

# Lots 5, 250, 253 and 254 Helena Valley Road Helena Valley

## DISTRICT WATER MANAGEMENT STRATEGY



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## 1 EXECUTIVE SUMMARY

This District Water Management Strategy (DWMS) has been prepared to support the future development of Lots 5, 250, 253 and 254 Helena Valley Road, Helena Valley (subject land).

The objective of this DWMS is to detail the best management practices approach to water management that will be undertaken for this future development, while considering its former land uses and onsite features. This will include managing, protecting and conserving the total water cycle of the proposed rezoning area.

The developers are committed to the concepts and outcomes outlined within this report. This includes providing a framework to assist with the future implementation, monitoring and maintenance of the best management practices designed specifically for this development.

The effectiveness, efficiency and benefits provided by the best management practices outlined, require a long-term collaborative effort between the landowners, Shire of Mundaring, strata bodies and other relevant regulatory authorities. Through this collaboration, the strategies will allow the water management on site to complement the proposed Residential and Commercial land uses, by providing sustainable water servicing, stormwater management and manage the environmental attributes of the site and nearby. The practices utilised are summarised in more detail in the Key Elements Section.

### SITE SUMMARY

The subject land area is located within the Shire of Mundaring. The site is approximately 14.06 hectares. It is located on both sides of Helena Valley Road. The southern portion is bordered to the west by Midland Road, future residential to southeast and bushland to the south.

The northern portion is bordered by unmade road reserves/ Roe Highway on the west, with the Kadina Brook floodplain located to the north and east.

The location can be seen in Figure 1.

The floodplain and wetland system in the north-eastern portion of the subject land contains some native vegetation. In the northwest there are a range of planted eucalyptus species, while the rest of the site is predominately cleared pasture. A shed, hardstand and old machinery are located in the northwest portion. There is also a residence and associated shed in the southeast corner.

The soil type is generally composed of sand in the higher portions of the subject land, with some areas filled as part of the industrial works in the north west. River sediments are likely in the lower portions.

### PLANNING SUMMARY

The DWMS supports a Metropolitan Region Scheme (MRS) amendment to rezone the subject land from 'Rural' to 'Urban'. It has been prepared in support of the proposed rezoning, demonstrating the site is capable of accommodating future commercial uses in the west and residential uses in the east.

The layout can be seen in Figure 2.

### MAIN REFERENCING DOCUMENTS

This document has been compiled from the following reports. These reports should be referred to where more detail is sort.

- Peritas (2022) Engineering Services Report Lots 5, 250, 253 And 254 Helena Valley Road
- PGV (2022) Lots 5, 250, 253 And 254 Helena Valley Road, Helena Valley Environmental Assessment Report
- PGV (2022) Lots 5, 250, 253 And 254 Helena Valley Road, Helena Valley Flora, Vegetation And Fauna Survey

- Galt Geotechnical (2021) Report on Due Diligence Geotechnical and environmental study proposed subdivision Lots 5 and 250 Helena Valley Road, Helena Valley WA.
- Oversby Consulting (2022) Lots 5, 250, 253 and 254 Helena Valley Road, Helena Valley Drainage Analysis.



Figure 1 Location plan

## 2 KEY ELEMENTS PLAN

The water management strategies for the subject land are based on best practice water sensitive urban designs that integrate sustainability into future commercial and residential landuses. The strategies will be achieved through the synthesis of planning and designs, with long-term collaborative management of the total water cycle. The plans and designs for the development are appropriate for the subject land's development constraints, surrounding environment and proposed landuse.

A summary of the Water Sensitive Urban Design (WSUD) elements that will be implemented within the development to achieve best management practices are outlined below, and visually represented in Figure 2.

### **DRAINAGE AND FLOOD MANAGEMENT STRATEGY**

- On lot and off lot detention systems, combined with treatment systems such as POS based bioretention gardens, will capture and treat stormwater flows.
- On lot storage is to be in accordance with the Shire's guidelines at the time of development. Where required and subject to detailed design, small lots may have a direct connection to the road network storm water system, after storage is exceeded on the lot.
- Flow rates leaving the site up to the 1% AEP event are to match or be lower than the pre development rate.
- POS based basins will detain flows to required levels, prior to discharge

All storage is to have a the ability to infiltrate stormwater at the base to allow systems to drain completely, minimising any standing water.

- All finished floor levels will be designed to maintain a clear separation of 300mm between the habitable floor level and the 1% AEP event flood level, generated on site. The site is to be designed to allow for safe flow paths of water throughout the development.
- All finished floor levels will be designed to maintain a clear separation of 500mm between the habitable floor levels and the modelled 1% AEP event flood level of the Kadina Brook and any other relevant large waterway/flowline.

### **GROUNDWATER MANAGEMENT STRATEGY**

- Inflows to the groundwater are to be treated through bioretention media and plants within the basins, to improve the quality of water prior to it entering the groundwater.
- Where required, fill and subsoil systems will be used to achieve suitable separation between groundwater level and road infrastructure, houses and other sensitive infrastructure.
- Groundwater discharge regimes are to be generally maintained so that there are no negative impacts on the subject land or downstream significant ecosystems.

### **SUSTAINABLE WATER SERVICING**

- All lots are to be connected to the Water Corporation potable reticulated water main.
- All lots are to be connected to the Water Corporation reticulated sewer main.
- Awareness raising material on water saving measures is to be provided to lot purchasers.
- Landscaping of the POS areas is to utilise waterwise practices. These include basins/swales etc directly watered by stormwater, minimal lawn areas and low/no irrigation areas planted with suitable native flora species.

### **WATER DEPENDENT ECOSYSTEM MANAGEMENT**

- New habitat will be created within the bioretention systems and detention basins that mimic ephemeral wetlands and seasonal waterways.
- The Kadina Brook and adjoining wetland systems will be protected and enhanced through the creation of a foreshore reserve. This will include appropriate weed control and revegetation.
- The WSUD elements used on site will treat stormwater and groundwater, improving the water quality prior to it entering downstream sensitive ecosystems.
- Flows rates to downstream sensitive ecosystems will be managed to suitable rates.

### **MONITORING AND MAINTENANCE**

- Pre development monitoring of groundwater is to be undertaken as part of the Local Water Management Strategy (LWMS) and reviewed in relation to other nearby studies and groundwater records.
- Monitoring is to be undertaken through the construction phase of each stage for surface water and potentially groundwater in relation to possible contamination.
- Post development monitoring is to consider surface and groundwater quality, ecosystem enhancement and WSUD structural performance.

### **IMPLEMENTATION AND GOVERNANCE**

- Developers are to undertake a detailed Local Water Management Strategy (LWMS) and Urban Water Management Plan's (UWMP's) to provide the necessary information for management of water across the site.
- The Shire, Water Corporation and Department of Water and Environmental Regulation are to continue to provide guidance, direction and assistance so that the targets outlined in this report are able to be realised.

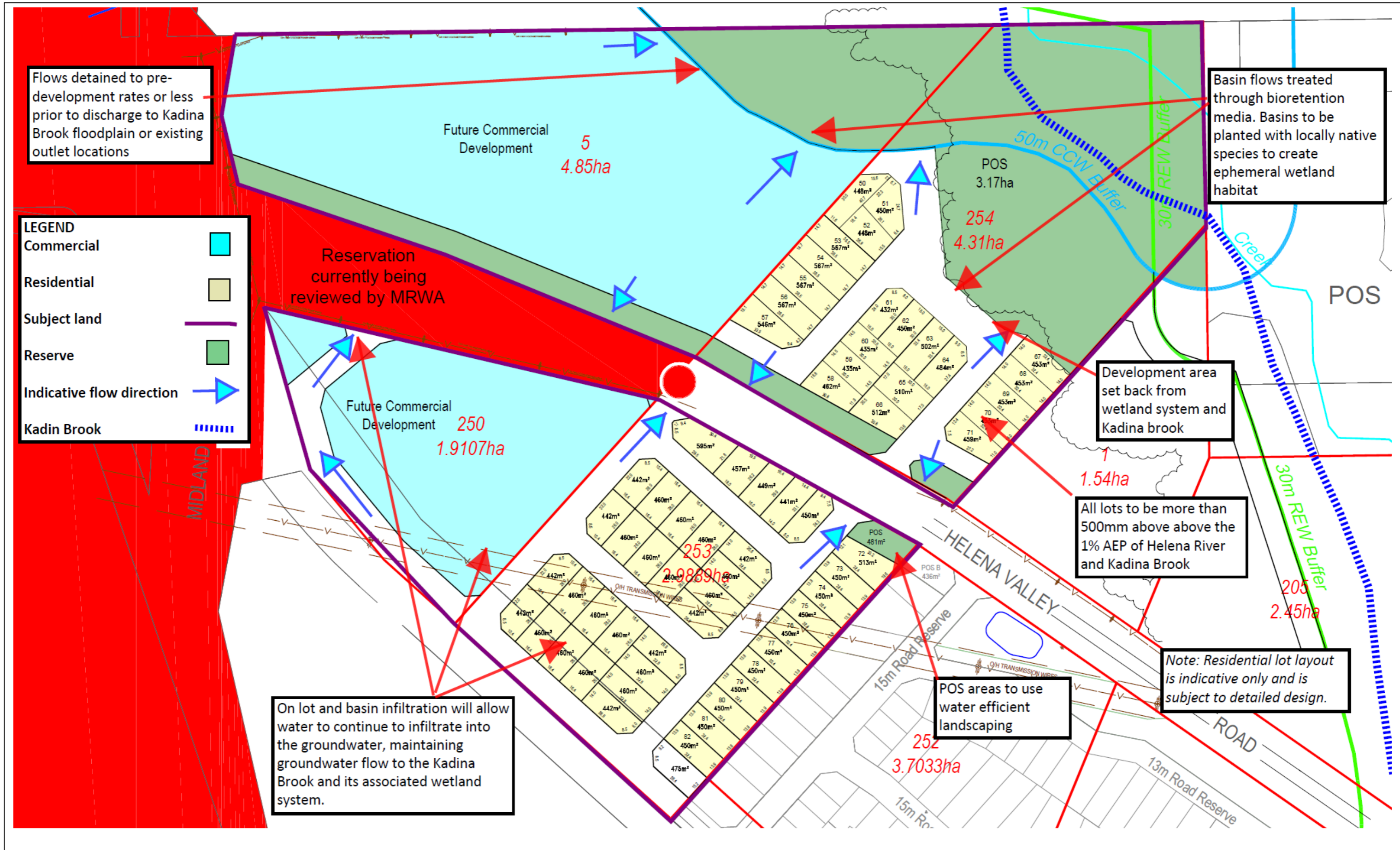


Figure 2 Key Elements Plan

### 3 LANDFORM PLAN

Lot 5 is generally mild sloping from west to east for the majority of the proposed development area with some steeper grades in the northeast of the site. The natural surface is approximately 19m AHD in the southwest of the site down to 17m in the north east. From here the slope increases down to the Kardina Brook and wetland system, which is located at approximately 11mAHD. Lot 254 follows a similar progression from 19m AHD along the southern boundary, with the drop to the Brook starting at 18mAHD down to 11m AHD, where it flattens out to 10mAHD on the northern boundary. There has been some minor earth working within lot 5 to accommodate its previous industrial use and there has been some stockpiling of soil near the eastern boundary.

Lots 250 and 253 are generally flat to mild sloping from south to north, with the north western portion sloping towards the north east. to east for the whole of the proposed development area. The natural surface is approximately 22m AHD in the southeast of Lot 253 and 18m AHD in the northwest of Lot 250. The north eastern portion forms part of a trapped low that extends into the Helena Valley Road verge and into Lot 21 to the south.

