# Dardanup Park

Lot 2 Harold Douglas Dr and Lot 185 Venn Rd, Dardanup West

## DISTRICT/LOCAL WATER MANAGEMENT STRATEGY

# DOCUMENT QUALITY CONTROL

| Project Reference | | B21026 |
|---|---|---|
| Ver No. | Purpose | Date |
| V1 | Client Review | January 2022 |
| V2 | Submission for approval | January 2022 |
| | | |
| | | |
| | | |


Oversby Consulting

*Water and Environmental Management*

**Brendan Oversby**
Director

0447 614 411
brendan@oversbyconsulting.com.au
www.oversbyconsulting.com.au
PO Box 369 DARDANUP WA 6236

# Contents



## Figures



## Appendices

# 1 EXECUTIVE SUMMARY

This District/Local Water Management Strategy (D/LWMS) has been prepared to support the future development of Lot 2 Harold Douglas Drive and Lot 185 Venn Road, West Dardanup.

The objective of this D/LWMS 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 waterway. This will include managing, protecting and conserving the total water cycle of the Structure Plan (SP) area and the greater catchment.

The Rezoning and Structure Planning process is being undertaken by Dardanup Park Pty Ltd. They 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 Dardanup and other relevant regulatory authorities. Through this collaboration, the strategies will allow the water management on site to complement the proposed rural residential 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 Dardanup. The site is approximately 84 hectares. It is bordered by the Dardanup townsite to the east, with rural properties to the north and south of the site. The western boundary is shared with rural small holdings properties.

The exact area can be seen in Figure 1.

The area is predominately cleared and used for low intensity agricultural activities and historical flood irrigation in the northern and eastern portions. There is some area of overstorey native trees however the understorey is predominately introduced pasture species

The soil type is generally loam/clays, on the flats with some raised sand dune areas. some small areas of low sand dunes in the northeast. The slopes are generally gentle. Gavin's Gully Main Drain, a degraded natural waterway traverses the site, and forms the main drainage point for the subject land.

The site currently is not serviced with a potable water supply or a mains wastewater.

## PLANNING SUMMARY

This LWMS has been prepared to support the rezoning and structure planning for Lot 2 Harold Douglas Drive and Lot 185 Venn Road, Dardanup. The subject land is currently zoned 'General Farming' under the Shire of Dardanup's Planning Scheme. The area is to be developed for 37 low density rural small holding lots 1 hectare and above. A reserve also is to be created over the on site waterway and surrounding land. A balance lot of 29.78ha will also be created on the eastern portion, with a continuation of its current rural usage. 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.

- Lushfire & Planning (2021) Dardanup Park Bushfire Management Plan
- Accendo Australia (2021) Environmental Assessment Report Lot 2 Harold Douglas Drive and Lot 185 Venn Road Dardanup
- WML Consulting Engineers (2021) Dardanup Park Lot 2 Harold Douglas Drive and Lot 185 Venn Road Dardanup West Site and Soil Evaluation
- WML Consulting Engineers (2021) Dardanup Park Lot 2 Harold Douglas Drive and Lot 185 Venn Road Dardanup Preliminary Geotechnical Investigation
- Oversby Consulting (2012) Lot 2 Harold Douglas Drive and Lot 185 Venn Road Dardanup Groundwater Monitoring Report

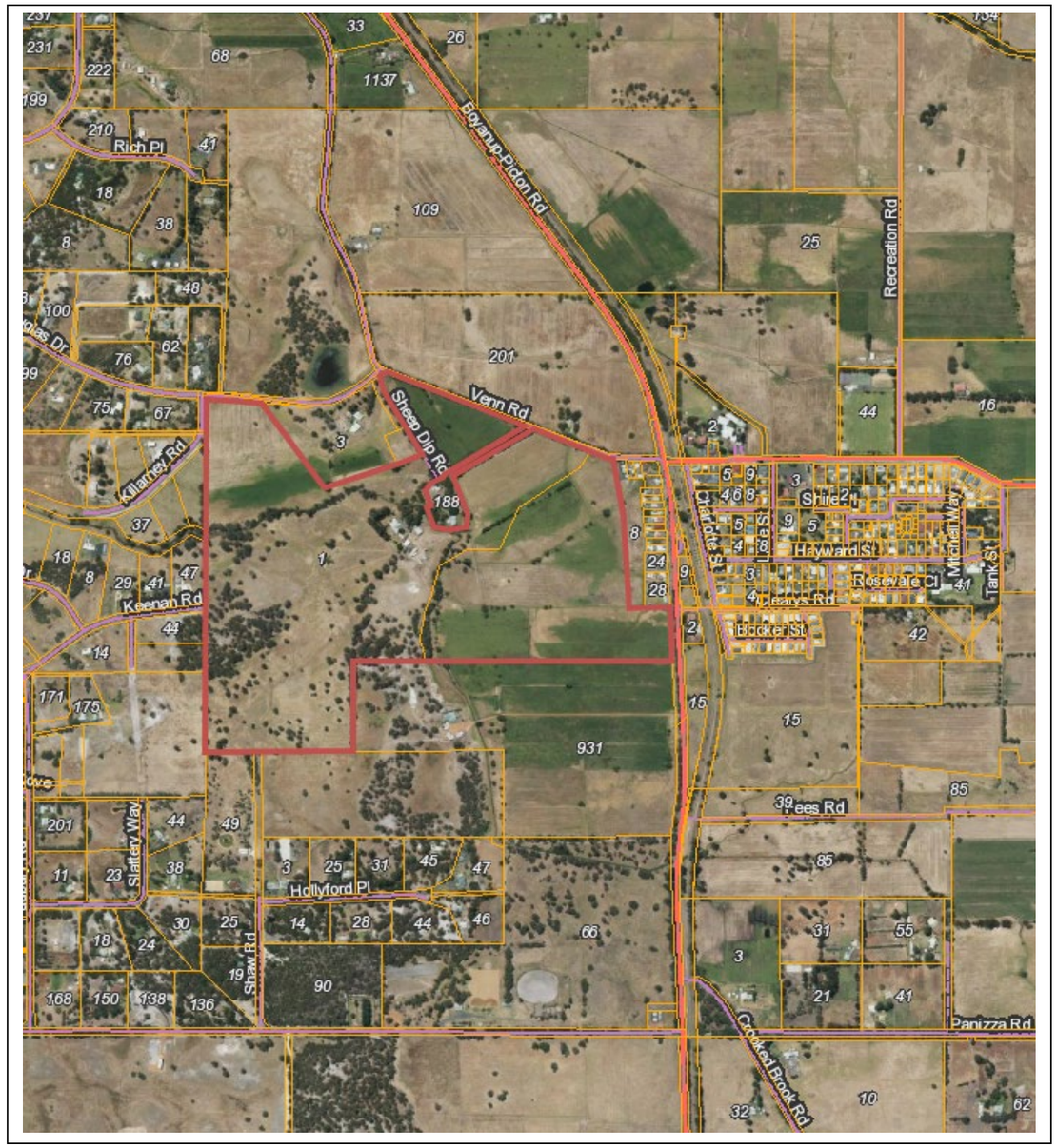



Figure 1 Location plan

# 2 KEY ELEMENTS PLAN

The water management strategies for the subject land are based on best practice water sensitive urban designs that integrate sustainability and the provision of functional residential areas. 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.

## WATER CONSERVATION AND SERVICING

- All houses are to supply their own water, predominately through rainwater capture. Tank Storage is to be a minimum of 120kl.
- Each lot to treat its effluent to a standard that minimises the risk for pollution to the downstream systems. All treatment is to be in accordance with the approved Site and Soil Evaluation report.
- Private, standalone fire fighting water tanks for each lot are to be encouraged. Water is supplied by individual lot owners. These tanks will be additional to strategic tanks for bush fire fighting in the locality (managed by the Shire of Dardanup).

## STORMWATER MANAGEMENT

- The swale network and detention basins volumes provide suitable detention volumes so that all new roads are able to limit the flow rate off the site to the Water Corporation Standard of 8.5$m^3$/s/1000hectares.
- The detention outlets have been designed so that they also allow flow off the entire development at pre-development rates.
- Detention basins will be planted with suitable native species while roadside swales will be grassed.
- All lots will detain part of the peak flow off the roof within a 1KL air gap within their rainwater tanks. A link to the roadside drainage system is not envisaged to be necessary.

## FLOOD PROTECTION

- All building pads will be designed to maintain a minimum separation clearance of 300mm between the habitable floor levels and the relevant 1%AEP flood levels on roads (assumed to be the crest of the road).
- All relevant lots are to have a finished floor level a minimum of 500mm above the 1%AEP flood level for the on site waterway, which is assumed to be 200mm above the top of the main channel bank.
- The drainage network will flow at capacity and excess water will be directed down the road reserves and drainage reserves to protect houses and other infrastructure.

## GROUNDWATER MANAGEMENT

- Inflows to the groundwater from the road network will predominately be treated through the vegetated swales.
- Filling building pads and infrastructure sites will be undertaken where necessary so that adequate clearance is maintained between average annual maximum ground water level (AAMGL) or controlled groundwater level (CGL) and finished surface level.
- Groundwater within the road reserve will be controlled via the roadside swales and filling of the pavement area.
- Groundwater discharge regimes are to be maintained so that there are no negative impacts on the subject land or downstream significant ecosystems.
- Each lot to treat its effluent to a standard that minimises the risk for pollution to the groundwater. All treatment is to be in accordance with the approved Site and Soil Evaluation report.

## WATER DEPENDENT ECOSYSTEM MANAGEMENT

- Water sensitive urban designs (WSUD) will include grassed swales and planted detention basins to capture sediments, large debris and nutrients from all water runoff from impervious surfaces.
- The on site waterways are to be rehabilitated with native vegetation planting and weed control.
- New ephemeral wetland and waterway habitat will be created through the appropriate planting with native vegetation within the detention basins. This will be complemented by the protection of existing on site vegetation, and planting of new vegetation along the waterway to enhance habitat creation and fauna linkages.
-

