Imagery	
Image	Image Date
	November 2020

360

environmental



10 Bermondsey Street West Leederville WA 6007 **t** (+618) 9388 8360 **f** (+618) 9381 2360

PO BOX 14, West Perth WA 6872

w 360environmental.com.au **e** admin@360environmental.com.au

● people ● planet ● professional
1290

**Attachment 5.0
Environmental Assessment Report**



Onslow Township Village

Environmental Assessment Report

**Prepared for
Mineral Resources Limited**

November 2021

● people ● planet ● professional

Document Reference	Revision	Prepared by	Reviewed by	Admin Review	Submitted to Client	
					Copies	Date
4755AA_Rev0	Internal Draft	V. Mugabe / G. Abolis	T. Smith	-	-	-
4755AA_Rev1	Client Draft	V. Mugabe / G. Abolis	T. Smith	LI	1x electronic	06/08/2021
4755AA_Rev2	Client Report	V. Mugabe / G. Abolis	T. Smith	LI	1 X Electronic	27/08/2021
4755AA_Rev3	Internal Draft	G.Abolis	T.Smith	NC	1 x electronic	25/11/2021

Disclaimer

This report is issued in accordance with, and is subject to, the terms of the contract between the Client and 360 Environmental Pty Ltd, including, without limitation, the agreed scope of the report. To the extent permitted by law, 360 Environmental Pty Ltd shall not be liable in contract, tort (including, without limitation, negligence) or otherwise for any use of, or reliance on, parts of this report without taking into account the report in its entirety and all previous and subsequent reports. 360 Environmental Pty Ltd considers the contents of this report to be current as at the date it was produced. This report, including each opinion, conclusion, and recommendation it contains, should be considered in the context of the report as a whole. The opinions, conclusions and recommendations in this report are limited by its agreed scope. More extensive, or different, investigation, sampling and testing may have produced different results and therefore different opinions, conclusions, and recommendations. Subject to the terms of the contract between the Client and 360 Environmental Pty Ltd, copying, reproducing, disclosing, or disseminating parts of this report is prohibited (except to the extent required by law) unless the report is produced in its entirety including this cover page, without the prior written consent of 360 Environmental Pty Ltd.

© Copyright 2021 360 Environmental Pty Ltd ACN 109 499 041

Executive Summary

360 Environmental Pty Ltd (360 Environmental) was commissioned by Mineral Resources Limited (MRL) to provide environmental and bushfire support for the development of short stay worker accommodation at Lot 300 Back Beach Road, Onslow (referred within as Onslow Township Village). Onslow Township Village is referred within as the site. The site covers 20.45 hectares and is located within the Onslow townsite in the Pilbara Region of Western Australia.

This Environmental Assessment Report (EAR) is supplemented with a Preliminary Contamination Assessment, Flora and Fauna Survey and Urban Water Management Plan (UWMP) prepared by 360 Environmental and a Bushfire Management Plan (BMP) and Bushfire Emergency Management Plan (BEMP) to demonstrate the opportunities and constraints to development of Onslow Township Village.

Onslow Township Village is currently undergoing extensive master planning to consider design and environmental impacts associated with the proposed development in this locality.

The site will be cleared and constructed for the purpose of short stay workforce accommodation. Preliminary investigations identified that some native vegetation would be cleared to facilitate the proposed development however native vegetation is proposed to be retained for open space and surrounding accommodation pods. The EAR focuses on the environmental issues and management measures associated with the proposed development and its relationship to Onslow townsite and surrounding land uses.

The environmental issues identified in the EAR do not pose a significant constraint to development of the site. All environmental features can be managed through further technical investigations and/or the implementation of a Construction Environmental Management Plan (CEMP) for the proposed development during the construction phases of the development. Aboriginal heritage approvals shall be sought separately to the development approval process.

Table of Contents

1	Introduction.....	1
1.1	Background.....	1
1.2	Environmental Assessment Objectives.....	1
1.3	Scope of Works.....	1
2	Key Environmental Legislation.....	3
2.1	International Agreements.....	3
2.2	Commonwealth Legislation.....	3
2.3	State Legislation.....	3
2.4	Relevant Standards, Guidelines and Policies.....	5
2.5	Planning.....	6
3	Site Environmental Features.....	7
3.1	Climate.....	7
3.2	Surrounding Land Uses.....	7
3.3	Topography.....	8
3.4	Regional Geology and Soils.....	8
3.5	Hydrogeology.....	10
3.6	Hydrology.....	10
3.7	Environmentally Sensitive Areas.....	11
3.8	Conservation Areas.....	11
3.9	Flora and Vegetation.....	11
3.10	Fauna.....	15
3.11	Heritage.....	17
3.12	Bushfire Risk.....	18
4	Environmental Constraints and Management.....	19
4.1	Key Environmental Issues, Factors and Objectives.....	19
4.2	Vegetation and Flora.....	19
4.3	Terrestrial Fauna.....	21
4.4	Hydrological Processes.....	22
4.5	Aboriginal Heritage.....	25
4.6	Acid Sulfate Soils.....	26
4.7	Contamination.....	26
4.8	Bushfire Management.....	28
5	Key Environmental Constraints and Management Review.....	32
6	Summary and Conclusion.....	36
6.1	Summary of Key Findings.....	36
6.2	Conclusions.....	38
7	Limitations.....	39
8	References.....	40