Helena Valley Road divides the site on a cadastral basis as well as restricting overland flow that would of previously continued from Lots 250 and 253 across to Lot 5 and Lot 254

#### **Water features.**

Kadina Brook and its associated oxbow lake wetland system is the main water feature within the subject land. This system passes through the northern portion of Lot 5, flowing in a north westerly direction. The waterway is seasonal in nature. Its location can be seen on Figure 3.



*Flat sandy plain across upland area*



*Gentle slope from upland down to Kadina Brook wetland system*

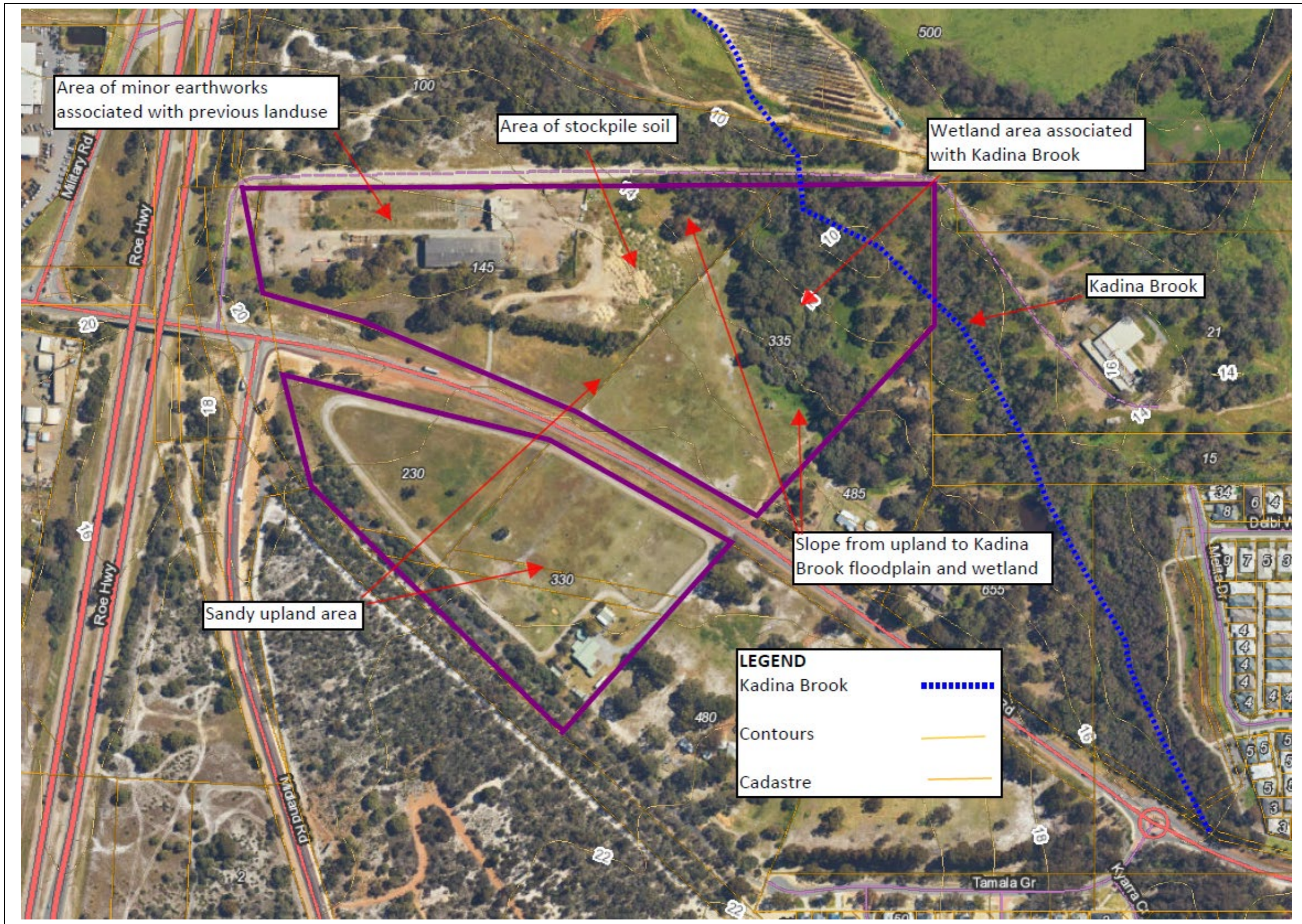


Figure 3 Current Landform

## 4 GEOTECHNICAL PLAN

The following information has been taken from the *Report on Due Diligence Geotechnical and environmental study proposed subdivision Lots 5 and 250 Helena Valley Road, Helena Valley WA* (Galt Geotechnical 2021). The field works were undertaken in October 2021. It is noted that this report was only focused on the western half of the site and some extrapolation has been undertaken for Lots 253 and 254. The testing locations can be seen in Figure 4.

### 4.1 GENERAL SOIL CONDITIONS

The Perth sheet of the 1:50,000 scale Environmental Geology series map indicates that most of the site is underlain by clayey soils of the Guildford Formation. The south eastern corner of Lot 250 is shown on the map to have a thin overlying layer of Bassendean sand over the Guildford Formation. The onsite geotechnical investigation found that the thickness of Bassendean Sand over the site is thicker than that indicated on the geological map. Surficial fill layers were also encountered and are associated with previous development of the site. The subsurface conditions encountered across the site can be summarised as follows:

EITHER:

- In the vicinity of existing building and salvage yard (BH01, BH02, BH04, BH06, BH07 and BH11): FILL: SAND / FILL: SANDY GRAVEL / FILL: GRAVEL, gravel includes crushed rock, laterite and limestone, includes construction waste (building rubble, glass, metal, etc ...) in BH06 and BH07, extending from ground surface to depths of up to about 0.5 m; OR
- Elsewhere on the site (BH03, BH05, BH08, BH09, BH10): TOPSOIL: ORGANIC SAND, fine to coarse grained, dark grey, trace/with fines, with rootlets and organics, extending from ground surface to depths of up to about 0.1 m; overlying

SAND (SP / SP-SC): fine to coarse grained, sub-angular to sub-rounded, brown / orange / grey / white, typically medium dense (locally loose), typically trace fines, trace gravel in some zones, trace organics, extends beyond depth of investigation at all test locations except BH07; overlying

AT BH07 ONLY (lower elevation / north eastern portion of site) Clayey SAND / SANDY CLAY (SC / CI): medium plasticity, pale grey, sand is fine to coarse grained, moisture near plastic limit, extends from 1.9 m below ground level to beyond depth of investigation.

Coffee rock was also encountered in BH09 at about 1.5 m depth within the cut slope. A summary of each bore can be seen in Table 2.

### 4.2 PERMEABILITY

Infiltration tests were carried out in hand-auger boreholes using the 'inverse auger hole' technique described by Cocks<sup>1</sup>. The results of the infiltration testing are presented in Appendix D, Infiltration Test Results and are summarised in Table 1.

Table 1 Summary of Infiltration Test Results

Test Location	Description	Pipe Embedment (m)	Minimum Unsaturated Hydraulic Conductivity, k (m/day)		
			Test 1	Test 2	Test 3
IT01 / BH05	SAND	0.93	7.6	10.2	8.0
IT02 / BH02	SAND	0.90	> 15	13.7	9.1
IT03 / BH09	SAND	0.90	> 15	14.1	12.4

- Note:**
- The unsaturated hydraulic conductivities shown were recorded at pressure heads varying between about 0.3 m and 0.1 m.
  - Conductivities in excess of 15 m/day are not reported due to the inaccuracy of the test in highly permeable soils.

### 4.3 ACID SULPHATE SOILS

No onsite Acid Sulphate soil (ASS) testing has been undertaken to date. ASS mapping (DWER) of the site suggests that there is a moderate risk of ASS across most of Lot 254 (Figure 5). It is possible that there may be ASS associated with Kadina Brook and surrounds, however this has not been mapped.

Table 2 Summary of ground conditions

Test Name	Test Depth (m)	Depth to Groundwater (m)	Stratigraphy
BH01	3.0	GNE <sup>1</sup>	ASPHALT; overlying BASE COURSE; overlying FILL: SAND; overlying SAND
BH02	1.5	GNE	FILL: SANDY GRAVEL; overlying SAND
BH03	2.0	GNE	TOPSOIL ORGANIC SAND; overlying SAND
BH04	3.0	2.35	FILL: GRAVEL / SANDY GRAVEL; overlying SAND
BH05	3.0	2.70	TOPSOIL ORGANIC SAND; overlying SAND
BH06	1.5	GNE	UNCONTROLLED FILL: SANDY GRAVEL; overlying SAND
BH07	3.0	GNE	UNCONTROLLED FILL: SANDY GRAVEL / SAND; overlying SAND; overlying CLAYEY SAND; overlying SANDY CLAY
BH08	1.5	GNE	TOPSOIL ORGANIC SAND; overlying SAND
BH09	3.0	2.45	
BH10	1.5	GNE	
BH11	1.5	GNE	FILL SANDY GRAVEL; overlying SAND