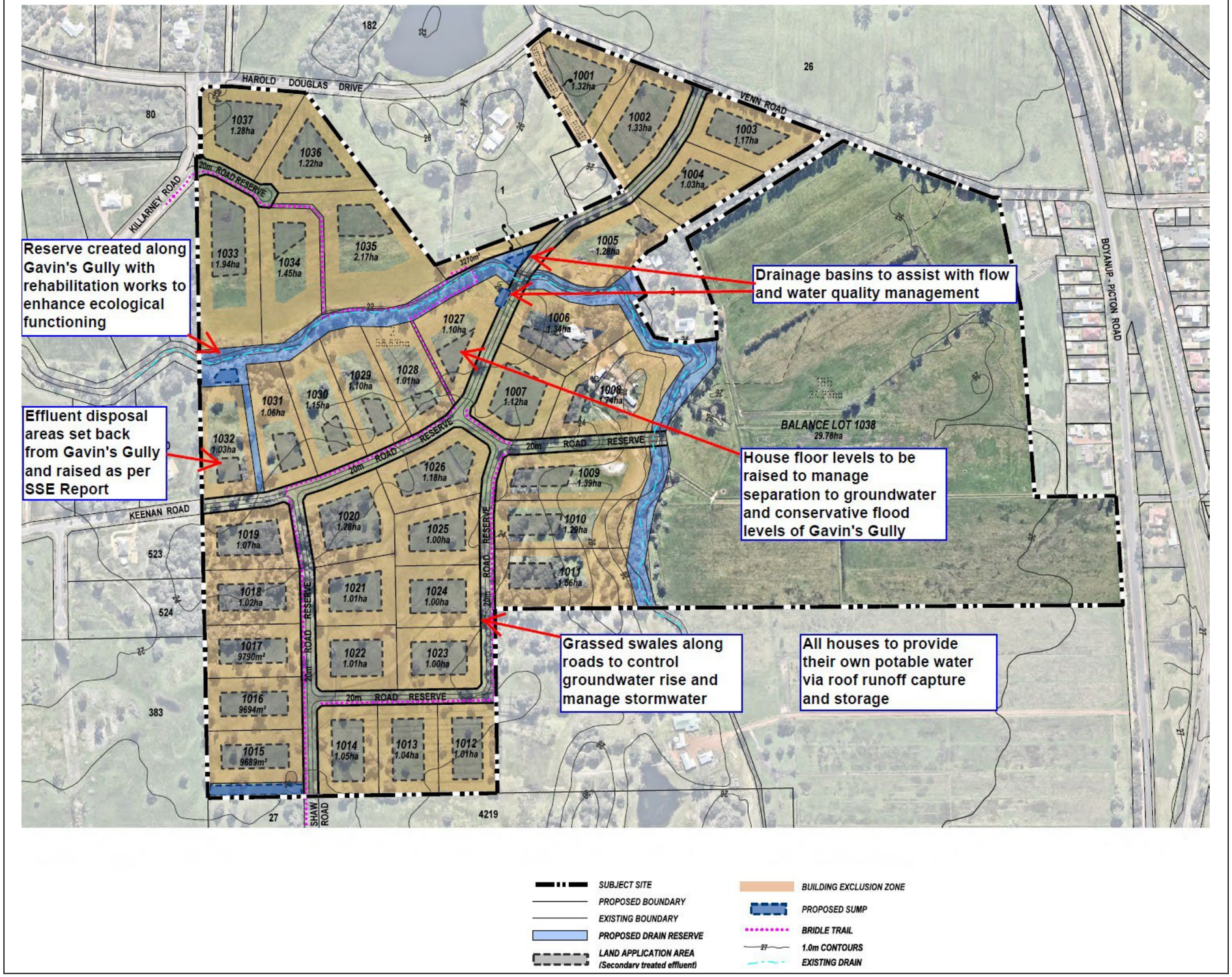



Figure 2 Key Elements Plan

# 3 LANDFORM PLAN

The subject land is composed of low to medium sand dunes as well as flat loam flats. Approximately dividing these main landforms is Gavin's Gully Main Drain.

The following is a summary of these landform areas. Figure 3 shows these landforms diagrammatically.

**Sand dune and interdunes**

In the south west of the subject land there are 2 sand dune systems. The western system rises to approximately 25.2mAHD. The eastern dune system rises to approximately 29mAHD. Between these lies a winter wet interdunal flat. This flat is generally between 21.5mAHD and 23mAHD, with grades approximately 1:500 to 1:1000. This area contains a number of shallow rural drains which partially drags water northward to Gavin's Gully or its historical side gullies.

**Flat Loam Plains**

The loamy plains predominately occur in the north and east of the subject land. In the east they grade towards the west and discharge into Gavin's Gully (from 25.8mAHD to 24m AHD). Much of this area has previously been levelled to facilitate flood irrigation. In the north east the plain generally slopes to the north and onto current drains on Venn Road (24.4mAHD to 22.8mAHD). In the north west area the plain slopes to the west, where it discharges either into Gavin's Gully or the neighbouring rural residential land or its associated roadside drainage (23mAHD to 21.4mAHD). The north and north west sections are divided by a sand dune that sits outside the subject land.

**Gavin's Gully**

Gavin's Gully is the main water feature of the site. It enters the site in the south east of the site, traveling northward. Towards the middle of the site, it turns 90 degrees to the west. It eventually discharges off the site via the western boundary. The gully generally sits 1.5m to 2.5m below the surrounding area. While historically a natural channel, it is likely that it has had some training and excavation to assist with its ability to manage stormwater. There are some small areas of coffee rock which result in low rapids within the channel base. There are at least 2 bridge crossings.

Gavin's Gully forms part of the Water Corporation's rural drainage infrastructure. Just downstream of the subject land it becomes a highly modified drain which eventually discharges to the Preston River.

**Other water bodies.**

There are 3 small soaks located in the interdunal area. These are generally 1.5m lower than the surrounding ground. They tend to be filled to the surface in Winter/early spring.

*Soak in winter wet interdunal area*

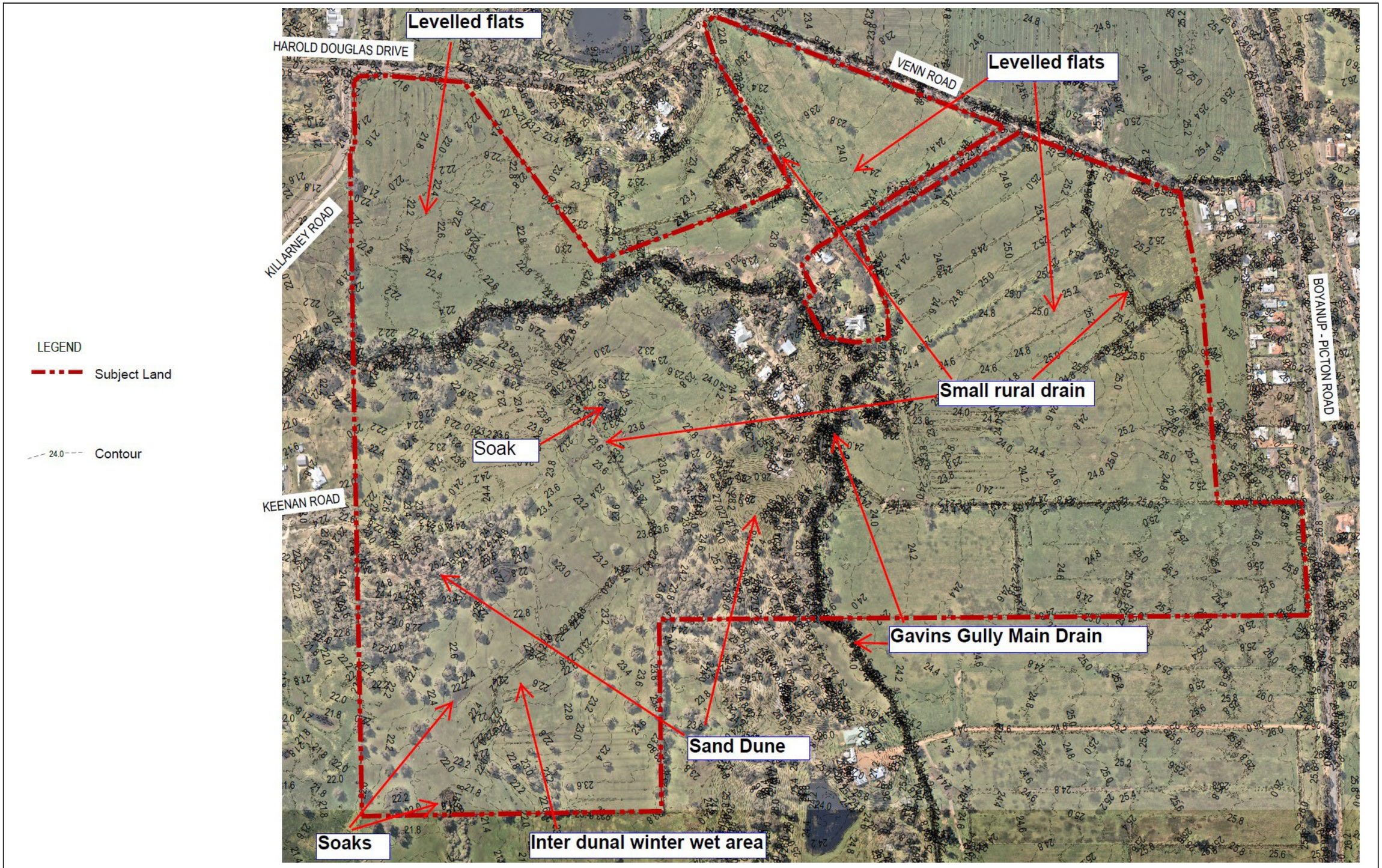



Figure 3 Current Landform

# 4 GEOTECHNICAL PLAN

A preliminary geotechnical investigation was undertaken for the subject land by WML Consulting Engineers, with the findings outlined in the report titled *Lot 185 Harold Douglas Drive and 1 (Lot 2) Harold Douglas Drive, Dardanup West Preliminary Geotechnical Investigation* (2021). Further investigations to the guidelines of the Government Sewage policy were also undertaken and recorded in *Lot 185 Harold Douglas Drive and 1 (Lot 2) Harold Douglas Drive, Dardanup West Site-And-Soil Evaluation* (SSE)

The site works were undertaken in September 2021 and included excavating 20 test pits to a depth of between 1.2m and 2.5m. Test pit locations can be seen in Figure 4.

## 4.1 Soil Conditions

The site can be broken down into three zones based on the geology of the existing soils:

**Zone 1: Bassendean Sand**

This zone comprises low dunes of SAND (SP), generally fine to medium-grained, pale grey, grey and pale yellow mottled grey, but also yellow and yellow-orange, generally loose to medium dense, moist to wet and typically encountered to the test pit termination depths of between 1.6 m and 2.1 m below ground surface. At three test pit locations (TP 7, 14 and 16), an indurated sand layer was observed at the end of the test pit, commonly called 'Coffee Rock'. This layer wasonly visually identified immediately prior to the test pit collapse or was excavated as sand/gravel/cobble mix until test pit collapse.

**Zone 2: Guildford Formation**

This zone comprises mainly Alluvium represented by the variable type of soils, including Sandy CLAY (CL, CI, CH), Clayey SAND (SC), SAND (SP) and CLAY (CI, CH). There was no consistency in the structure of the layers or their thickness. The soils were typically brown mottled orange and grey, with a trace of fine-grained gravel, moist to wet, soft to very stiff (clays), or loose to dense (sands). At TP 1 and TP 2, Clayey SAND and Sandy CLAY with fine to medium-grained lateritic gravel were encountered from a depth of 2.1 m and 1.6 m, respectively.

A soft ORGANIC CLAY layer (OL) was encountered in TP 23 below the topsoil layer, to a depth of 0.9 m below the ground surface.

**Zone 3: Shallow Bassendean Sand over Guilford Formation**

This zone was observed only in one test pit, TP 1, and comprised SAND (SP) to a depth of 0.9 m below the ground surface underlain by 'Coffee Rock' excavated as Sandy GRAVEL (GP) to a depth of 1.3 m, which in turn was underlain by Sandy CLAY (CH) and Clayey SAND (SC) of Guilford Formation to the test pit termination depth of 2.5 m.

Topsoil was encountered at all test pit locations to a depth of between 0.1 m and 0.45 m below the existing ground surface.

## 4.2 Permeability

Four in-situ permeability tests were undertaken adjacent to TP 6, TP 8, TP 16 and TP 18 locations for the geotechnical investigation. Boreholes 90 mm in diameter and 500 mm depth were excavated and filled with water to saturate the surrounding soil. A constant head ofwater was applied, and a known volume of water was timed to dissipate. Generally, the permeability of the soil decreased with each successive test. No change in water level was observed adjacent to TP 18, potentially due to fully saturated soils. The results are tabulated below In Table 1. The permeability results indicate that the material encountered across the site is indicative of weakly to moderately structured loams in AS NZS 1547:2012.

Table 1 Summary of constant head hydraulic conductivity test results

| Location | Insitu Permeability Test | |
|---|---|---|
| | m/s | m/day |
| TP 6 | $7.84*10^{-5}$ | 6.77 |
| TP 8 | $8.09*10^{-5}$ | 6.99 |
| TP 16 | $6.28*10^{-5}$ | 5.43 |
| TP 18 | Not recorded | Not recorded |

## 4.3 Acid Sulphate Soils

Forty-six (46) field test results were assessed using the following criteria:

- $pH_f$ less than 4;
- $pH_{fox}$ less than 3;
- The change in pH was greater than 2;
- There was a strong reaction following the addition of hydrogen peroxide;
- A sulphurous smell was present during sampling;
- Dominant vegetation on site is characteristic of vegetation tolerant to salt, acid and/or waterlogging.

The presence of Actual Acid Sulfate Soils (AASS) is indicated by $pH_f$ value of less than 4. The results of this investigationdid not identify any samples with a $pH_f$ less than 4 requiring the assessment of further ASS indicators to determine if Potential Acid Sulfate Soils (PASS) are present on site.