List of Tables

Table 1: Key State Legislation and Regulations	3
Table 2: Relevant Standards, Guidelines and Policies	5
Table 3: Surrounding Land Uses	7
Table 4: Broad Vegetation Types within the State, Regional and Local Representation (Government of Western Australia, 2019)	12
Table 5: Introduced Flora Species within the Site	14
Table 6: Overview of Vertebrate Fauna Species Recorded	16
Table 7: Aboriginal Heritage Locations	17
Table 8: Other Heritage Locations	17
Table 9: EPA Environmental Factors and Objectives.....	19
Table 10: Key Environmental Aspects	32

List of Graphs

Graph 1: Climate Statistics for Onslow Airport Station (005017) 1940-2021 (BOM 2021)....	7
--	---

List of Figures (out of text)

Figure 1: Study Area Location
Figure 2: Proposed Master Plan
Figure 3: Soil Land Systems
Figure 4: Acid Sulphate Soils
Figure 5: Areas of Potential Concern
Figure 6: Hydrography
Figure 7: Vegetation Associations
Figure 8: Vegetation Types
Figure 9: Vegetation Condition
Figure 10: Aboriginal Heritage Sites

List of Appendices

Appendix A Lot 300 Back Beach Road, Onslow, Contamination Review
Appendix B Lot 300 Back Beach Road, Onslow, Flora and Fauna Survey
Appendix C Onslow Township Resort Bushfire Management Plan
Appendix D Onslow Township Resort Bushfire Emergency Management Plan
Appendix E Urban Water Management Plan for Lot 300 Back Beach Road, Onslow
Appendix F Likelihood of Occurrence – Marine Species

1 Introduction

1.1 Background

360 Environmental Pty Ltd (360 Environmental) was commissioned by Mineral Resources Limited (MRL) to provide environmental and bushfire support for the development of short stay worker accommodation at Lot 300 Back Beach Road, Onslow (referred within the Onslow Township Village). Onslow Township Village is referred within as the site. The site covers approximately 20.45 hectares and is located within Onslow townsite in the Pilbara Region of Western Australia (Figure 1).

This environmental assessment report (EAR) is supplemented by the following:

- Preliminary Contamination Assessment (360 Environmental)
- Detailed Flora and Fauna Assessment (360 Environmental)
- Urban Water Management Plan (360 Environmental)
- Bushfire Management Plan (BMP) (Linfire Consultancy)
- Bushfire Emergency Management Plan (BEMP) (Linfire Consultancy).

1.2 Environmental Assessment Objectives

The EAR highlights the key environmental and bushfire issues associated with the proposed short stay workforce accommodation at the site. High level environmental advice will be incorporated into the EAR to support the proposed master plan for the short stay workforce accommodation at Onslow Township Village.

1.3 Scope of Works

The scope of work includes a review of desktop information for the site including government databases and search tools and online reports available for the site. The desktop environmental assessment included the following:

- NatureMap database search.
- Searches of the Federal Department of Agriculture, Water and Environment's (DAWEs) *Environment Protection and Biodiversity Conservation Act 1999* Protected Matters Search Tool.
- Review of publicly listed ecological information where available (previous reports and any relevant scientific literature).
- Review of applicable environmental legislation, policies and guidelines and their relevance to the site.
- Topography, soil, and potential acid sulfate soils.
- Groundwater levels, groundwater protection areas, surface water and geomorphic wetlands.

- Review of regional vegetation association and complex mapping (Beard and Heddle).
- Fauna and habitats: Desktop and habitat assessment, DBCA NatureMap and DAWE MNES PMST databases for recorded species and their habitats within the vicinity of the site and a likelihood assessment (based on mapped habitat) of these species potentially occurring on site.
- Heritage sites (Aboriginal and non-Aboriginal) that may be located within or nearby the site. Search of the Department of Planning Lands and Heritage (DPLH) Aboriginal and State and Local Heritage databases.
- Identification of environmental constraints and opportunities associated with the site.
- Site inspection familiarization and identification of environmental constraints and opportunities associated with the site.
- Preparation of this report summarizing the existing ecological and heritage information for the site.
- Preparation of figures supporting the desktop information.

Further assessments and surveys to address bushfire management, contamination, flora and vegetation, fauna, and urban water management applicable to the proposed development have been undertaken. The recommendations and environmental issues and associated mitigation measures raised in these reports have been included within the EAR.