**Notes:** All boreholes reached target depth. <sup>1</sup>"GNE" = Groundwater was not encountered.

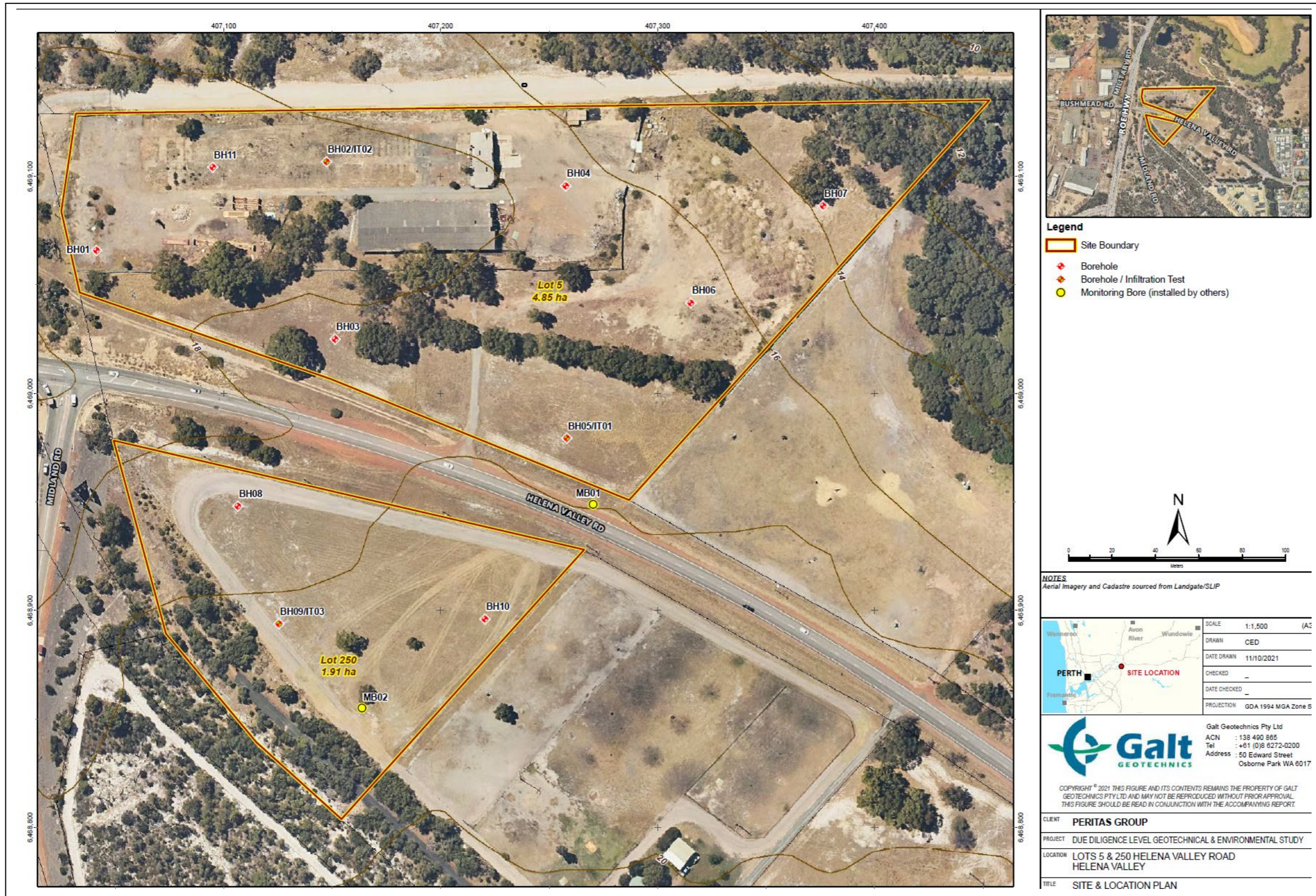


Figure 4 Geotechnical test locations

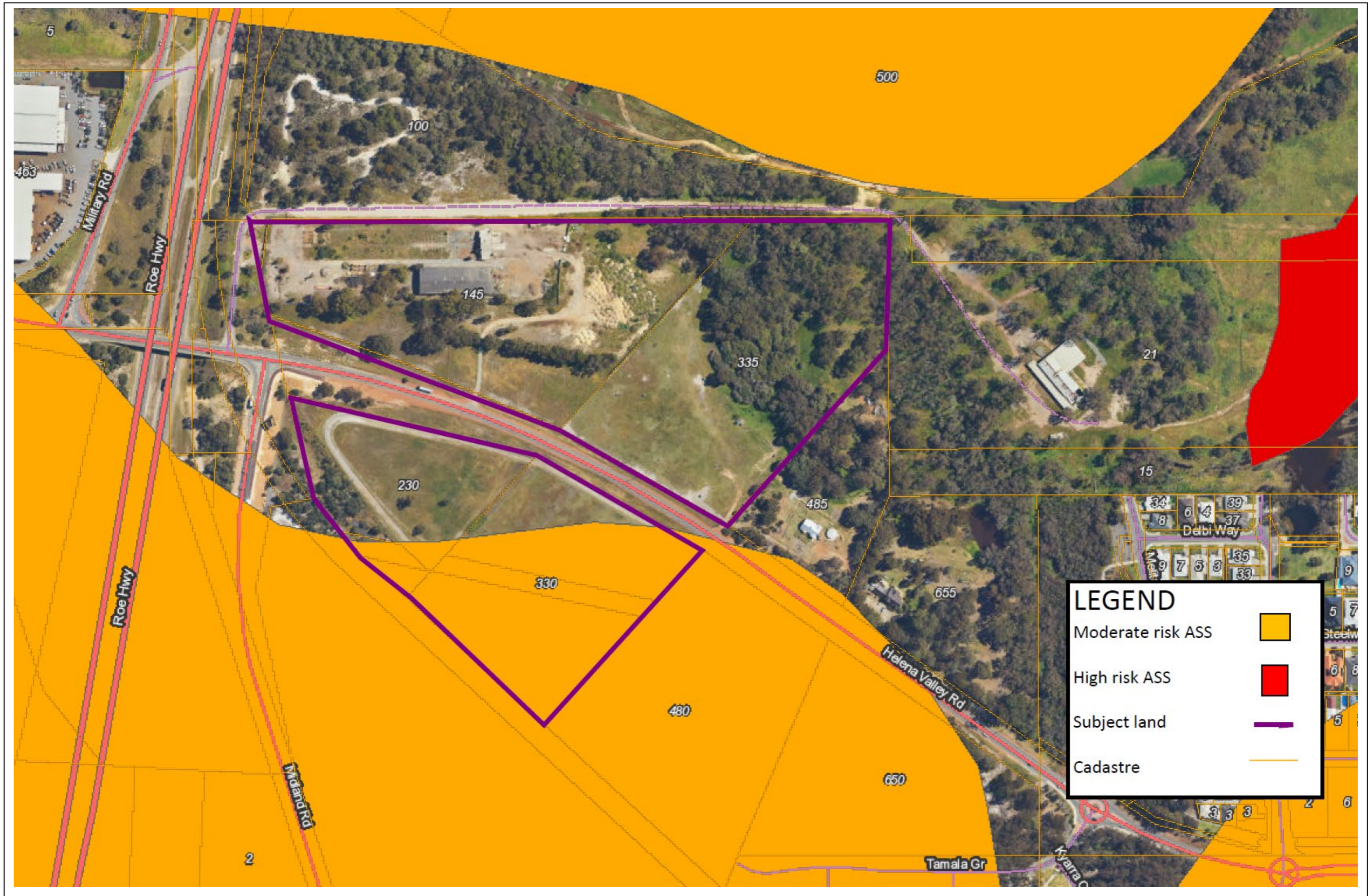


Figure 5 ASS mapping

## 5 ENVIRONMENTAL CONDITIONS

The following information is based on the reports by PGV (2022) titled:

- *Lots 5, 250, 253 And 254 Helena Valley Road, Helena Valley Environmental Assessment Report*
- *Lots 5, 250, 253 And 254 Helena Valley Road, Helena Valley Flora, Vegetation And Fauna Survey*

as well as site inspections by Oversby Consulting (April 2022). The PGV reports are based on site inspections in September 2022.

The subject land is predominately cleared within the upland areas and has been for over 70 years. There are however some environmental values still associated with Kadina Brook and its surrounds, as well as a strip of upland vegetation.

### 5.1 WATERWAY/WETLANDS

According to the DBCA's Geomorphic Wetlands of the Swan Coastal Plain dataset, there is a Conservation Category Wetland (15440) that covers the north eastern corner of the subject land. Adjoining this is a Resource Enhancement Wetland (15885, 14230) and a Multiple Use Wetland (15884). These wetlands are associated with the Kadina Brook and Helena River waterways and their surrounding floodplains. Based on the vegetation and landform found to the south west of the mapped wetland, it is likely that the wetland area extends towards the edge of the riparian vegetation (see Figure 8).

The Kadina Brook flows in a northerly direction until it reaches the north eastern corner of the subject land. From here it heads in a north westerly direction, where it eventually joins the Helena River. The Kadina Brook generally has a winter seasonal flow.

### 5.2 FLORA AND VEGETATION

7 vegetation types were found on site. Of these, 3 are riparian in nature. These are:

#### ***Eucalyptus rudis* Woodland over *Melaleuca raphiophylla* Low Open Woodland**

Two areas containing this vegetation type occur on the southern banks of Kadina Brook. *Eucalyptus rudis* (Flooded Gum) is up to 28m high and moderately dense (25-40%).

*Melaleuca raphiophylla* trees are 4-6m high and sparse. The understorey of one stand is almost completely Kikuyu Grass with no native species. The other stand has some native shrubs (*Taxandria linearifolia*, *Astartea affinis*) and sedges (*Lepidosperma tetraquetrum*) and ground covers (*Centella asiatica*).

#### ***Eucalyptus rudis* Woodland over weeds**

Most of the flat floodplain through which the Kadina Brook watercourse runs contains Flooded Gums 25-28m high.

Paperbarks are almost completely absent as are smaller native shrubs, sedges and herbs. Annual Veldtgrass (*Ehrharta longiflora*) dominates the understorey. A few native *Melaleuca teretifolia* shrubs occurred in the understorey which was predominantly weeds, including Annual Veldtgrass

#### ***Melaleuca raphiophylla* Low Open Forest over weeds**

One stand of *Melaleuca raphiophylla* Low Open Forest occurred on the southern boundary of the Kadina Brook floodplain. No Flooded Gums occurred in this area. The *M. raphiophylla* trees were up to 8m high and quite dense.

The remaining vegetation was generally rated as Degraded to Completely Degraded. Only one area close to Kadina Brook was rated as Very Good with some native understorey.

These vegetation types can be seen in Figure 6 and the condition in Figure 7.

### 5.3 FAUNA

The Woodland habitat has connectivity with other parts of the Kadina Brook environment to the south-east and north-west and is therefore rated as Good Fauna Habitat. The remainder of the habitats on the site are considered to be Highly Degraded Fauna Habitat.

### 5.4 SITE CONTAMINATION

A search of the DWER's known contaminated sites database (DWER 2021) identified that the subject site is not listed as a contaminated site. There are no known contaminated sites directly adjoining the subject site either.