Twenty (20) samples from seven (7) test pits indicated that Potential Acidic or Acid Sulfate Soils might be present at the site.

According to the "Identification and Investigation of Acid Sulfate Soils and Acidic Landscapes" guideline prepared by DWER (former DER) in June 2015, Bassendean Sands, whilst perhaps not fitting the traditional description of ASS, nonetheless have some acid generating potential and can release a significant amount of acidity and/or iron when disturbed. These soils have many of the same properties as ASS and should be investigated and managed as ASS wouldbe.

It is recommended that detailed ASS investigation, including chromium reducible sulphur testing, is performed within the areas where soil disturbance is likely.

## 4.4 Phosphorus Retention Index

Phosphorous Retention Index (PRI) indicates the ability of the subject land's soils to absorb and treat nutrients within the soil (soil microbe disinfecting ability).

All sites had medium to very high abilities to absorb phosphorus. The results can be seen in Table 2.

Table 2 Summary of PRI testing

| Location | Depth (m) | Phosphorous Retention Index |
|---|---|---|
| **TP 4** | 0.5 | 30 |
| **TP 5** | 0.5 | 51 |
| **TP 9** | 0.5 | 520 |
| **TP 13** | 0.5 | 174 |
| **TP 15** | 0.5 | 0.2 |
| **TP 18** | 0.7 | > 1000 |
| **TP 21** | 0.5 – 0.7 | > 1000 |
| **TP 24** | 0.5 | 383 |
| **TP 25** | 0.5 – 0.6 | > 1000 |
| | | |

## 4.5 Groundwater

At the time of the investigation fieldwork (beginning of September 2021), groundwater seepage was observed in 12 of the 20 test pits at depths between 0.6 m and 1.5 m below the existing ground surface.

No stabilized water table was observed during the investigation.

Based on the information provided by the Client, ten (10) groundwater monitoring wells were installed on site in the past, with the maximum recorded groundwater levels for 2021 (20 September 2021) between 0.13 m and 1.33 m below existing ground level.

A large portion of the site is susceptible to seasonal waterlogging due to the clayey nature of the topsoil within those areas and/or the underlying clay layer on top of which stormwater is ponding during the wet season and during/following heavy rainfall events. Therefore, groundwater is expected to influence the proposed development.

For the design of the drainage system, the pre-development peak groundwater level shall be considered at the existing ground surface for the majority of the site, except the elevated sand dune area located within the south-eastern portion of the site.

## 4.6 Suitability for on-site effluent disposal

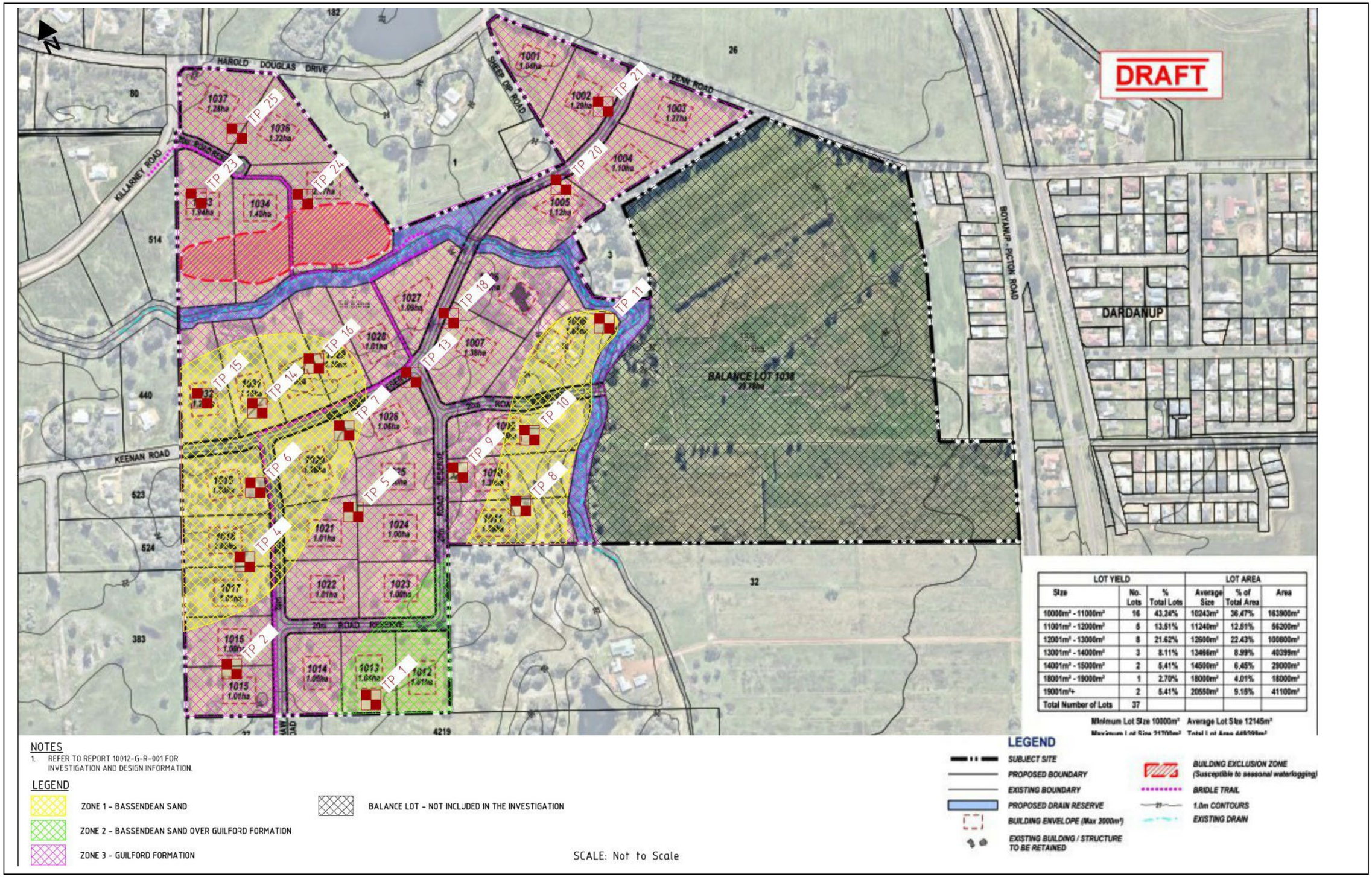
The soil survey indicated that there are two typical sub-surface soil profiles that categorise the site: delineated within Zone 1 and Zone2. A summary of both zones can be seen in Table 3 and 4, with the zones represented diagrammatically in Figure 5.

Table 3 Soil assessment of the Zone 1 – sand sub-soils.

| Feature | Assessment | Level of Constraint | Mitigation Measures |
|---|---|---|---|
| **Phosphorous Retention Index** | Clean sand: PRI = <5 | Medium | The phosphorus retention ability ofthe sand is limited, clay should be imported to the site and blended with the existing sands. |
| **Rock Fragments** | Rock fragments were not encountered. | Low | NN |
| **Soil Depth** | Topsoil: ≤ 150mm | Low | NN |
| | Subsoil: >150 mm | Low | NN |
| **Soil Permeability** | SAND: Saturated hydraulic conductivity ($k_{sat}$) < 2.0 m/day. | Low | The subsoil is moderately permeable; consideration to begiven to transport of effluent through the soil |
| **Soil Category** | Subsoil (>150 mm): clean sand (Category 1) | Low | NN |
| **Water Table Depth** | Groundwater was not encountered within 2 m of the surface during the August 2021 investigation. | Low | NN |

Table 4 Soil assessment of the Zone 2 clayey sub-soils

| Feature | Assessment | Level of Constraint | Mitigation Measures |
|---|---|---|---|
| **Phosphorous Retention Index** | Sand with clay subsoil: PRI = 30<br>Clayey sand to clay subsoil: PRI = 51 to >1000 | Low | The clayey sand subsoil is suitable for nutrient retention |
| **Rock Fragments** | No coarse fragments we encountered during the investigation | Low | NN |
| **Soil Depth** | Topsoil: <300 mm | Low | NN |
| | Subsoil: >300 mm. Total permeable soil depth greater than 2.0 m | Low | NN |
| **Soil Permeability** | Clayey sand to clay: Saturated hydraulic conductivity ($k_{sat}$) >1.0 m/day. | Low | NN |
| **Soil Category** | Subsoil (>200 mm): clayey sands (Category 2) to clay (Category 4) | Medium | The subsoil should be considered to be a low permeability soil |
| **Water Table Depth** | Groundwater was encountered between from 0.0 - >1.8 m | High | Imported fill must be used to maintain minimum groundwater clearance to theeffluent discharge point of 1.5 m |




| LOT YIELD | | | LOT AREA | | |
|---|---|---|---|---|---|
| Size | No. Lots | % Total Lots | Average Size | % of Total Area | Area |
| 10000m² - 11000m² | 16 | 43.24% | 10243m² | 36.47% | 163900m² |
| 11001m² - 12000m² | 5 | 13.51% | 11240m² | 12.51% | 56200m² |
| 12001m² - 13000m² | 8 | 21.62% | 12600m² | 22.43% | 100800m² |
| 13001m² - 14000m² | 3 | 8.11% | 13466m² | 8.99% | 40399m² |
| 14001m² - 15000m² | 2 | 5.41% | 14500m² | 6.45% | 29000m² |
| 18001m² - 19000m² | 1 | 2.70% | 18000m² | 4.01% | 18000m² |
| 19001m²+ | 2 | 5.41% | 20550m² | 9.15% | 41100m² |
| Total Number of Lots | 37 | | | | |

Minimum Lot Size 10000m² Average Lot Size 12145m²

NOTES
1. REFER TO REPORT 10012-G-R-001 FOR INVESTIGATION AND DESIGN INFORMATION.

LEGEND
- ZONE 1 - BASSENDEAN SAND
- ZONE 2 - BASSENDEAN SAND OVER GUILFORD FORMATION
- ZONE 3 - GUILFORD FORMATION
- BALANCE LOT - NOT INCLUDED IN THE INVESTIGATION

SCALE: Not to Scale

LEGEND
- SUBJECT SITE
- PROPOSED BOUNDARY
- EXISTING BOUNDARY
- PROPOSED DRAIN RESERVE
- BUILDING ENVELOPE (Max 2000m²)
- EXISTING BUILDING / STRUCTURE TO BE RETAINED
- BUILDING EXCLUSION ZONE (Susceptible to seasonal waterlogging)
- BRIDLE TRAIL
- 1.0m CONTOURS
- EXISTING DRAIN

Figure 4 Geotechnical bore holes and testing locations

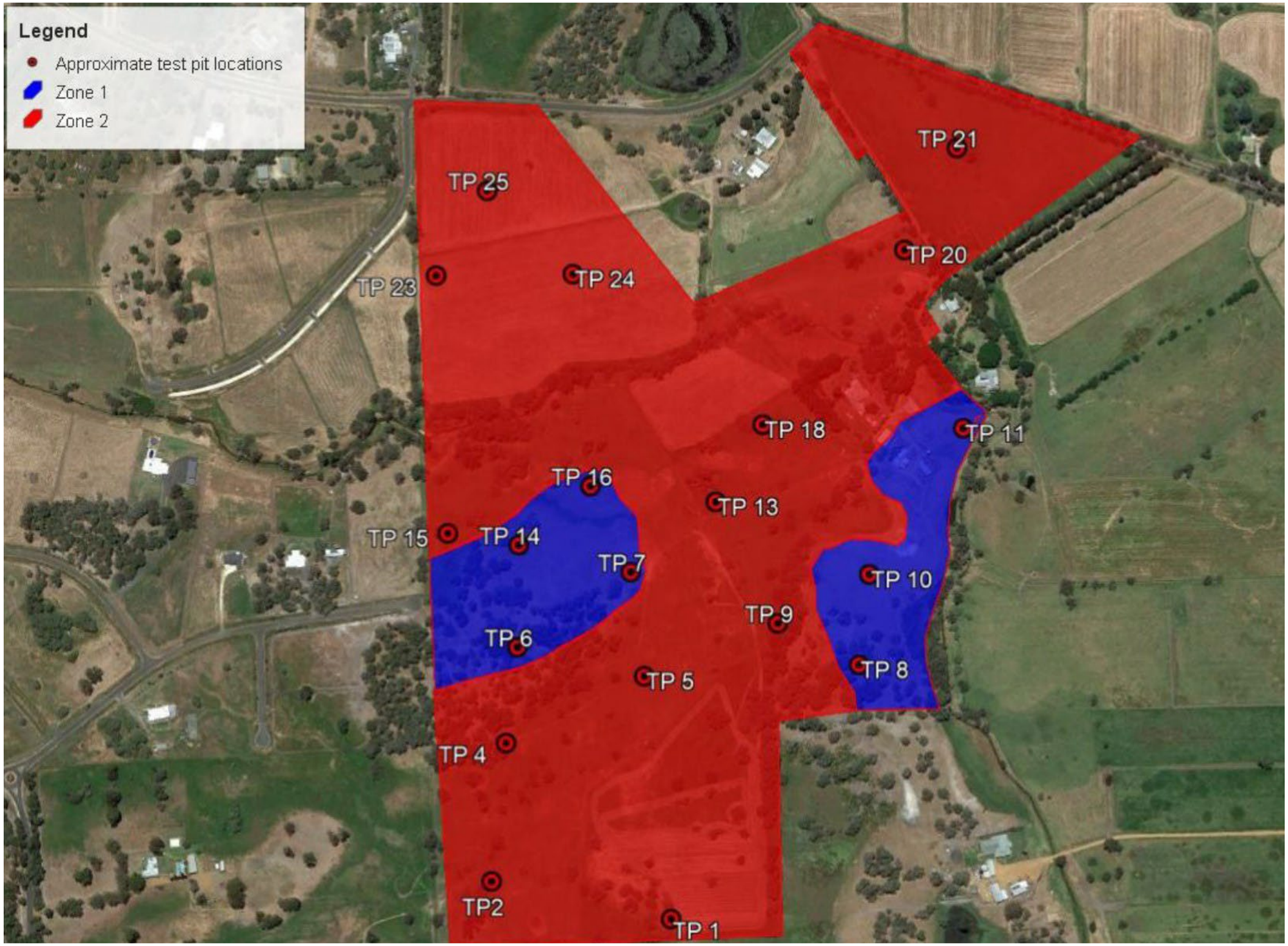



Figure 5 Site and Soil Report mapped zones

# 5 ENVIRONMENTAL CONDITIONS

An environmental assessment was undertaken for the subject land in 2021 by *Accendo Australia*. A site visit was also conducted by Oversby Consulting in 2021 to understand the environmental aspects related to water management. The following is a summary of the water related environmental values, which can also be seen visually in Figure 6.

## 5.1 CONSTRUCTED WATERBODIES

There are 3 small soaks within the south west interdunal area. The soaks have limited ecological value as they contain very little to no native vegetation (one contains some *Melaleuca rhaphiophylla*). They likely provide some low-quality habitat to generalist aquatic species and water birds.

## 5.2 WETLANDS

The Subject site is mapped as containing three Multiple Use (MU) wetlands (UFI 14,329, 15,221 and 1,757), with these effectively being palusplain in nature (Figure 8). These have limited vegetation or ecological value, as they are predominately cleared paddocks, with some isolated *Corymbia calophylla*, *Eucalyptus rudis, Agonis flexuosa* and *Melaleuca rhaphiophylla* trees. There are some isolated *Juncus pallidus* and *Juncus subsecundus* clumps.

## 5.3 WATERWAYS

The Gavin's Gully Waterway is highly degraded. It does contain  line of trees with isolated shrubs along its banks. These are predominately *Eucalyptus rudis, Agonis flexuosa* and *Melaleuca rhaphiophylla* trees with some isolated *Acacia saligna* shrubs. The understorey is predominately composed of pasture species and Watsonia.

There are some areas of erosion due to the lack of vegetation along the base of some sections.

Due to the release of irrigation water, the waterway maintains a low flow for the majority of the year.

## 5.4 VEGETATION

The majority of the area has been cleared for agricultural uses and is now covered in pasture species. The remaining vegetated is generally considered to be completely degraded and predominately composed of mature trees over pasture.  The subject site includes one vegetation complex as defined by Mattiske and Havel (1998) including:

• Dardanup Complex: Mosaic of vegetation types from adjacent complexes, which includes the Southern River Complex and Guildford Complex. The Dardanup Complex is made up of a woodland with majority of *Eucalyptus marginata* (Jarrah), *Corymbia calophylla* (Marri) and *Eucalyptus wandoo* (Wandoo) species.

There is some general garden and exotic species around the house and shed area.

The significant trees can be seen in Figure 7.

## 5.5 FAUNA

A fauna assessment has been undertaken for the subject land by Greg Harewood, for Accendo, with field work in October and November 2021 consisting of  both day and night surveys.

The fauna habitats present range from completely degraded (cleared pasture) to degraded, largely a consequence of historical clearing and livestock grazing over many years. Given the degree of disturbance the original fauna assemblage within the survey area is likely to be depauperate in many aspects, in particular with respect to ground dwelling species which rely on dense native understory (midstorey and ground cover) vegetation, which is almost absent or very sparse in most areas.

Despite the history of disturbance the areas of more coherent remnant vegetation are still likely to be utilised in some fashion be a reasonably wide range of species though most would be relatively common and widespread bird species. Forty fauna species (mainly common bird species) were observed or secondary evidence of their presence recorded during the field survey.

A total of 204 potential black cockatoo breeding "habitat trees" were identified within the survey area. The vast majority of these trees (149) appeared to not contain hollows of any size. Fifty one (51) trees contained apparent or obvious hollows, all of which were assessed as being unlikely to be suitable for black cockatoos to currently use for nesting purposes, due to the hollows apparent small size, unsuitable orientation and/or low height above ground level. Four trees (4) appear to contain at least one hollow considered potentially suitable for black cockatoos to use for nesting purposes but this was not confirmed in any instance and no actual signs of use were noted.

Quality black cockatoo foraging habitat within the survey area can mainly be defined as the areas containing marri. It is not possible to define the area of this resource as the trees are generally scattered amongst other species such as peppermint and flooded gum, but the total area is likely to be relatively small. No evidence of black cockatoos roosting within the survey area was noted.

The only evidence of western ringtail possums observed during the day and night surveys survey were a small number of old scats found under a tree along Gavin's Gully.

No evidence of any other fauna species of conservation significance identified during the literature review was observed. However, this does not eliminate the potential for some species to still occur, if only infrequently.

In summary one vertebrate fauna species of conservation significance were positively identified as utilising the survey area:

- Western Ringtail Possum - Critically Endangered (WA/Federal)The limited area of the riparian vegetation areas means that it is likely that waterway and wetland dependent fauna species using the site will be generalist in nature.