*E. rudis* over weeds vegetation along Kadina brook floodplain

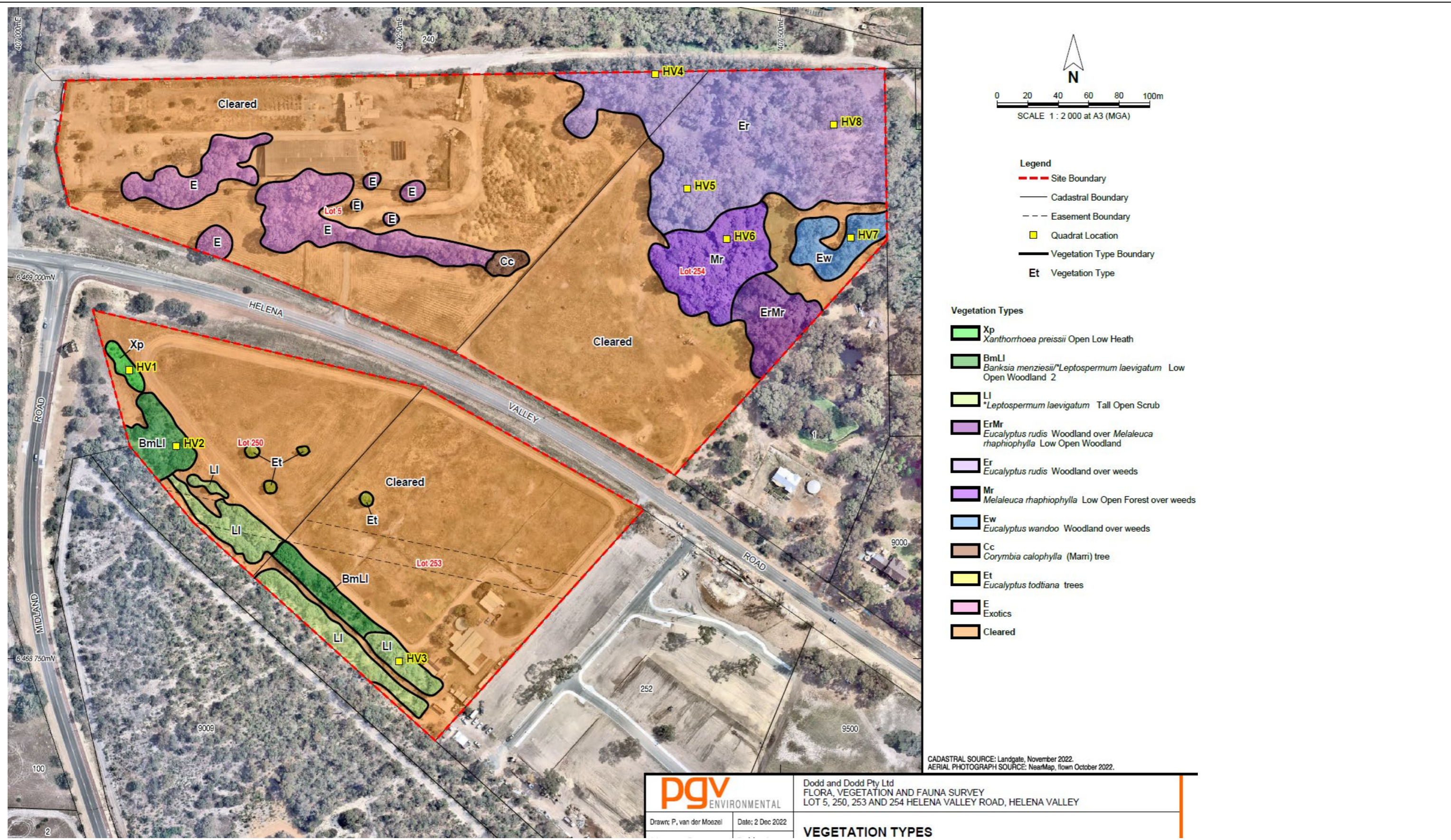


Figure 6 Vegetation types

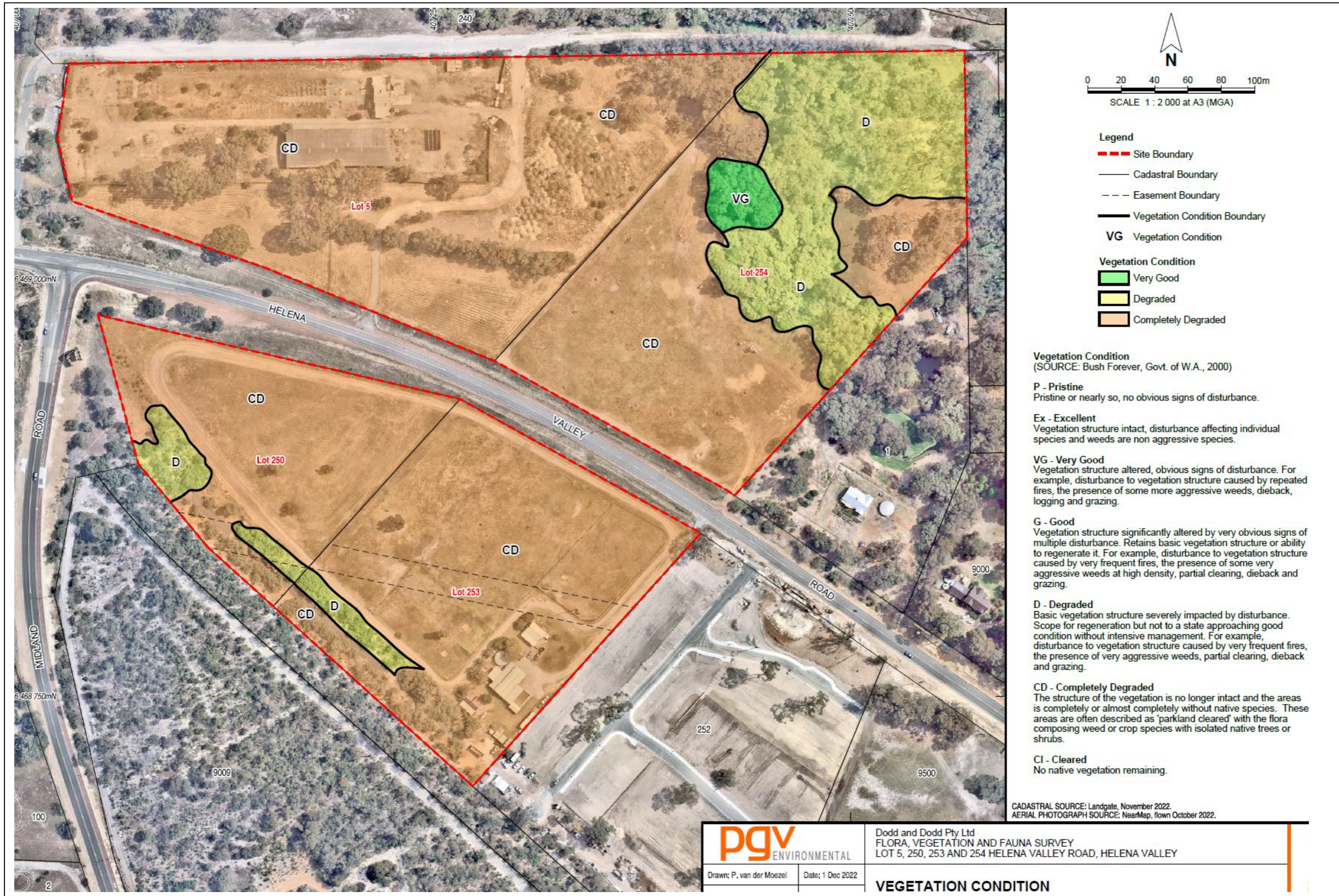


Figure 7 Vegetation Condition

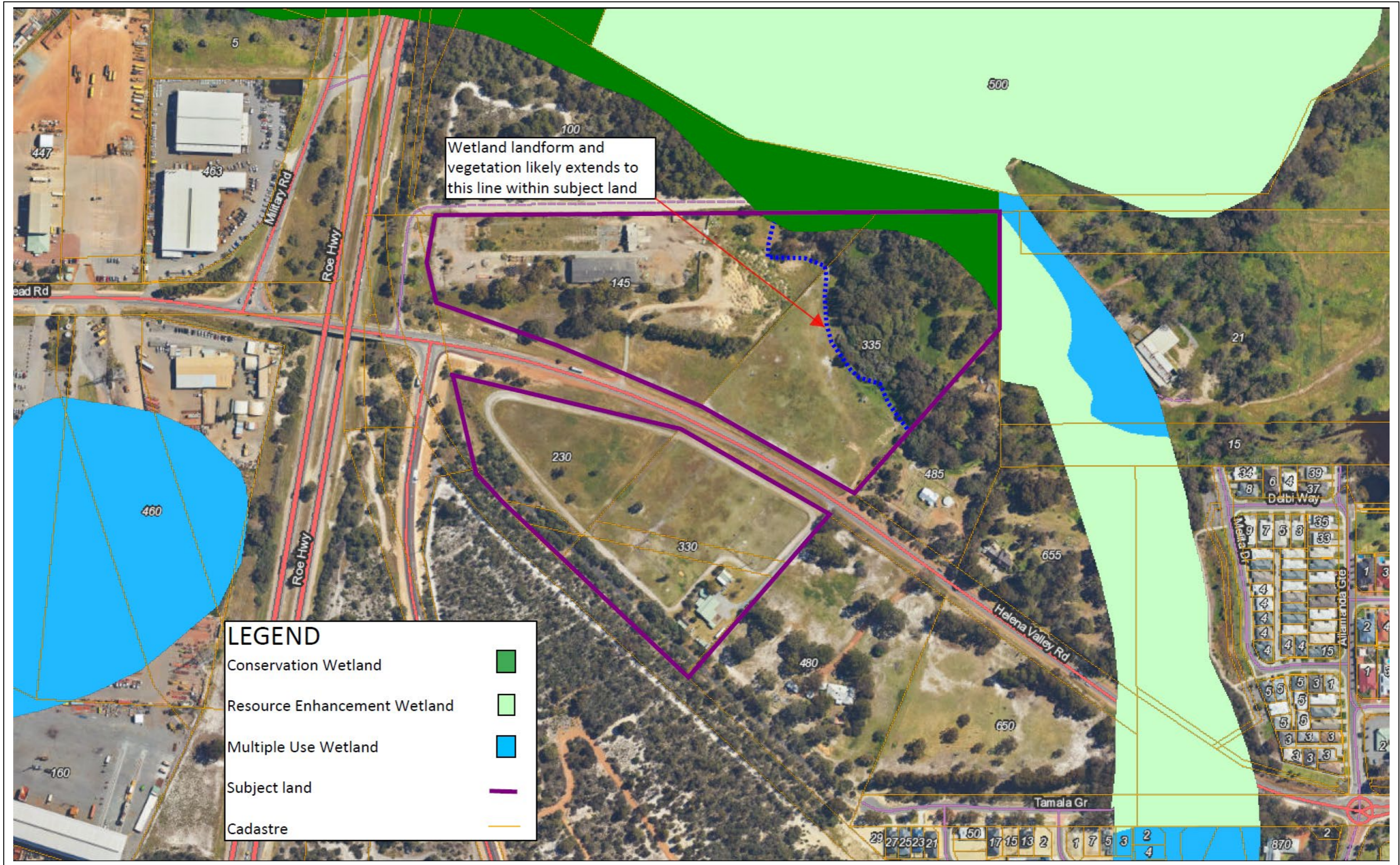


Figure 8 Wetlands

## 6 SURFACE WATER (PRE-DEVELOPMENT)

The Kadina Brook and its associated floodplain wetland system runs through the north east portion of the subject land. The water flows in a north westerly direction. Historically the majority of the site would of flowed as sheet flow in a north/north easterly direction to the Kadina Brook system.

The creation of Helena Valley Road has formed a constriction to overland flow across the southern portion of the subject land (Lots 250 and 253) to the north. Stormwater in larger events now pools behind the southern side of the road. It then moves predominately in a easterly direction, except for small section on the western end, which is likely to flow westward due to road earthworks changing the levels. There is no formal drainage network along this portion of Helena Valley Road.

Due to the highly pervious sands however, there is generally little surface flow from the site, with most of the water infiltrating through to the groundwater. The exception to this are the areas of hardstand and sheds constructed as part of the former industrial uses within Lot 5 as well as the house, shed and driveway for Lot 253.

The general water features and flow directions can be seen in Figure 9.

### 6.1 MODELLING

The stormwater analysis has been completed using DRAINS modelling software utilising an ILSAX Hydrological model. DRAINS software is widely used to perform design and analysis calculations for stormwater drainage systems. The ILSAX hydrological model uses a loss model involving depression storages and the Horton Infiltration model for pervious areas. The time area method is used as a routing model to convert rainfall hyetographs to runoff hydrographs (DRAINS, 2018).

The stormwater modelling utilises ARR 2016 procedures as presented in Chapter 5 of Book 2 of ARR 2016 and current rainfall data obtained from the ARR Data Hub (DRAINS, 2018). An analysis was undertaken for the pre and post-development scenario.

The general focus was that the overall post-development flow rate could not exceed the pre-development rate for both the 20% AEP/10% AEP and 1% AEP events.

The key modelling assumptions included:

- Initial loss was assumed to be 5mm and a Soil factor 4 was used to represent high ongoing rainfall loss into the sandy soil
- It was assumed that there was no constricting significant back flow, as the flow off the subject land is generally not constrained and in large storm events the water can leave as sheet flow, from the area likely to be developed (eg it is significantly above the flood level of the adjoining Kadina Brook).
- Lot 5 was assumed to have 40% impervious area to account for the hardstand and sheds (of which 10 % is supplementary and flows into surrounding sandy areas).
- Lot 253 was assumed to 5% impervious area and another 5% of supplementary area that flows to sandy areas to account for the existing house, shed and driveway.
- Grass areas were assumed to have a Retardance coefficient of 0.1.
- Existing hardstand areas were assumed to have a retardance coefficient of 0.013.
- Pervious areas were assumed to provide 1mm of initial loss.
- The continual loss assumed sandy soils (eg soil type 1)
- The storms modelled were the 5min, 15min, 30min, 1 hr, 2hr, 3hr, 4.5hr, 6hr, 9 hr, 12hr and 24hr. These were modelled for the 20% AEP, 10% AEP and 1%AEP.