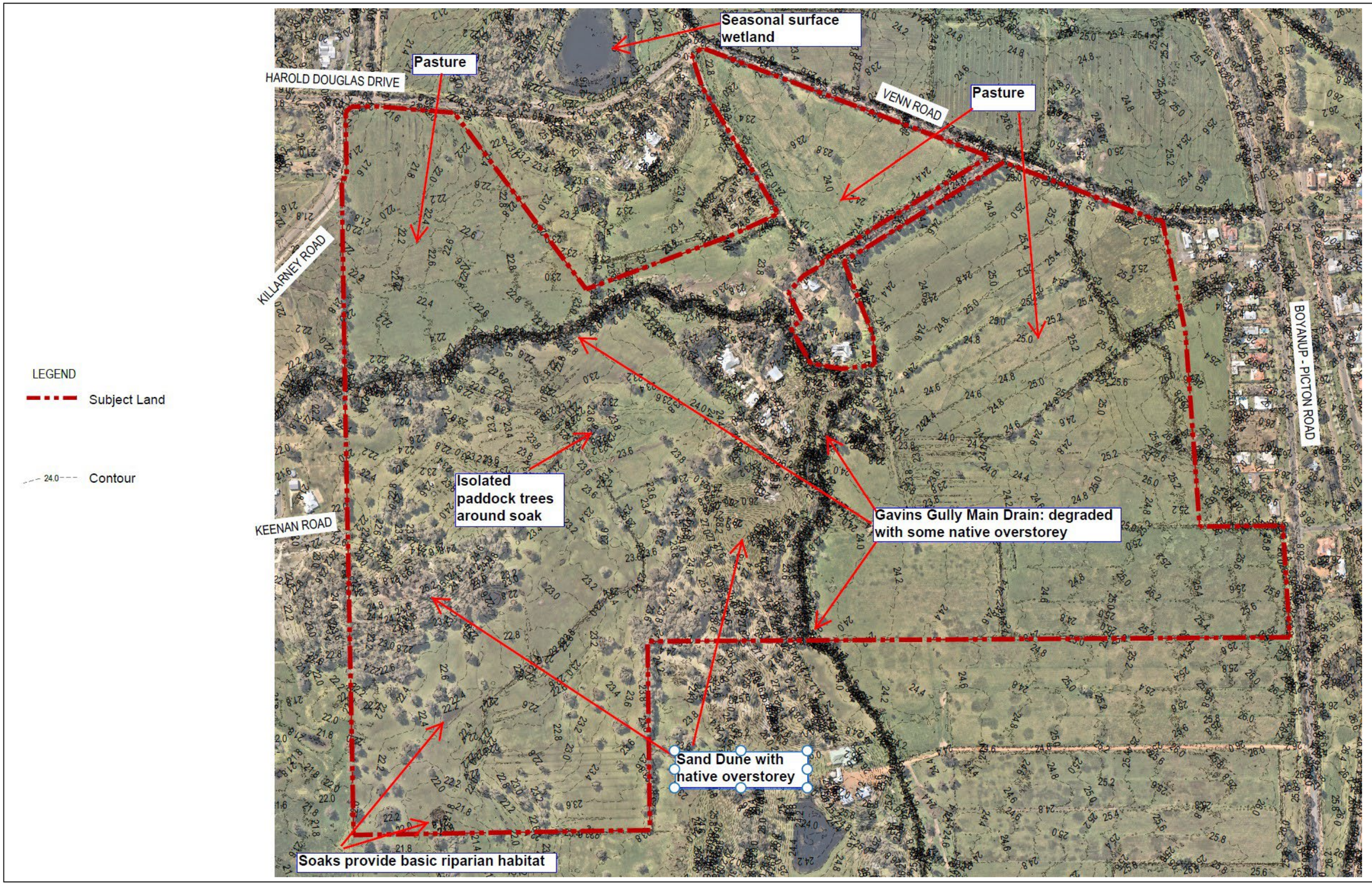



Figure 6 Environmental characteristics of subject land and surrounds

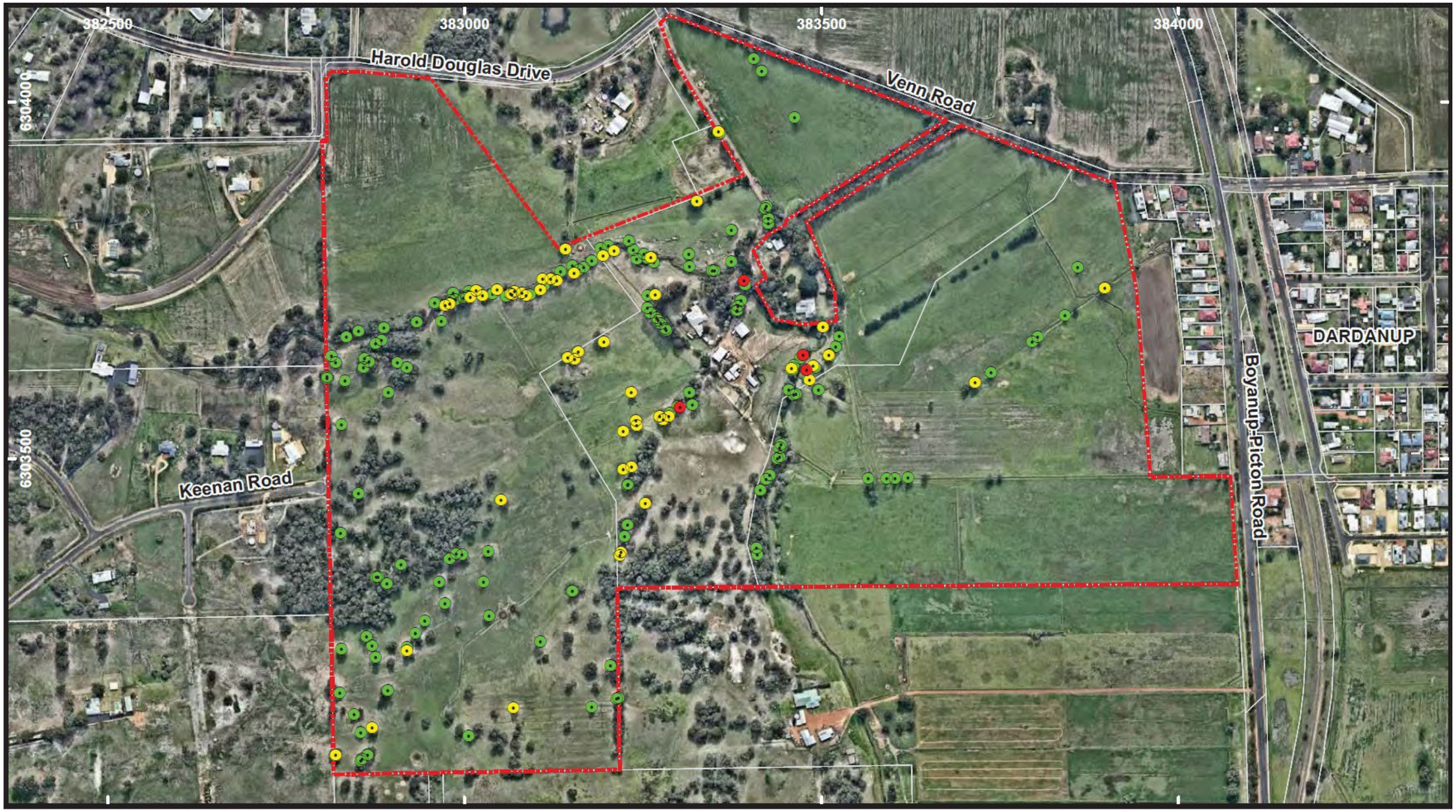



Figure 7 Habitat trees

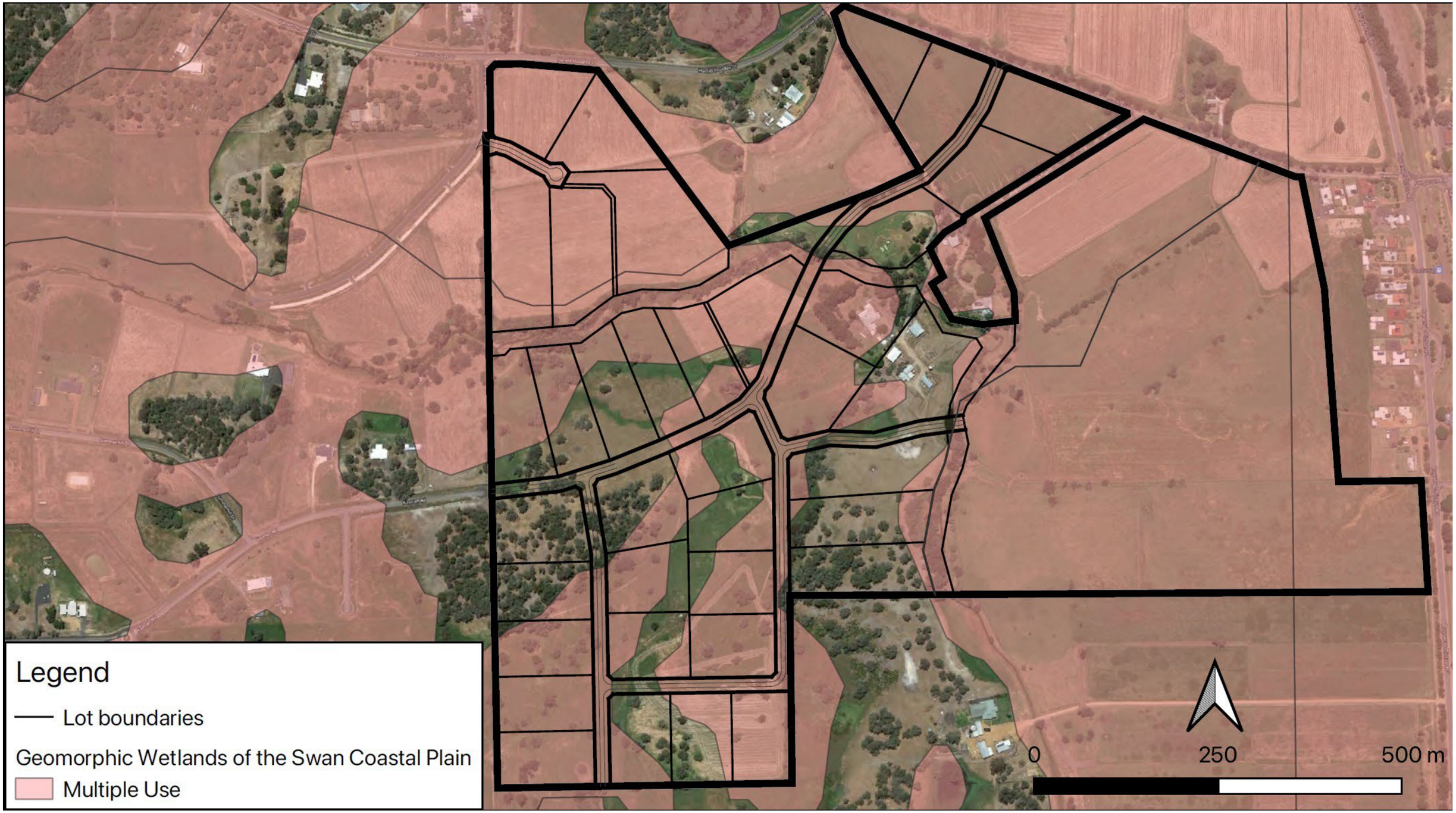



Figure 8 Geomorphic Wetlands

# 6 SURFACE WATER PLAN (PRE-DEVELOPMENT)

The subject land is within the greater Preston River catchment.

There is little surface run-off from the sandy portions of the site, except for the low sandy areas where groundwater rises close to the surface. The heavier soils on the flats will tend to run after moderate rainfall, noting that the pasture assists with capturing and slowing flow.

Most of the surface water on subject land that doesn't infiltrate directly, flows into the waterway of Gavin's Gully, noting that some land also drains northward to Harold Douglas Drive/Venn Road and a portion southward to adjoining farmland and the unmade Shaw Road reserve.

The pre-development subject land has been divided into 8 sub-catchments. These catchments reflect where water generally flows towards. The catchments can be seen in Figure 9, while their areas and other details can be seen in Table 5.

Generally, there are 2 catchments (1 and 2) that flow north to Harold Douglas Drive/Venn Road, where they enter existing road side drains. 5 catchments contribute flows to Gavin's Gully (3-7), with Catchment 6 flowing into catchment 5 before discharging into the gully.

1 Catchment (8) currently flows completely southward, to discharge into neighbouring farmland and the unmade Shaw Road reserve.

It is also noted that Catchment 6 likely historically flowed southward too. A small rural drain, that is currently considerably blocked, diverts this flow into Catchment 5. It is likely however that from time to time, as the drain becomes even more blocked, that the flow turns south again. For this reason an analysis was undertaken of the likely total flow south under these conditions.

## 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 industrial 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 and 1% AEP events. Furthermore, for the road reserves, an analysis was undertaken to determine the level of storage that would be needed to choke flows back to the Water Corporations design rate of 8.5m3/s/1000ha for all events up to and including the 1%AEP.

The key modelling assumptions included:

- Areas containing standing surface water due to high groundwater were treated as impervious areas. They were assumed to have an Retardance coefficient of 0.019 to reflect some minor resistance to flows.
- Areas containing saturated pasture, but not inundated were considered supplementary impervious areas, as they are likely to contribute significant flows during the 20% and 1% AEP event situations.
- It was assumed that there was no back flow, as the flows off the subject land peak prior to the flow off Gavin's Gully, and flows to the north and south were assumed to be at natural surface (rather than the base of any drains).
- No on site storage volumes were modelled as investigations over the winter and spring show that all storages were full to the surface.
- The minor drains were not modelled, as they are generally less than 0.3m deep and much of the sites water does not directly flow to them.
- Non-inundated grass areas were assumed to have a Retardance coefficient of 0.2
- Building rooves were assumed to have an Retardance coefficient of 0.013 to reflect the more likely rapid discharge during these larger events, when gutters overflow.
- Hardstand areas, and the inundated areas were assumed to have an Retardance coefficient of 0.019 to reflect some minor resistance to flows.
- The storms modelled were the15min, ,30min, 1 hr, 2hr, 6 hr, 12hr, 24hr and 48hr. These were modelled for the 20% AEP and 1%AEP.
- The results are outlined in Table 5.

Table 5 Pre-development Flow summary

| Catchments | Area | Flow Discharge Direction | 20% AEP max (m3/s) | 1% AEP max (m3/s) | Comments |
|---|---|---|---|---|---|
| **1** | 2.92 | North | 0.318 | 0.633 | Harold Douglas road drain |
| **2** | 3.2 | North | 0.35 | 0.695 | Harold Douglas and Venn Road drain |
| **3** | 5.5 | Gavins Gully | 0.614 | 1.21 | Direct discharge, with some likely flow westward to adjoining development (Killarney Glen) |
| **4** | 3.1 | Gavins Gully | 0.277 | 0.629 | Direct discharge |
| **5** | 15.5 | Gavins Gully | 2.59 | 6.41 | Direct discharge |
| **6** | 16.2 | Cat 5 | 1.67 | 3.98 | Flows into Cat 5 via small drain |
| **7** | 3.26 | Gavins Gully | 0.035 | 0.286 | East of main sand dune |
| **8** | 3.2 | South | 0.197 | 0.576 | Overland flow south |
| **Total to Gavins Gully** | 43.56 | | 3.516 | 8.535 | Combine Catchments 3-7 |
| **Total** | 52.88 | | **4.381** | **10.439** | |
| ***Former catchment to south (or when drain blocked - currently partially blocked)*** | *19.4* | *South* | *1.87* | *4.56* | *Combines Catchments 8 and 6* |

## 6.2 Flood analysis of Gavin's Gully

The subject land is located within the area affected by potential flooding of Gavin's Gully. There is no known flood modelling of the waterway, which is registered as a Water Corporation Main Drain. Technically the waterway has been cleaned out and deepened to accommodate the Water Corporation's management rate of 8.5m$^3$/s/1000ha. It is noted that at the point where the water turns westward the size of the channel width increases greatly, although it does maintain some characteristics of a natural waterway including a slightly meandering nature and isolated trees. Just downstream of the subject land, the waterway has been channelised into a typical drain. Pictures of the waterway, that show the increase in channel size can be seen below.

Anecdotal evidence is that the waterway rarely floods outside of the main channel. The broad flat nature of the surrounding plain means that any flood waters are likely to spread sideways in a shallow flow. The sand dune along

the eastern boundary also effectively protects the eastern portion of the proposed development from flooding out of the waterway. A conservative level of 0.3m above the top of the main channel bank has been assumed for the 1%AEP.

A conservative level of 0.1m above the top of the main channel has been assumed for the 10% AEP, with the 20% being inside the channel itself.

There are some basic bridges currently across the channel to allow for owner and stock movement. These are not restricting flows for events at least up to the 20%AEP.