Table 3 Pre-development Flow summary

Catchments	Area (hectare)	20% AEP (m <sup>3</sup> /s)	10% AEP (m <sup>3</sup> /s)	Critical storm	1% AEP (m <sup>3</sup> /s)	Critical storm	Flow Discharge Direction	Comments
Lot 5	3.64	0.202	0.245	5-15min	0.413	5-15min	North to Kadina Br floodplain	Area modelled was the portion that is proposed to be developed.
Lot 250	1.9107	0.01	0.012	5-15min	0.018	5-15min	NW corner, then road reserve	
Lot 254	1.97	0.004	0.005	5-15min	0.007	5-15min	North to Kadina Br floodplain East	Area modelled was the portion that is proposed to be developed.
Lot 253	2.988	0.04	0.047	5-15min	0.071	5-15min	North then road reserve.	
<b>Total</b>		<b>0.256</b>	<b>0.318</b>		<b>0.509</b>			

### 6.2 FLOOD ANALYSIS

The mapped 1% AEP flood level for the Helena River adjoining the subject land shows that the very northern portion may be affected by the flood waters. This is the area associated with Kadina Brook and wetland system. The following advice was provided by DWER through the Servicing Report:

*“The Helena River Flood study shows a small part of the Lot 5 is affected by flooding during major river flows with the 1 in 100 (1%) AEP flood levels estimated to be 10.8 m AHD.*

*Based on our floodplain management strategy for the area:*

- *Proposed development (ie, filling, building, etc) that is located outside of the floodway is considered acceptable with respect to major flooding. However, a minimum habitable floor level of 0.5 metre above the adjacent 1% AEP flood level is recommended to ensure adequate flood protection (e.g. 11.3 m AHD).*
- *Proposed development (ie, filling, building, etc) that is located within the floodway (marked yellow on the map) and is considered obstructive to major flows is not acceptable as it would increase flood levels upstream. No new buildings are acceptable in the floodway.*

Flood studies taken upstream along the Kadina Brook, and reported in the adjoining LWMS suggest that the 1% AEP flood level is generally 0.8m deep. To be conservative a level of 1.5m above the channel invert should be adopted for preliminary planning within the subject land.

### 6.3 WATER QUALITY

Kadina Brook is an ephemeral stream that flows during the rainfall season (Shire of Kalamunda, undated). Water quality monitoring in Kadina Brook in 2011/12 and reported in the adjoining LWMS indicates that the water quality generally meets ANZECC Guidelines with:

- pH neutral: pH 6.9 – 7.8
- electrical conductivity: 487-904 µS/cm (slightly brackish)
- total suspended solids: less than 6 mg/L
- total nitrogen: 0.3-1.2 mg/L
- total phosphorus: 0.006-0.02 mg/L (SoK undated).

The sampling locations can be seen in Figure 10.



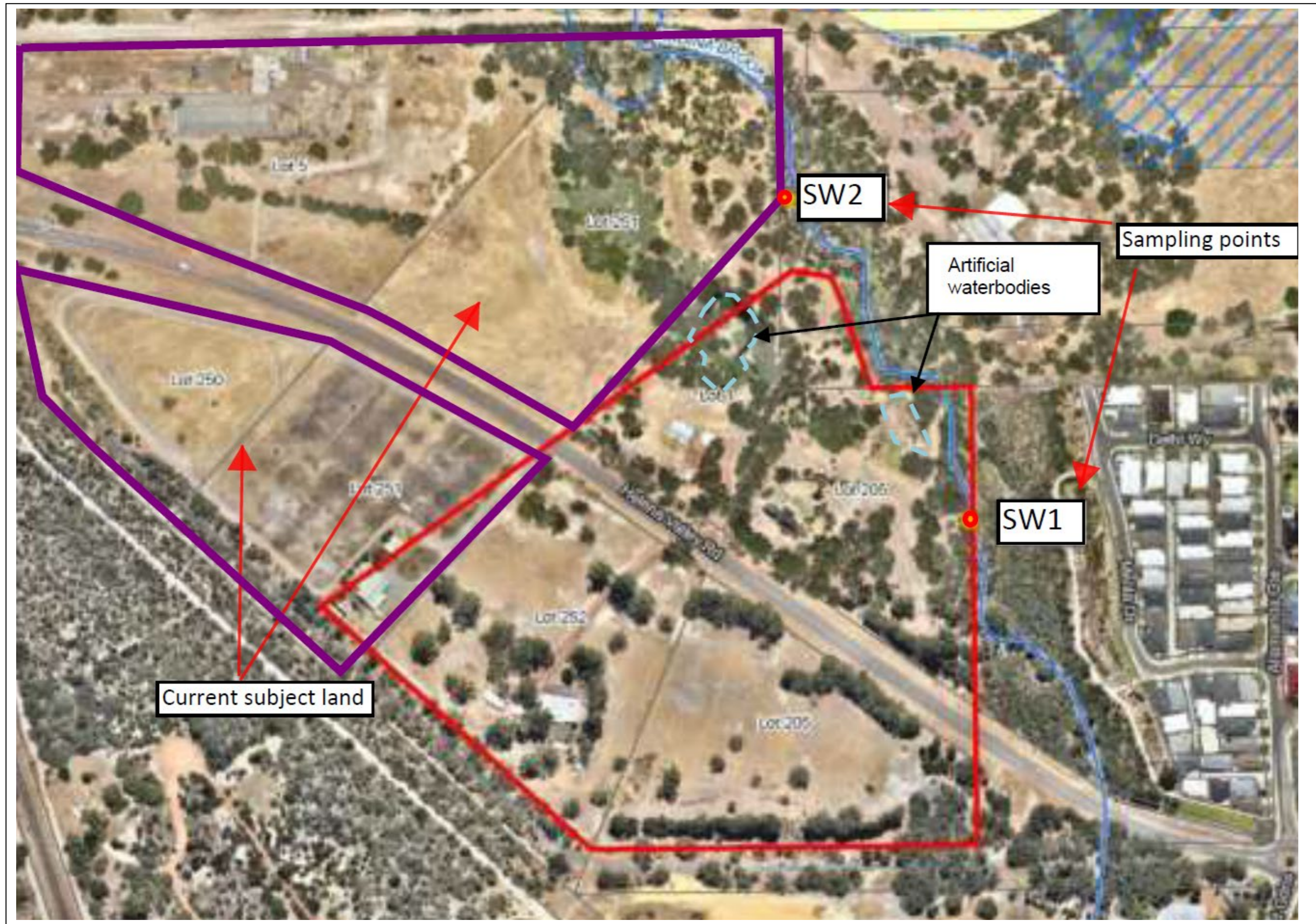


Figure 10 Surface water sampling points

## 7 GROUNDWATER (PRE-DEVELOPMENT)

### 7.1 SUPERFICIAL GROUNDWATER LEVELS

The superficial formation on the site largely consists of sandy materials. Groundwater monitoring was undertaken on subject land and nearby areas to the east between July 2015 and February 2017 (18 month period) by Emerge and Ace Environmental. A summary of the bores used is presented in Table 4 with locations presented in Figure 11. A maximum groundwater level (MGL) and Average Annual Maximum Groundwater Level (AAMGL) have been calculated for the site. The results relevant to the subject land can be seen in Table 4. Groundwater flow is in a generally north-easterly direction towards Kadina Brook.

To estimate the MGL and AAMGL, water levels at the site were correlated to a regional monitoring bore (WIN ID 6224) located approximately 1.2 km north of the site in Bellevue, which has a record from 1985 to the present. This resulted in a 0.63 m correction from the highest groundwater levels recorded on the site (30 September 2016) to the AAMGL and 2.15 m for the MGL. Where the MGL or AAMGL was higher than the surface level, this was reduced to represent the surface level. The contours can be seen in Figure 12.

Areas of seasonal waterlogging may occur in the vicinity of Kadina Brook where groundwater is at or above surface level.

Table 4 Depth to groundwater -

Name	Easting	Northing	Natural surface (mAHD)	Top Casing (mAHD)	of Screened interval (mBTOC)	Water level 30/09/16	MGL (mAHD)	AAMGL (mAHD)
MB02	407098.8	6469049.7	18.68	19.18	7 to 10	14.50	16.65	15.13
MB03	407162.2	6468854.1	19.40	19.87	4.3 to 7.3	16.33	18.48	16.96
MB04	407396.1	6468901.9	19.08	19.65	4.6 to 7.6	15.47	17.62	16.10
MB05	407471.0	6469074.1	10.98	11.51	5.85 to 8.85	10.28	10.99	10.91

Groundwater was also recorded as part of the preliminary geotechnical investigation for Lots 5 and Lot 250 (see Section 4). The test pits were excavated on the 6<sup>th</sup> October 2021. The depths ranged from 2.5 to 2.7m below ground level. The results can be seen in Table 5. The bore locations can be seen in Figure 4.

The difference in levels found is likely due to the Emerge/Ace bores being screened lower and may not of picked up isolated areas or perching within the upper portions of the superficial.

### 7.2 GROUNDWATER AVAILABILITY

The site is located in the Shire of Mundaring, Perth Superficial Swan Groundwater Area. The DWER Water Register indicates that Lot 1 has a groundwater licence for 5225 kL/yr (Licence No. 178485). Allocations are available for groundwater in this aquifer. Lot 252 has an allocation of 3519 kL/yr. As at 20 September 2018, the Water Register indicated that groundwater was available for allocation in this aquifer.

The deeper Leederville and Yarragadee aquifers in the area are fully allocated.

Table 5 Depth to groundwater -

Test Name	Test Depth (m)	Depth to Groundwater (m)
BH01	3.0	GNE <sup>1</sup>
BH02	1.5	GNE
BH03	2.0	GNE
BH04	3.0	2.35
BH05	3.0	2.70
BH06	1.5	GNE
BH07	3.0	GNE
BH08	1.5	GNE
BH09	3.0	2.45
BH10	1.5	GNE
BH11	1.5	GNE

Notes: GNE = Groundwater was not encountered.

### 7.3 SUPERFICIAL GROUNDWATER QUALITY

Groundwater quality sampling was undertaken in December 2016 and February 2017. Results are presented in Table 6 and indicate that groundwater quality is generally worse than both the Swan Canning Water Quality Improvement Plan (WQIP) water quality targets and the ANZECC (2000) water quality guideline values for lowland river ecosystems for total nitrogen, total phosphorus and NO<sub>x</sub>-N. Historical contamination of the site from grazing of livestock is likely to be the cause of current groundwater quality at these locations.

Table 6 Recorded groundwater quality

Parameter	ANZECC Guideline value	Swan Canning WQIP	MB04	MB06
Total N (mg/L)	1.2	1	1.70	3.30
TKN (mg/L)	-	-	1.10	2.20
NO <sub>x</sub> -N (mg/L)	0.15	-	0.58	1.06
NH <sub>3</sub> -N (mg/L)	0.08	-	0.05	0.10
Total P (mg/L)	0.065	0.1	0.52	4.64
FRP (mg/L)	0.04	-	<0.01	<0.01

1. Values adopted for Lowland River, South West Australia.
2. ANZECC (2000) trigger values for freshwater for a 95% level of protection (slightly to moderately disturbed ecosystem).
3. Shaded values exceed ANZECC guideline values.
4. Swan Canning Water Quality Improvement Plan (WQIP) (Swan River Trust, 2009) - Water quality and nutrients load targets, Table 14, Target for median TP and TN concentrations, Helena River.

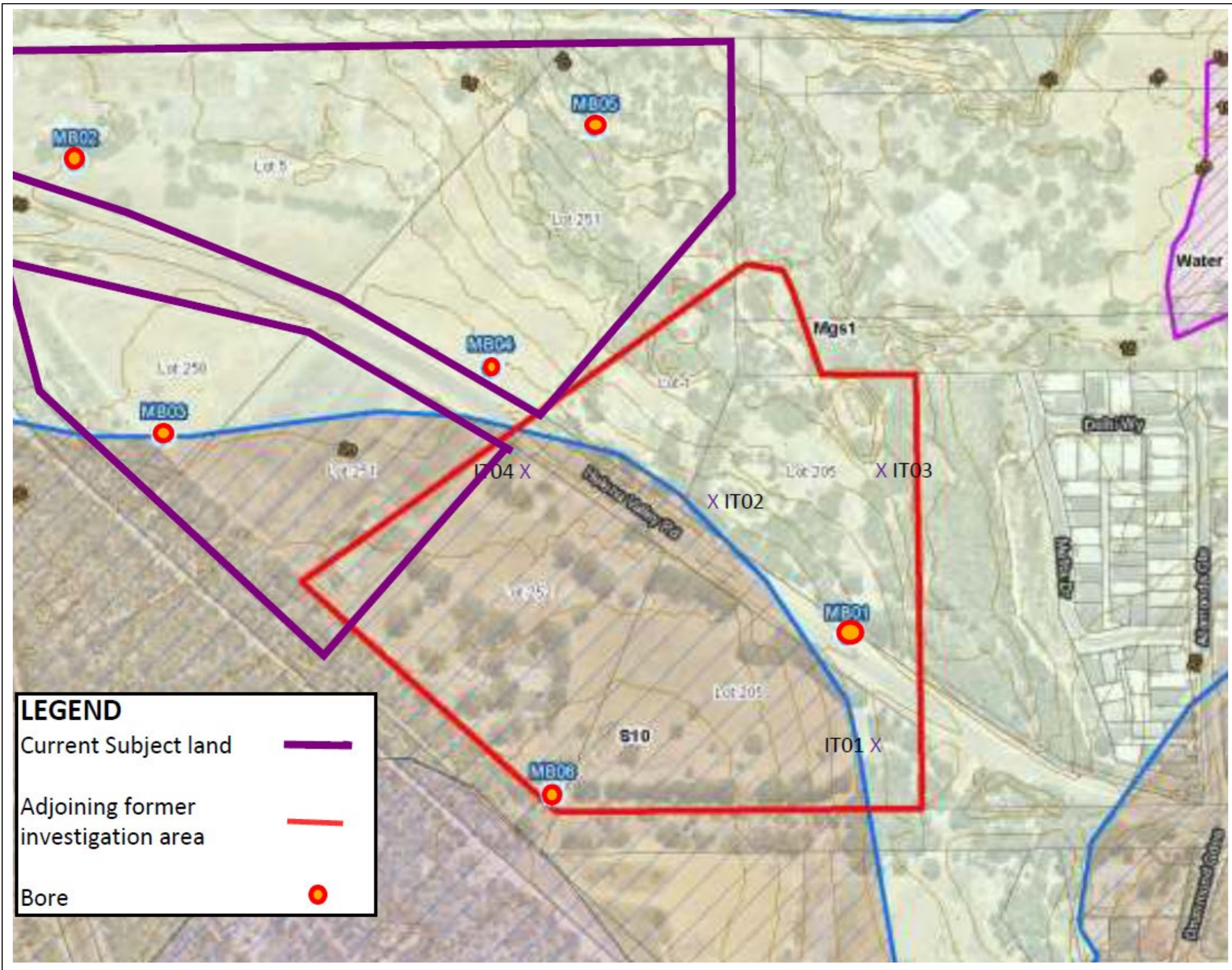


Figure 11 Groundwater contours, depth and spot height locations

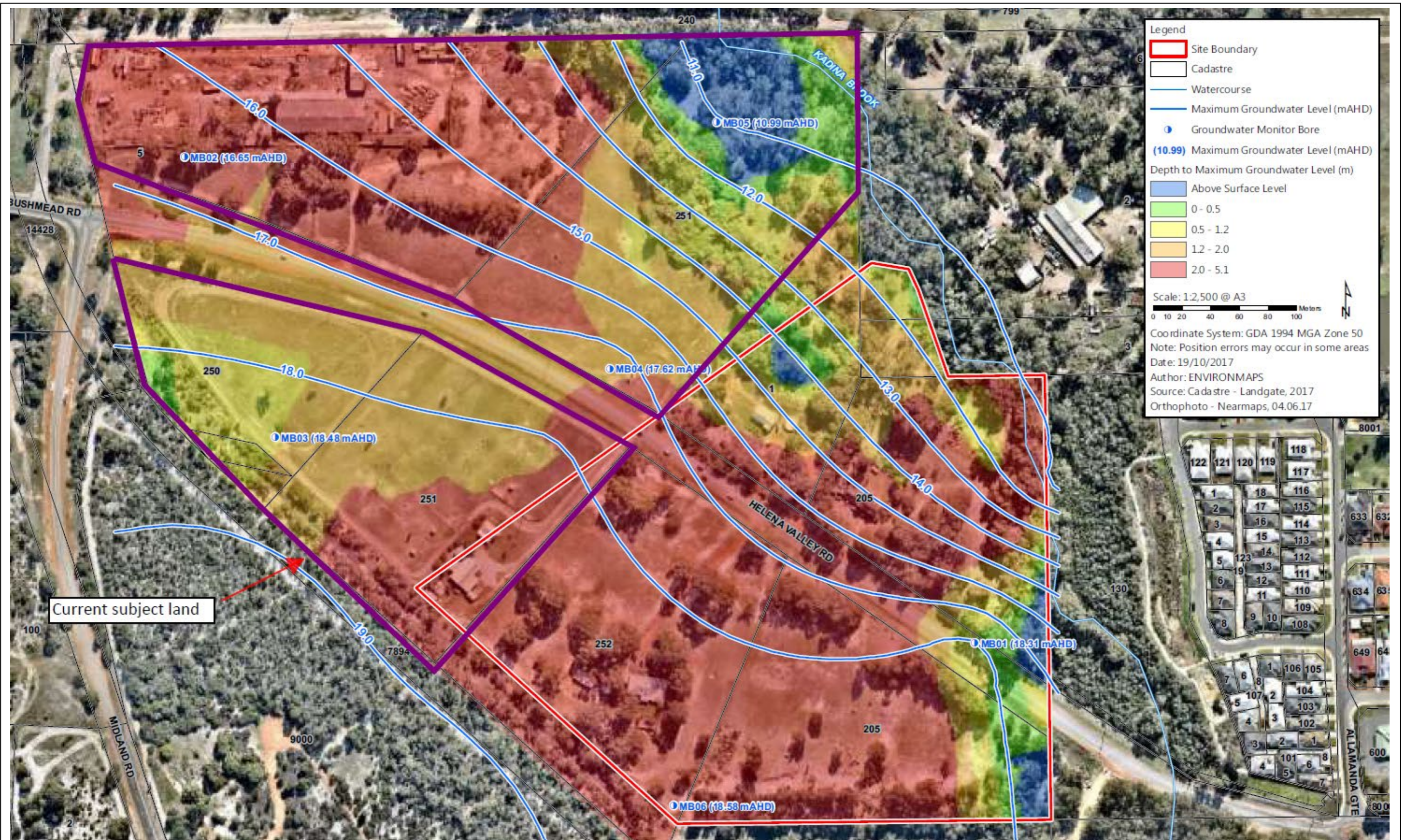


Figure 12 Groundwater contours (from adjoining LWMS)

## 8 DRAINAGE MANAGEMENT STRATEGY

### 8.1 SUMMARY

The aim of Surface Drainage Management for the subject land is to generally manage the water flows so that water treatment happens on site for minor events and that the major storms are controlled to pre-development flow rates off the subject land.

All flows up to the 1EY are to be treated to reduce nutrients, sediments and other contaminant prior to discharge offsite. Above the 1EY, the main function is to control the flow of drainage water throughout the subdivision and its release from the subdivision. This water will predominately be captured and directed down a pipe network, to infiltration basins. Here water will either be directed into the adjoining waterway network or infiltrated on site. The system is also to be designed so that there is no flooding of houses and other critical infrastructure during the 1% AEP storm.

The post-development modelling was undertaken for the development's proposed internal catchments. These were divided based on the current lots, to reflect the likely future land uses and discharge locations as follows:

- a) Lot 5 – Commercial with discharge to the floodplain of Kadina Brook
- b) Lot 254 – Residential with discharge to the floodplain of Kadina Brook
- c) Lot 250 – Commercial with discharge to Helena Valley Road and potentially across NE boundary
- d) Lot 253 – Residential with discharge to Helena Valley Road

Within the relevant Catchments these were further refined into sub-catchments to represent the different sections of roads and lots. No external catchments were modelled, as there is no significant flow onto portion of the subject land that is to be developed.

With no final road network designed, the commercial roads were assumed to be 20% of the developable area and the residential areas were assumed to be 40% (which reflects the need for boundary roads due to fire). The residential lots were assumed to detain flows in soakwells at a rate of 1m<sup>3</sup> per 65m<sup>2</sup> of impervious area (which is an approximation of the 20% AEP). The commercial lots were assumed to detain the 10% AEP within their lots. Given the highly permeable soils (8m/day to >15m/day) and groundwater being more than 2m below the surface, lot infiltration is deemed suitable for this development area.

As there is no development within the large POS area associated with Kadina Brook and its wetland system, this portion of the development was not modelled.

The total peak flow to Kadina Brook is shown to be slightly less post development. The post development flow rate for the land south of Helena Valley Road is close to the pre development rate. A comparison of flows pre to post can be seen in Table 8, with an overall summary of the post-development flows in Table 7. Figure 13 shows the catchment boundaries (current lot boundaries), and general post-development drainage characteristics.

The following sections show in more detail how water is treated and conveyed in three different AEP scenarios,

- 8.3 – 1EY
- 8.4 – 20% and 10% AEP
- 8.5 – 1% AEP

### 8.2 MODELLING

The key modelling assumptions and characteristics are as follows:

- Catchments were designed to be logical areas of stormwater capture and discharge. Sub catchments were created within each area to represent likely flow areas and the differences between lots and roads.
- The catchments were analysed to determine appropriate impervious surfaces (roads, rooves, pathways) and pervious surfaces (gardens, unsealed verges, POS areas).
- Impervious areas had an assumed retardance coefficient of 0.013, while pervious surfaces were assumed to have a retardance coefficient of 0.2.
- Basins were assumed to have 1:6 sides.

- The basin permeability was assumed to be 2m/day to be conservative, due to early planning (to be refined based on testing in basin locations as part of detailed design)
- Commercial lot on lot storage was assumed to be the entire 10% AEP.
- Residential lots were assumed to detain at a rate of 1m<sup>3</sup> of storage per 65m<sup>2</sup> of impervious area
- The storms modelled were the 5min, 15min, 30min, 1 hr, 2hr, 3hr, 4.5hr, 6hr, 9 hr, 12hr and 24hr. These were modelled for the 20% AEP, 10% AEP and 1%AEP.

Table 7 Post development flow summary

Catchments	Area (hectare)	20% AEP (m <sup>3</sup> /s)	10% AEP (m <sup>3</sup> /s)	Critical storm	1% AEP (m <sup>3</sup> /s)	Critical storm	Flow Discharge Direction	Comments
Lot 5	3.64	0.094	0.0116	15min	0.23	2 hour	North to Kadina Br floodplain	Area modelled was the portion that is proposed to be developed.
Lot 250	1.9107	0.004	0.005	3 hour	0.013	9 hour	NW corner, then road reserve	
Lot 254	1.97	0.004	0.006	4.5 hour	0.011	9 hour	North to Kadina Br floodplain East	Area modelled was the portion that is proposed to be developed.
Lot 253	2.988	0.019	0.024	4.5 hour	0.053	6 hour	North then road reserve.	
<b>Total</b>								

Table 8 Pre vs Post development flow summary for major discharge directions

Catchments	20% AEP (m <sup>3</sup> /s)		10% AEP (m <sup>3</sup> /s)		1% AEP (m <sup>3</sup> /s)		Max basin volume (m <sup>3</sup> ) 1m deep, 1:6 sides
	Pre	Post	Pre	Post	Pre	Post	
Lot 5	0.202	0.094	0.245	0.116	0.413	0.230	16.3
Lot 254	0.004	0.004	0.005	0.006	0.007	0.011	140
<b>Kadina Brook total</b>	<b>0.206</b>	<b>0.098</b>	<b>0.250</b>	<b>0.124</b>	<b>0.420</b>	<b>0.241</b>	
Lot 250	0.01	0.004	0.012	0.005	0.018	0.013	61
Lot 253	0.04	0.019	0.047	0.024	0.071	0.053	180
<b>Helena valley total</b>	<b>0.050</b>	<b>0.023</b>	<b>0.059</b>	<b>0.029</b>	<b>0.089</b>	<b>0.066</b>	
<b>Total</b>	<b>0.256</b>	<b>0.121</b>	<b>0.318</b>	<b>0.153</b>	<b>0.509</b>	<b>0.307</b>	

### 8.3 1EY MANAGEMENT

The Drainage Management system is to be designed to manage contaminants within the stormwater for the 1EY. There are two main directions that drainage water will take; infiltration to groundwater and surface run off. To deal with these different flow paths, two separate treatment trains have been designed.