*Western portion Gavin's Gully showing wide channel*

*Eastern portion showing narrower channel and sand dune*

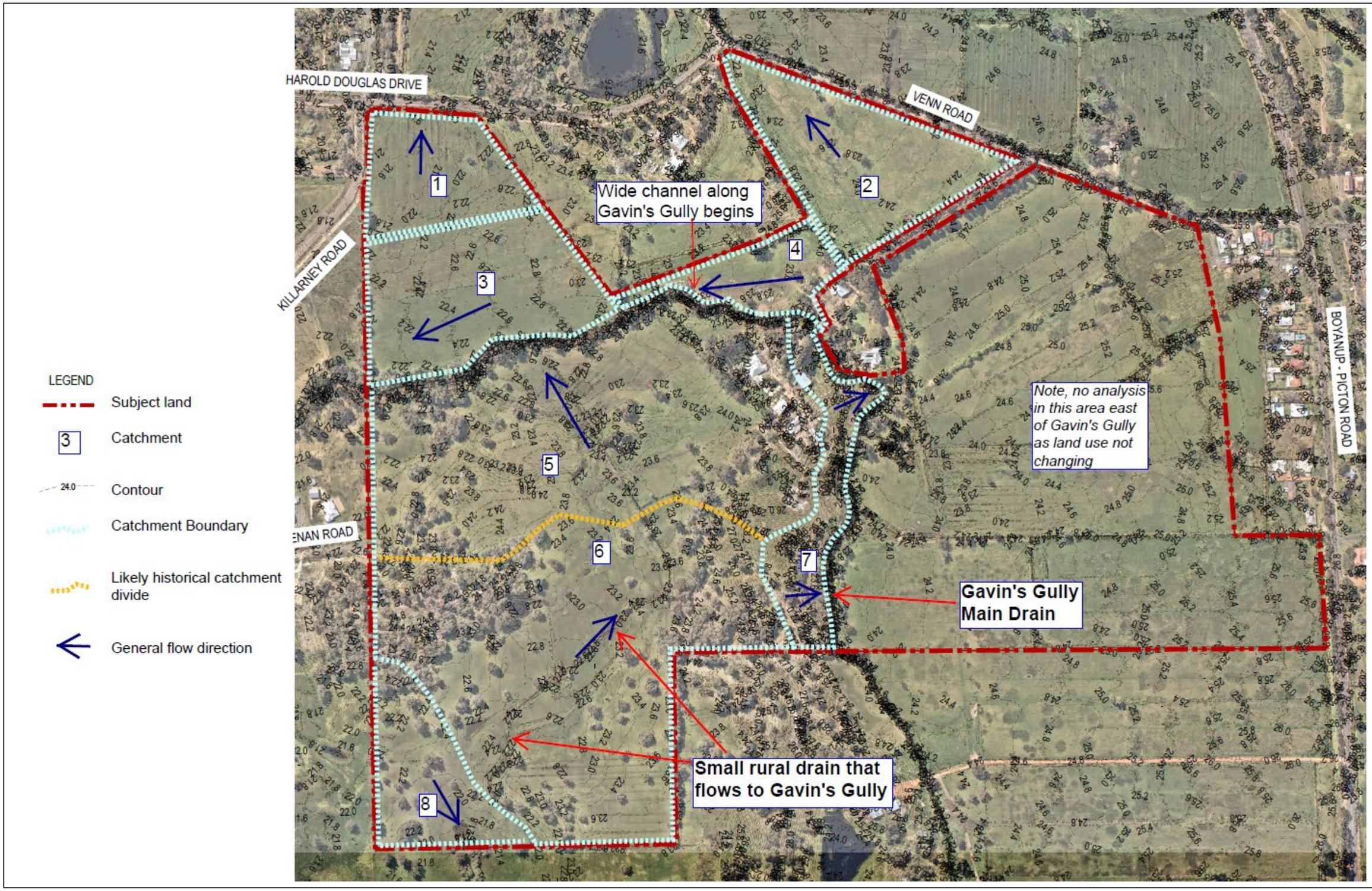



Figure 9 Pre-development Catchment and characteristics

# 7 GROUNDWATER (PRE-DEVELOPMENT)

**SHALLOW SUPERFICIAL AQUIFER**
Groundwater levels were monitored by Oversby Consulting. 10 bores were monitored between June 2021 and October 2021. All bores are within the superficial aquifer, with bores being drilled to approximately 3.5 meters. Figure 10 shows the bore locations.
Further data was also collected by WML in September. This consisted of 20 sample pits at the locations shown in Figure 4. This helps provide information between the monitoring bores.

## 7.1 LEVELS

Table 6 provides a summary of the level for each bore at each monitoring run. The 2021 September 20th results were used as the general seasonal maximum. This reading was equal to or higher than all other times that each bore was measured. Table 7 shows the shallowest depth of water from the surface (highest groundwater) as well as the height of the groundwater in metres AHD based on this reading. The ground surface contours were produced from LiDAR. Full details of each monitoring run can be found in the *Lot 2 Harold Douglas Drive and Lot 185 Venn Road Dardanup Groundwater Monitoring Report*

Table 6 Groundwater Level record

| Monitoring Well | Depth to water from surface (mmbgl) | | | | | |
|---|---|---|---|---|---|---|
| | 28/06/2021 | 19/07/2021 | 16/08/2021 | 30/08/2021 | 20/09/2021 | 25/10/2021 |
| **1** | 2200 | 1400 | 1070 | 1040 | 1040 | 1040 |
| **2** | 2930 | 200 | 230 | 230 | 190 | 270 |
| **3** | 490 | 230 | 250 | 360 | 250 | 330 |
| **4** | 1790 | 350 | 410 | 490 | 380 | 710 |
| **5** | 1900 | 600 | 510 | 500 | 500 | 670 |
| **6** | 860 | 240 | 220 | 200 | 180 | 170 |
| **7** | 1350 | 450 | 510 | 580 | 490 | 730 |
| **8** | 750 | 120 | 130 | 140 | 130 | 170 |
| **9** | 1730 | 1050 | 720 | 720 | 630 | 720 |
| **10** | 2560 | 1780 | 1330 | 1430 | 1330 | 1540 |

Table 7 Highest groundwater recorded

| Monitoring Well | Shallowest depth to groundwater from surface (mbgl) | Surface level at bore (mAHD) | Groundwater level (mAHD) |
|---|---|---|---|
| **1** | 1.04 | 22.32 | 21.28 |
| **2** | 0.19 | 24.07 | 23.88 |
| **3** | 0.25 | 21.45 | 21.2 |
| **4** | 0.38 | 21.83 | 21.45 |
| **5** | 0.5 | 22.75 | 22.25 |
| **6** | 0.18 | 21.97 | 21.79 |
| **7** | 0.49 | 21.55 | 21.06 |
| **8** | 0.13 | 23.51 | 23.38 |
| **9** | 0.63 | 23.42 | 22.79 |
| **10** | 1.33 | 23.15 | 21.82 |

Using the bore information as well as the collected data on ponding surface water (taken as reflecting groundwater rising to the surface), soaks and drainage features including the small rural drains, a groundwater contour plan was developed for the site.

From this plan, it can be seen that the groundwater is locally influenced by the landform features and soil types of the site (Figure 10).

There is a general trend of a decreasing groundwater contours from east to west, however the presence of the sand dunes and Gavin's Gully provide localised influences. The two main sand dune areas in the middle of the site and on the western boundary cause some minor mounding of groundwater, with the water then seeping out around the base. Gavin's Gully provides a localised draw down, as it is incised 1.5m+ into the surrounding ground, it also allows the other local rural drains to discharge any surface flow and rising groundwater into the drain.

In the southwest corner, due to the land sloping away to the south west, the groundwater contours are also drawn in a south west direction.

Bore 1 was located in dense clay. As such the surface water was only able to infiltrate at a very slow rate. While the surface of the land was waterlogged, this surface water continually flowed off the surface and into nearby rural drains, rather than infiltrating into the superficial groundwater layer. For the other more permeable clayey soils however, the rainfall was able to infiltrate and this led to shallow groundwater readings.

The general depth to groundwater was also determined and is represented in Figure 11. Generally the groundwater is around 1m or less from the surface on the flat heavier soils with this extending t greater than 3m under the sand dunes. There are some localised areas where groundwater is at the surface

## 7.2 QUALITY

Groundwater quality was not investigated due to the site deemed to be of a low risk of a groundwater quality that would differ significantly from rural landuses on the Swan Coastal Plain. The site is likely to have moderate nutrient levels and elevated Aluminium and Iron as is common through this area. The proposed landuse is also unlikely to change groundwater levels or significantly increase groundwater flows from the site.

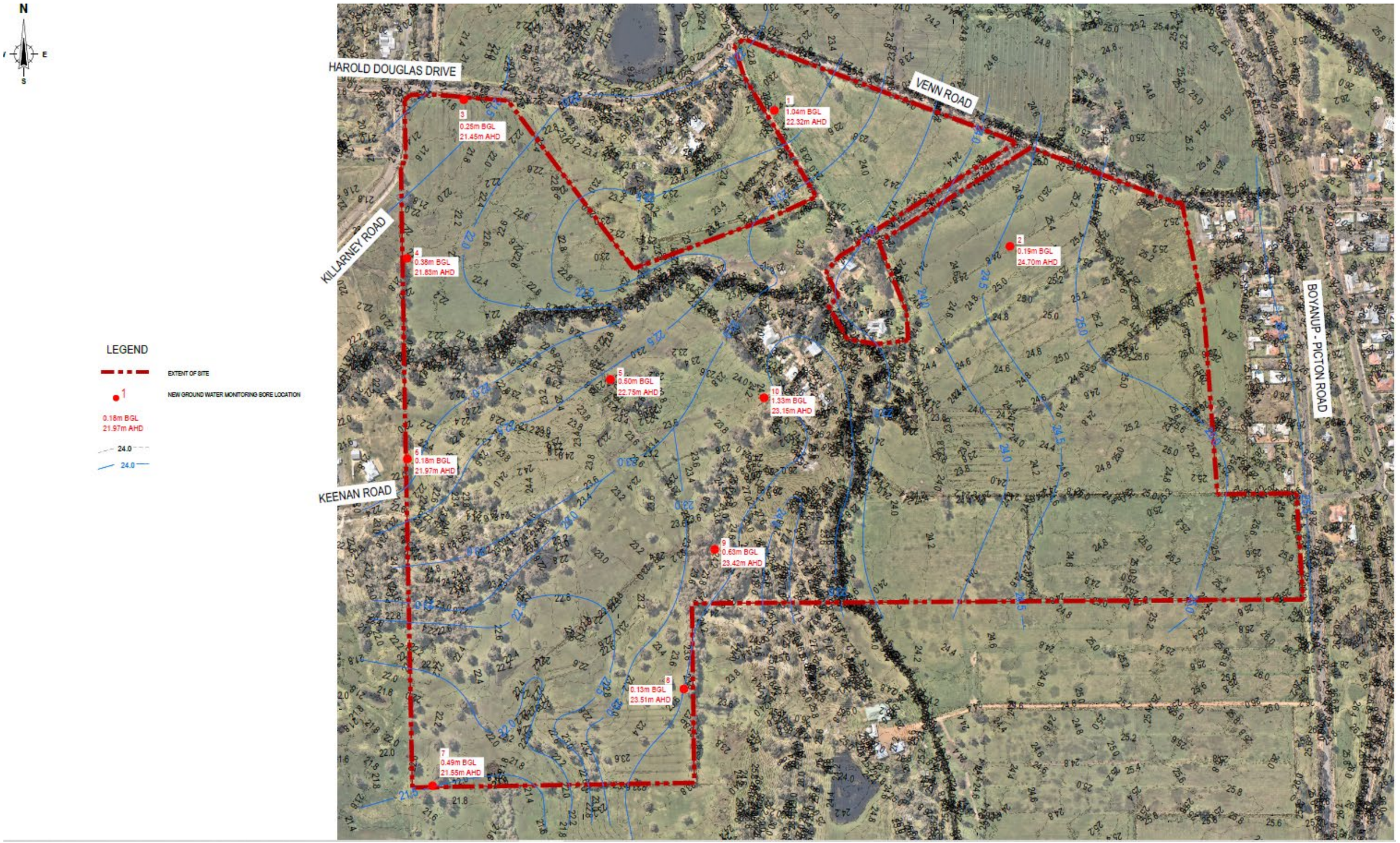



Figure 10 Groundwater contours and bore locations

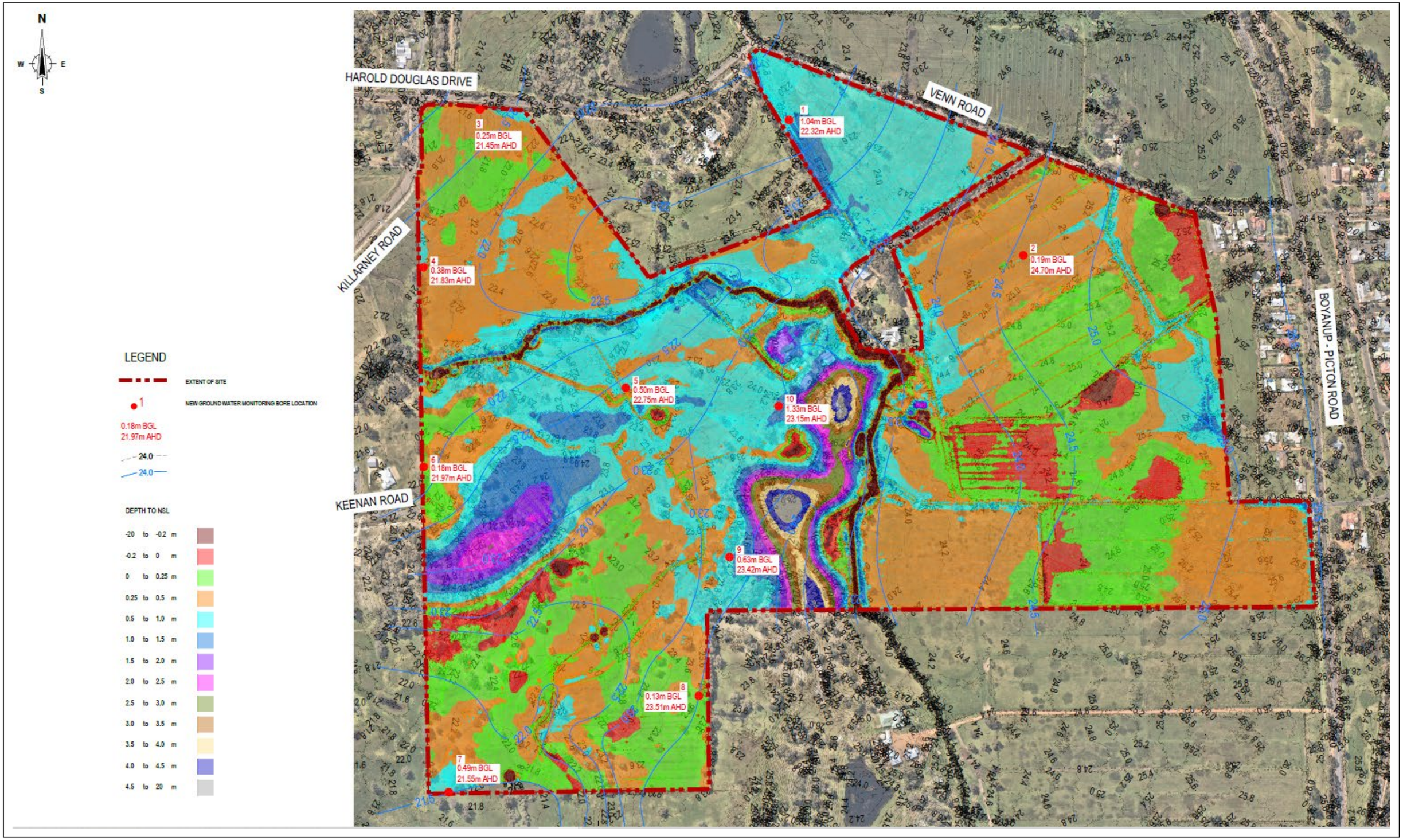



Figure 11 Depth to Groundwater

# 8 DRAINAGE MANAGEMENT STRATEGY

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 the swale and pipe network, to designated basin and discharge points while protecting lots from flooding and minising flood impacts on Gavin's Gully and other receiving waterways.

The post-development modelling for the development has been split into road and lot sub-catchments. Where possible these have been grouped to replicate the current pre-development catchments, so as to allow for comparisons.

33 internal sub-catchments, were modelled. These were then grouped into catchments relevant to their discharge location. A full summary of the catchments can be seen in Table 9 and Figure 12. These catchments are as follows:

- 2 small catchment (HD1 and HDV2), composed solely of lots still discharge northwards.
- 1 small road catchment (2 sub-catchments, A1 & A2) has been designed to flow into the current swale on Killarney Road.
- 4 main catchments (B,C,D,E) discharge into Gavin's Gully (through 3 modelled outlets) with the sub-catchments being composed of both lot and road catchments types.
- 1 main catchment (F) discharges south, with flow assumed to be to spread into the unmade Shaw Road reserve. The contributing sub-catchments are composed of both lot and road catchments types.

The road catchments assume a sealed road, gravel verge and swales on either side. The lot catchments assumed some impervious areas (inundated areas and driveways, rooves etc) as well as supplementary areas that are waterlogged. Appropriate portions were also assumed for drier sand areas that include the natural dunes as well as likely imported sand around buildings.

Flows off lots were either directed to the roadside swales, or where relevant, directly to Gavin's Gully of the downstream receiving body. The storage breakdown for each catchment can be seen in Table 8 and 9.

Figures 12 shows the catchment boundaries and discharge points.

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

8.2 – 1EY
8.3 – 20%AEP
8.4 – 1% AEP

In relation to the 10%AEP flood level, to assist with locating of wastewater land application areas, it is assumed that all flows generated on site are confined to the swales and basins. It is noted that there will likely be a shallow sheet flow through some portions of some lots, so for this reason, application areas should be built up at least 0.3m above the surrounding soil and not block any sheet overland flow paths. In relation to Gavin's Gully, it is assumed that the 10% will be 0.1m above the top of the main channel. Areas on the surrounding floodplain within this location are generally confined to the actual waterway reserve, and all application areas are set a minimum of 100m back (except for the current house and one other lot that has a 50m setback).

## 8.1 MODELLING

The key modelling assumptions and characteristics are as follows:

- Catchments were designed to be logical areas of stormwater capture and discharge.
- The catchments were split into paved/impervious surfaces and pervious surfaces.
- Paved and impervious (inundated) areas had an assumed retardance coefficient of 0.013, while pervious surfaces (eg areas of non inundated sand) were assumed to have a retardance coefficient of 0.2.
- Swales are generally assumed to be 0.5m deep to the invert of the overflow. A further 0.1m is assumed to be available until it floods into adjoining paddocks. The sides are assumed to be sloped at 1:4 approximately. The initial overflow is assumed to be directed by pipe to the downstream swale/basin/discharge location as relevant. The outlets were assumed to be at the base of the swales. The exception is Catchment F where the swales were assumed to have a1m flat base to assist with storage requirements.
- Basins were assumed to be a maximum of 1m deep. They have flat bases and side slopes between 1:4 and 1:6.
- The swales and basins for catchments C, D and F were sized to achieve the required storage (in conjunction with the upstream swales) to accommodate the Water corporations required flow rate of 8.5$m^3$/s/1000ha for the actual road reserve (not lots). Small orifices were incorporated into the base to match the flows allowed. As summary of the results can be seen in Table 2.
- To be conservative, no infiltration is assumed from the base of the swales or basins as for most of the catchments there is unlikely to be any appreciable infiltration during winter/early spring. Catchment E infiltration may be revisited as part of detailed design, as the road through here is predominately in deep sand.
- All final discharge pipes area assumed to be a minimum of 300mm diameter. 375mm diameter have generally been used throughout the road network.
- The final storms modelled were the15min, 25min, 30min, 1 hr, 2hr, 6 hr, 9hr, 12hr, 24hr and 48hr.

Table 9 provides a breakdown of the 20% and 1% AEP flows for the post-development scenario.
A visual capture of the model with the 1% AEP results can be seen in the Drainage Report in the Appendix. This also shows the pre-development catchments modelled across the top.

Table 8 Summary of required storage to achieve Water Corporation run off rates for roads

| Catchment | Subcatchment | Area (ha) | Swale Storage (m3) | Basin Storage (m3) | Allowable WC flow (M3/s) | Orifice required (mm) | 1% post achieved with orifice (m3/s) | Comments |
|---|---|---|---|---|---|---|---|---|
| **A** | | | | | | | | |
| | A1 | 0.136 | 260 | | | | | |
| | A2 | 0.136 | 260 | | | | | |
| **Total To Killarney** | | **0.271** | | | **0.0023** | **50** | **0.003** | |
| **B** | | | | | | | | |
| | B1 | 0.351 | 900 | | | | | |
| | B2 | 0.351 | 900 | | | | | |
| | | **0.703** | | | **0.0060** | **65** | **0.006** | |
| **C** | | | | | | | | |
| | C1 | 0.385 | 880 | | | | | |
| | C2 | 0.385 | 880 | | | | | |
| | C3 | 0.462 | 1020 | | | | | |
| | C4 | 0.308 | 680 | | | | | |
| | | **1.541** | | 3000 | **0.0131** | **65** | **0.014** | |
| **D** | | | | | | | | |
| | D1 | 0.305 | 700 | | | | | |
| | D2 | 0.322 | 740 | | | | | |
| | D3 | 0.244 | 625 | | | | | |
| | | **0.871** | | 1100 | **0.0074** | **60** | **0.007** | |
| **E** | | | | | | | | |
| | E1 | 0.085 | 250 | | | | | |
| | E2 | 0.085 | 250 | | | | | |
| | | **0.170** | | 0 | **0.0014** | **45** | **0.002** | Pre is Cat 7 |
| **Total to Gavin's Gully** | | **3.285** | | | **0.0279** | | **0.0290** | All catchments combined that discharge to Gavin's Gully |
| **F** | | | | | | | | |
| | F1 | 0.401 | 1057.5 | | | | | F Catchments swales have been widened with 1m base. |
| | F2 | 0.479 | 1350 | | | | | |
| | F3 | 0.234 | 675 | | | | | |
| **Total to South** | | **1.114** | | 2800 | **0.0095** | **40** | **0.012** | |
| **ROAD TOTAL** | | **4.670** | | | **0.0397** | | **0.0440** | |

## 8.2 1EY MANAGEMENT

The Drainage Management system is 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 sandy high portions of road verges and lot area) in the subdivision will infiltrate through to the groundwater. These areas are predominately in the southern portion area, within the 2 sand dunes. .The majority of contaminants will be removed from surface water as it filters through the soil profile.

### SURFACE FLOW

For the majority of the impervious areas such as roads, pathways, driveways and the areas of inundation/waterlogged soil, the water will be directed to the edge of roads. From here it will flow into grassed swale network. These then direct water into vegetated basins or directly offsite via a controlling pipe. The vegetated swales and basins will trap sediments and assist with assimilating other contaminant prior to discharge.

## 8.3 DRAINAGE MANAGEMENT PLAN – 20%AEP

The 20% system utilises the swale basin areas to detain flows of the road and lot network. The flows from each basin will throttle the flows back via a controlled orifice pipe, as well as some flow infiltrating through the bioretention media.

Table 9 provides a comparison of the pre-development and post-development flows for the subject land for the different catchments, with Table 10 summarising the entire development. It is noted that there is a lower peak outflow for the post-development for all major catchments. This is predominantly due the large volume of storage within the road reserve swale network, so as to accommodate the Water Corporation's run of rate. This storage significantly slows the rate of outflow compared to the pre-development scenario where there is no significant storage. The new road network also creates barriers to the current overland sheet flow, which also contributes to a reduced overall flow rate during larger events.