#### DIRECT INFILTRATION TO GROUNDWATER

The majority of water that falls on pervious surfaces (eg non sealed portions of road verges and lot area plus POS) in the subdivision will infiltrate through to the groundwater. The majority of contaminants will be removed from surface water as it filters through the soil profile. Roof runoff will also be sent to infiltration devices within each lot with direct infiltration.

#### SURFACE FLOW

For the majority of the non-lot impervious areas such as roads, pathways and crossovers, the water will be directed to the edge of roads. From here it will flow into the pit and pipe network and out to the bioretention basins. Water will be treated via infiltration through the filter media.

### 8.4 DRAINAGE MANAGEMENT PLAN – 20% and 10% AEP

The Commercial area lots are to detain the 10% AEP on site. A portion of the 20% AEP will be detained within the residential lots, with the final volumes to be in keeping with the Local Governments guidelines at the time of development. The road network (and residential lots as relevant) will have their flows detained to predevelopment levels via the bioretention and infiltration basin systems. The flows from each detention system north of Helena Valley Road will throttle the flows back via a controlled orifice outlet to the Kadina Brook floodplain area as well as infiltration into the ground for the areas. South of the road, the majority of the water will be infiltrated in the basins and other infiltration infrastructures, with some minor discharge at predevelopment rates.

The management of flows off the site means that there will be minimal impact on the downstream receiving areas and ultimately the drainage networks/waterways that they enter.

### 8.5 DRAINAGE MANAGEMENT PLAN – 1%AEP

The subject land has been designed to safely convey the 1% AEP flood event so that impacts on infrastructure, the environment and people's safety are minimised.

During a 1% AEP event the road drainage system will flow at capacity, with excess water directed down the road network to the basins within the POS areas. The road network is to be designed to allow a safe flood route and maintain a minimum clearance between flood surface water levels and the building floor levels and important infrastructure.

All floor levels are also to be 500mm above the flood height of Kadina Brook and associated floodplain of the Helena River, noting that the proposed development area is already above the mapped flood levels as determined by DWER mapping of 10.8mAHD. More refined levels are to be determined for Kadina Brook as it travels upstream along the north eastern boundary of the site. A conservative initial estimate based on upstream modelling is that the flood level is likely to be 1.5m above the defined channel. The proposed development level is above this level of approximately 12m, where it adjoins the subject land. This is to happen as part of the UWMP and LWMS.



## **9 GROUNDWATER MANAGEMENT STRATEGY**

### **9.1 GROUNDWATER LEVEL MANAGEMENT**

The focus of groundwater management for the subject land is to maintain groundwater as close as possible to existing levels. Water will be infiltrated on site into the insitu soils and fill, replicating the current infiltration. A subsoil network system will be installed in areas where there may be a need to control groundwater to the predevelopment level. Due to the significant depth to groundwater recorded, it is likely that for most areas there will not be a need for subsoil control. The geotechnical investigations to date also suggest that on site infiltration is suitable due to the sandy material found throughout.

### **9.2 GROUNDWATER QUALITY MANAGEMENT**

Groundwater will be managed to improve water quality. This will be achieved through the majority of non roof runoff being infiltrated through bioretention gardens. The bioretention gardens will remove the majority of potential pollutants, prior to the water being infiltrated through the soil profile.

### **9.3 USE OF GROUNDWATER**

POS areas may be irrigated with groundwater. A suitable source of irrigation water, including potentially acquiring a groundwater licence, is to be determined as part of the LWMS.

### **9.4 MONITORING**

Groundwater level monitoring is to be undertaken for the subject land as part of the LWMS. The focus will be to determine the seasonal maximum and minimum groundwater levels. Post development monitoring may be undertaken, with this requirement determined as part of the LWMS and UWMP.

## **10 WATER SERVICING STRATEGY**

### **10.1 POTABLE WATER**

Potable water is to be supplied by Water Corporation.

Preliminary information from the WA Water Corporation indicates that there is a potable water supply network in the area. A 250P-12 potable water pipe is located approximately 350m to the southeast of the subject site along the northern verge of Helena Valley Road. The potable water main will need to be extended to the subject site to service the proposed development.

The requirements of the subject site will need to be confirmed prior to development to ensure that the current existing water infrastructure is sufficient to accommodate the proposed development without any required upgrades. Updated details are to be provided in the LWMS and UWMP. Further details can be found in the Engineering Services Report (Peritas 2022).

### **10.2 NON POTABLE WATER**

Irrigation of the POS areas will be determined as part of the LWMS. Should groundwater be used for POS irrigation, a licence is to be secured. This may be undertaken via trading, depending on water availability.

### **10.3 FIREFIGHTING**

The subject land will have a reticulated water supply with hydrants as per the Water Corporation's design standard that can be used for internal firefighting and bushfires along the edge.

### **10.4 WASTEWATER MANAGEMENT**

Reticulated sewage is to be supplied by Water Corporation.

Preliminary information from the WA Water Corporation indicates that there is no reticulated sewer service network within the immediate area.

There is a DN150 sewer main located approximately 350m down Helena Valley Road to the southeast of Lot 253. The Inver Level (IL) of the sewer main is 13.49m AHD and the ground level towards the subject site slopes up to 20 m AHD, this would require approximately 5m trenching or boring through the hill to service the proposed development. There is potential issues with cover to sewer mains at the furthest most lots meaning that additional fill may be required, however it is unlikely given the initial depth.

Another option involves connecting to a deeper DN225 sewer main at IL 10.41 m AHD approximately 350m to the east of Lot 254 that will go around the hill. Further details can be found in the Engineering Services Report (Peritas 2022).

## **11 WATER DEPENDENT ECOSYSTEMS MANAGEMENT STRATEGY**

There are two main focuses for the management of water dependent ecosystem (WDE) as part of the subject land's future development;

- enhancement and management of the adjoining Kadina Brook and associated wetland systems and secondly to treat water prior to discharge into this system and other downstream systems.
- creation of new WDE habitat across the site within bioretention gardens.

### **11.1 ON SITE WATER DEPENDENT ECOSYSTEM CREATION**

POS based bioretention gardens constructed as part of this development will provide some ephemeral wetland type habitat to generalist wetland and riparian species. The construction and planting of these structures can maximise this effect through shaping to create various zones and the use of locally native plants. This can be complemented by utilising native plantings in surrounding streetscape areas.

As such these areas can act as areas for future colonisation by a variety of small fauna and assist with fauna movement between larger natural systems that are being retained on the site and in the surrounding areas. The bioretention garden areas are to include both an understorey of sedges and rushes as well as an overstorey of wetland shrubs. In larger systems, trees may also be incorporated. Species should be chosen from the Vegetation guidelines for stormwater biofilters in the south west of Western Australia, or similar publications.

### **11.2 KADINA BROOK AND WETLAND PROTECTION.**

The Kadina Brook and associated wetland areas will be protected through the management of stormwater within the subject land. This will be achieved by matching pre and post development flows as well as improving the water quality.

Furthermore, the infiltration of water throughout the development, will assist with maintaining groundwater flow into the ecosystems.

Buffers are also to be established between the Brook and wetland to the developed portion. These buffers are to be revegetated, while taking into account the necessary bushfire requirements. This will enhance the current ecosystem values, including its use as a fauna corridor. A Foreshore/wetland management plan should be undertaken as part of future detailed design. The indicative area of POS to provide a buffer to these ecosystems can be seen in Figure 14, with this to be refined within the LWMS.

### **11.3 MOSQUITO MANAGEMENT**

To ensure that the proposed drainage system does not hold standing water unnecessarily over the spring and summer months, all bioretention gardens are to be designed to ensure that drainage flows will be infiltrated in accordance with the design objectives for WSUD. This will minimise the likelihood of ponded water being present during mosquito breeding times.

No new permanent water bodies are proposed for the project, which will reduce the chance of mosquitos breeding in the subject area.

A Mosquito Management Plan is to be undertaken as part of future detailed design to outline appropriate management actions to minimise the risk of mosquitos associated with the adjoining wetland and foreshore area. The treatment of stormwater prior to discharge will assist with reducing mosquito breeding, due to better water quality in these natural systems.

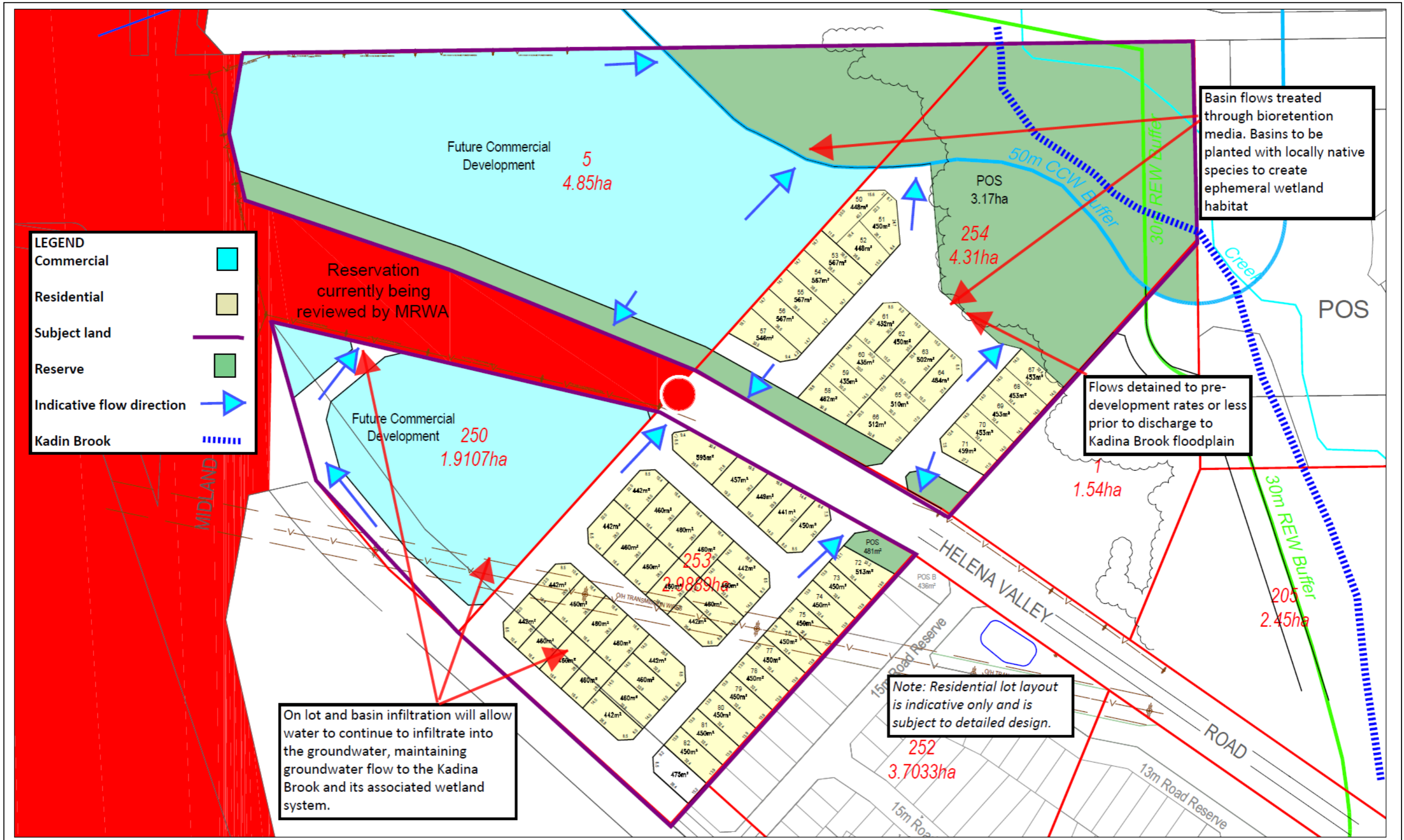


Figure 14 Wetland and waterway protection plan

## 12 MONITORING & MAINTENANCE

The following section provides information on both pre and post-development monitoring undertaken and required. Table 9 also provides a summary of the monitoring requirements.

### 12.1 PRE-DEVELOPMENT GROUNDWATER

Predevelopment groundwater has been collected for the site. A check of the Pre-development superficial groundwater monitoring for the subject land is to be undertaken as part of the LWMS to assist with refinement of the levels, noting that groundwater has not been recorded within 2m of the surface. This will utilise the existing on site bores. The focus is to be monitoring between July and October and April-May to capture the seasonal peaks and lows.

### 12.2 PRE-DEVELOPMENT SURFACE WATER

Additional pre-development surface water monitoring for water quality for Kadina Brook is not considered necessary, given the existing information collected as part of the adjoining development (including a sampling point on the subject land boundary) shows that levels are within ANZECC guidelines.

### 12.3 CONSTRUCTION PHASE

Installation of drainage control structures ahead of the construction phase of the development will be utilised. This will include the use of water sensitive urban design techniques such as sediment curtains, hydro mulching and temporary detention basins to maintain the quality of the water leaving the development area during construction. The bioretention gardens and other WSUD systems will be monitored for any damage, including compaction, sediment build up, oils, and litter during and at the completion of construction to ensure the structure's effectiveness is not diminished. Sediment and litter on roads will be monitored, with removal completed as necessary with street sweeping. To minimise issues with degradation of vegetated treatment systems, it is recommended that planting should be delayed until the risk of high sediment loads has passed.

### 12.4 POST-DEVELOPMENT

The post-development monitoring and maintenance regimes will focus on easy to observe aspects. The following provides guidance on the targets and likely process to be undertaken.

#### WSUD Structural Performance Monitoring

Performance monitoring of WSUD elements will be completed to ensure the system is working effectively. Indicators will be used as a cost effective method to evaluate the adequacies of WSUD performance. It can be assumed that if the WSUD elements operate in accordance to design then the desired management objectives are being met.

The key WSUD elements to be monitored will include:

- Ensuring the inlet and outlet structures are free of debris
- Vegetative cover of the systems is maintained;
- Sediment build up is not impeding the functionality
- Erosion is not present;
- Soils are not compacted;
- Litter is removed;
- Excessive hydrocarbons are not present in the system;
- Weeds are controlled;

- Infiltration of stormwater is maintained to reduce standing water;
- Flows are not excessively detained;
- Stormwater pipes are flowing freely;
- Subsoil pipes are flowing freely
- Water is not being held longer than expected in above of below ground infrastructure

Compared to traditional engineered structures for stormwater runoff management, the WSUD elements require different routine maintenance and these are generally of a landscape maintenance nature. The most common maintenance is the removal of weeds, debris and siltation. The most time intensive period of maintenance for a vegetated WSUD system is during plant establishment (which typically includes two growing seasons), when supplementary watering, plant replacement and weeding may be required. The WSUD elements will be constructed and utilised in different stages so that the functions of the WSUD elements are protected from elevated pollutant loads generated from a developing catchment.

The minor sections of drainage piped network will also require maintenance to make sure they continue to function as designed. This will include rodding, removal of sediments and other debris, as well as the replacement of broken components due to general longterm corrosion and wear.

Maintenance inspections should be conducted after significant storm events (mobilised sediments and coarse material). Inspections should focus on ponding time for the different systems, unequal surface flow distribution and scouring.

A key focus should also be on the control of litter and sediment that is often generated during the building construction phase. This is the most common time when systems are degraded or fail, due to large volumes of pollutants such as non-biodegradable litter, cement fines, direct vehicle compaction, sand movement and other sedimentation issues. Compliance aspects will need to be discussed with the Local Authority, so that rectification of the source problem can be achieved.

#### Groundwater and surface water

The need for post development groundwater and surface water monitoring is to be determined as part of the LWMS and refined within the UWMP. Any monitoring will look at potential changes from pre-development levels and quality as well as any potential impacts on adjoining ecosystems.

### 12.5 REPORTING

All information collected from the monitoring programs should be recorded and provided in a report, prepared by the developer, to the Department of Water and Environmental Regulation and Local Government. The report will compare monitoring results with target design and performance criteria to ascertain what, if any, actions may be required, and will provide ongoing assessment of the suitability of monitoring and reporting strategies. If a trigger value for a contingency action is reached, a more detailed report on the occurrence, its impact and proposed action to prevent recurrence is to be compiled by the developer and submitted to the Local Authority and Department of Water and Environmental Regulation. After 2 years of monitoring for the relevant Stage by the developer, the local authority will become responsible for any further monitoring they wish to undertake

Table 9 Monitoring requirements

Function	Item to Monitor	Purpose of Monitoring	Trigger for Immediate Action	Maintenance Action Required	Monitoring Frequency	Responsible Authority
<b>PRE - DEVELOPMENT</b>						
Water monitoring	Groundwater	Determine maximum groundwater levels/quality	Nil	Nil	Minimum 1 Winter/spring-DONE	Developer
	Surface water	Determine Kadina Brook quality	Nil	Nil	Minimum 1 Winter/spring-DONE	Developer
<b>CONSTRUCTION PHASE &amp; POST-DEVELOPMENT</b>						
<b>Drainage Management Systems and wetland rehabilitation (includes traditional and WSUD systems)</b>	Structural Design	Systems are constructed to engineer detailed design specifications.	System constructed differs to design specifications.	Remedial work to rectify system to meet design specifications.	During and after construction	Developer
	Structural Effectiveness (inlets, traps and outlets)	Inspection for debris, litter and sediments surrounding structural components.	Debris, litter or sediments causing blockages or impairing functions.	Remove any debris or blockages. Inspect system for any erosion related issues.	Every 3 months	Developer until handover to Local Government
	Erosion	Inspection for erosion.	Presence of severe erosion or erosion impairing functions.	Investigate, identify and rectify the cause of the erosion. Replace filter media as required.	Event based (mobilisation of sediments) and a minimum of every 3 months	Developer until handover to Local Government
	Sediment Build Up	Inspection for sediment accumulation within pits, on the surface of bioretention systems and within basins.	Accumulation of large volumes of sediments and/or silts in pits or on the surface (according to Shire standards).	Investigate, identify and stabilise cause of sediment source. Remove accumulated sediments and replace filter media or plants removed.	Event based (mobilisation of sediments) and a minimum of every 3 months	Developer until handover to Local Government
	Compaction	Inspection of filter media for compaction.	Water remains ponding longer than designed in bioretention system after a storm event.	Investigate cause of compaction. If localised, remove top 500mm of filter media, break up the filter and then return to system without any compaction. If extensive seek expert advice.	Every 3 months	Developer until handover to Local Government
	Weeds	Inspection for the presence of weeds.	Weeds are noxious or highly invasive or if weeds cover more than 25% of area.	Manual removal or targeting herbicide application, with waterway approved products.	Every 3 months	Developer until handover to Local Government
	Plant Condition	Inspection of vegetation health and cover, and presence of dead plants.	Plants dying or a pattern of plant deaths.	Investigate cause of plant deaths and rectify. Infill plantings may be required.	Every 3 months	Developer until handover to Local Government
	Organic Litter	Inspection for the presence of organic litter (e.g. leaves) on surface.	Litter coverage is thick or extensive, or detracting from the visual appearance of the system.	Investigate source of litter and undertake appropriate response, e.g. alter landscaping maintenance practices, community education). Remove litter.	Every 3 months	Developer until handover to Local Government
	Rubbish/Litter	Inspection for the presence of litter.	Litter is blocking structures or detracting from the visual appearance of the system.	Identify source of litter and undertake appropriate responses. Remove litter.	Every 3 months	Developer until handover to Local Government
	Oil/Hydrocarbons	Inspection for the occurrence of oil on surface.	Oil coverage persists for more than 3 weeks, and is thick.	Notify the EPA of the spill and clean up requirements.	Every 3 months	Developer until handover to Local Government
	Filter Media	Check that media is draining as designed	Infiltration rate is outside of the design specifications	Replacement of top layer or all of the filter media (depending on issue)	Every 3 months	Developer until handover to Local Government
	Surface Water	Monitor quality of surface water leaving basins	Water quality is significantly outside ANZECC guidelines	Improve treatment train in basin and upstream	Every 6 months	Developer for 2 years.
	Groundwater	Monitor bores for quality and levels	Water quality is more than 20% worse than predevelopment quality. Levels have risen more than 1m	Improve treatment of infiltrating water . If within 2m of the surface, look at possibility of subsoil control	Every 6 months	Developer for 2 years.

## 13 IMPLEMENTATION AND GOVERNANCE PLAN

The implementation of the water management strategies outlined in this report will rely on a range of detailed reports being undertaken, governance frameworks being established and implemented and commitments to on ground works, coupled with long-term maintenance/operations. The following is a summary of the process to achieve implementation.

### INDIVIDUAL DEVELOPER REQUIREMENTS

- As part of the local structure plans, complete LWMS's for the relevant subject land areas
- As part of the subdivision process complete UWMP's for each subdivisional area
- Modelling of all stormwater management systems
- Geotechnical assessments and Acid Sulphate Soil investigations.
- Produce and implement Construction and Sediment Control reports.
- Implement all servicing and drainage infrastructure in accordance with the overarching strategy for the entire subject land.
- Apply appropriate fill and groundwater control structures on site where required.
- The planting of vegetation within the bioretention gardens with appropriate locally native plants and maintenance of the plants until handover to the Local Authority.
- Enhancement of the foreshore areas as required.
- Water sensitive landscaping of the streetscape as approved by the Local Authority.
- Undertake pre and post development monitoring as required
- Undertake monitoring of WSUD infrastructure to assess their performance and respond accordingly for the required monitoring period.
- Provide Design Guidance to lot purchasers with regards to their on-lot obligations for stormwater management

### DEPARTMENT OF WATER AND ENVIRONMENTAL REGULATION REQUIREMENTS

- Review and approval of LWMS
- Provide guidance on the UWMP as requested by the Local Authority.

### DEPARTMENT OF BIODIVERSITY, CONSERVATION AND ATTRACTIONS REQUIREMENTS

- Provide advice and guidance in relation to the foreshore area and associated enhancement of its ecological functioning.

### SHIRE OF MUNDARING REQUIREMENTS

- Review and approval of the LWMS
- Approval of UWMP's
- Responsibility for the maintenance of the internal stormwater system, after handover.
- Maintenance of the foreshore areas so that the ecological water management functions are maintained.
- Ongoing encouragement of Waterwise and nutrient wise practices for lot owners.
- Review and approval of on lot stormwater detention as part of building applications

### WATER CORPORATION REQUIREMENTS

- Review and approval of water servicing.
- Manage the ongoing potable water service to the development.
- Manage the ongoing wastewater servicing from the development.

## 14 REFERENCES

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