The final discharge pipes could be increased to allow more flow off the site, however the swales are likely to remain similar in size, due to the need to control groundwater. The decreased overall flow rate also assists with helping manage flows into Gavin's Gully and provides some conservative management until such time as there is more detailed modelling of the entire system.

The reduced flow to the south also assists with not causing undue issues for the currently undeveloped areas. Flows could potentially be increased back to pre-development flows once Shaw Road is constructed and there is a designated swale to take any generated flows.

There is some minor flow generated into the Killarney Road swale (39l/s and 78l/s for the 20% and 1% AEP events respectively). While there is no flow shown in the pre-development scenario, it is likely that in larger events there would currently be some flows overland, due to the way in which the Catchment 3 was levelled (which directs water to the boundary).

Table 9 Post development flow summary

| Catchment | Subcatchment | Area (ha) | Swale Storage (m3) | Basin Storage (m3) | Pre dev 20% (m3/s) | Pre dev 1% (m3/s) | 20% post (m3/s) | 1% post (m3/s) | Comments |
|---|---|---|---|---|---|---|---|---|---|
| **A** | | | | | | | | | |
| | A1 | 0.136 | 260 | | | | | | |
| | A2 | 0.136 | 260 | | | | | | |
| **Total To Kilarney** | | **0.271** | | | **0** | **0** | **0.039** | **0.078** | |
| **B** | | | | | | | | | |
| | B1 | 0.351 | 900 | | | | | | |
| | B2 | 0.351 | 900 | | | | | | |
| | GGB1 | 3.480 | | | | | | | |
| | | **4.183** | | | **0.277** | **0.629** | **0.096** | **0.155** | Pre is approx Cat 4 |
| | GGA1 | **6.187** | | | **0.614** | **1.21** | **0.641** | **1.31** | Pre is approx Cat 3 |
| **C** | | | | | | | | | |
| | C1 | 0.385 | 880 | | | | | | |
| | C2 | 0.385 | 880 | | | | | | |
| | C3 | 0.462 | 1020 | | | | | | |
| | C4 | 0.308 | 680 | | | | | | |
| | GGC1 | 3.860 | | | | | | | |
| | GGC2 | 2.800 | | | | | | | |
| | GGC3 | 3.180 | | | | | | | |
| | GGC4 | 4.010 | | | | | | | |
| | | **15.391** | | 3000 | **2.59** | **6.41** | **0.365** | **0.897** | Combines Pre Cat 5 and 6 |
| **D** | | | | | | | | | |
| | D1 | 0.305 | 700 | | | | | | |
| | D2 | 0.322 | 740 | | | | | | |
| | D3 | 0.244 | 625 | | | | | | |
| | GGD1 | 2.290 | | | | | | | |
| | GGD2 | 2.090 | | | | | | | |
| | GGD3 | 4.340 | | | | | | | |
| | | **9.591** | | 1100 | | | 0.341 | 0.9 | |
| **E** | | | | | | | | | |
| | E1 | 0.085 | 250 | | | | | | |
| | E2 | 0.085 | 250 | | | | | | |
| | GGE1 | 1.040 | | | | | | | |
| | GGE2 | 1.370 | | | | | | | |
| | | **2.580** | | 0 | **0.035** | **0.695** | **0.042** | **0.279** | Pre is Cat 7 |
| **Total to Gavin's Gully** | | **37.932** | | | **3.516** | **8.535** | **1.485** | **3.541** | All catchments combined that discharge to Gavin's Gully |
| **F** | | | | | | | | | |
| | F1 | 0.401 | 1057.5 | | | | | | F Catchments swales have been widened with 1m base. |
| | F2 | 0.479 | 1350 | | | | | | |
| | F3 | 0.234 | 675 | | | | | | |
| | SF1 | 2.010 | | | | | | | |
| | SF2 | 3.100 | | | | | | | |
| | SF3 | 3.230 | | | | | | | |
| **Total to South** | | **9.454** | | 2800 | **0.197** | **0.576** | **0.059** | **0.144** | Pre is Cat 8 |
| **HD1** | | 2.500 | | 0 | 0.318 | 0.633 | 0.271 | 0.541 | Pre is Cat 1 |
| **HDV2** | | 2.650 | | 0 | 0.35 | 0.695 | 0.292 | 0.58 | Pre is Cat 2 |
| **Total to North** | | **5.150** | | | **0.668** | **1.328** | **0.563** | **1.121** | |
| **TOTAL** | | **52.807** | | | **4.381** | **10.439** | **2.146** | **4.884** | |

## 8.4 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, with some likely short term ponding within low areas of adjoining lots. The road height and swale size are 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. A 1% AEP flood level for Gavin's Gully is assumed to be 0.3m above the top of the main channel. This allows for waters to spill sideways across the adjoining broad flat plain. All finished floor levels should be a minimum of 0.5m above the 1% AEP flood level of Gavin's Gully to provide adequate separate in lieu of more detailed modelling (approx. 0.8m above the top of the main channel).

All finished floor levels should also be a minimum of 0.3m above the crest of the adjoining relevant road. This is to provide a suitable flood separation from localised flooding, including if culverts under the road are blocked. In this scenario, water can then flow over the road as a broad sheet, before discharging off site.

Actual flow rates can be seen in Table 9, noting that in general the peak flows are significantly lower post-development. Table 10 highlights that the peak flows are generally generated in the 15-30min range, meaning that their flows will generally not occur at the same time as the peak of Gavin's Gully, which is likely to be significantly later.

Table 10 Pre vs Post development flow summary

| Scenario | Area(ha) | 20% AEP ($m^3$/sec) | Critical Storm | 1%AEP ($m^3$/sec) | Critical Storm |
|---|---|---|---|---|---|
| Pre development | 52.8 | 4.381 | 15-30min | 10.439 | 15-30min |
| Post Development | 52.8 | 2.146 | 15-30min | 4.844 | 15-30min |

## 8.5 BRIDGE CROSSING

The proposed bridge crossing is to be designed to not impede flows down Gavin's Gully. Suitable bank protection is also to undertaken to protect the bridge and surrounding banks. Exact details are to be determined as part of the appropriate stage of development and in consultation with the Shire and Water Corporation.

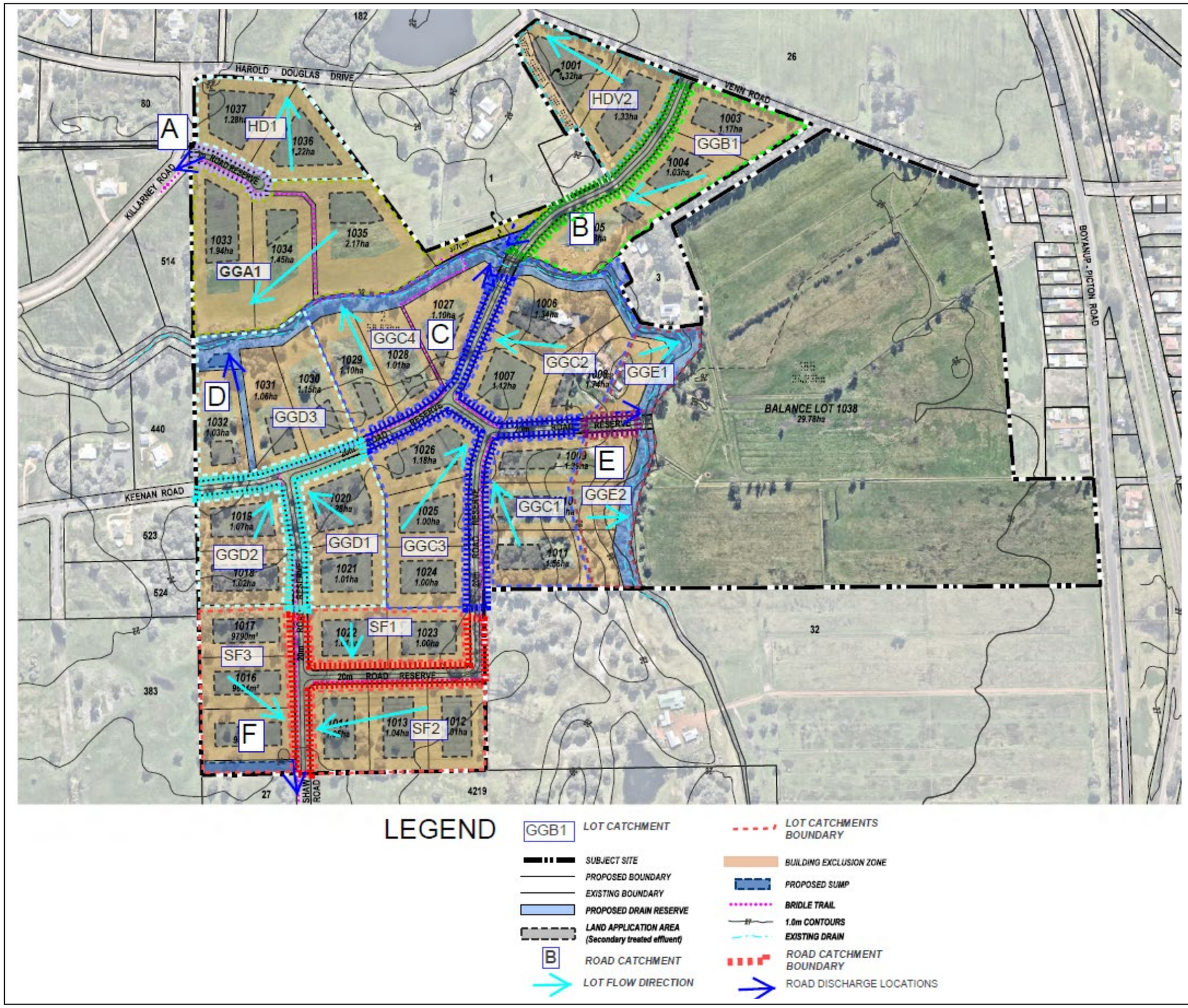



Figure 12 Post-development catchments and discharge locations

# 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, while maintaining separation from infrastructure.

Maintaining suitable separation between buildings and the road pavement from the maximum groundwater level will be achieved through two main methods.

The first method involves using porous, clean fill/insitu soils for roads and lots over the areas of the site that exhibit groundwater close to or at the surface of the site.

The roadside swales will also control the groundwater, with any groundwater intercepted being allowed to run along the base of the swale before exiting through systems discharge points.

## 9.2 GROUNDWATER QUALITY MANAGEMENT

Groundwater will be managed to improve water quality. This will be achieved through the following methods.

- The grassed swales will assist with taking up contaminants prior to water infiltrating through and into the groundwater.
- All onsite effluent disposal will also be undertaken in accordance the Site and Soil Evaluation report (see Section 10). Using the required management as outlined in the SSE report, potential contaminants will be managed to reduce their risk of entering the groundwater.

## 9.3 GROUNDWATER CONTAMINATED FROM PRIOR LANDUSE

The current low intensity agricultural landuse with its potential historical nutrient inputs is likely to be exporting these contaminants from the site to the on site waterway. There is no proposed lowering of the current groundwater. This means that legacy nutrients will not be fast tracked beyond the current discharge rate.

## 9.4 USE OF GROUNDWATER

There will be no irrigation of the drainage reserve or other public places using groundwater drawn from the subject land. There is the possibility of domestic scale bores being used on some lots for non potable uses. The use of these will be subject to DWER groundwater guidelines at the time of application.

## 9.5 MONITORING

Groundwater levels via bores have been monitored over the 2021 winter and spring period to develop an understanding of groundwater levels. This is considered sufficient for determining groundwater levels within the subject land as this was one of the wettest years in the last 40 years. Due to the low density of development and the use of open swales within the road network, the groundwater is unlikely to continue rising above the levels recorded to date. For this reason, no further level monitoring of the pre-development scenario is required.

Quality monitoring is not deemed necessary due to low density of development and the fact that the site is likely to be typical of agricultural areas with elevated nutrients. The contaminants within these systems are able to be dealt with through the methods outlined above.

# 10 WATER SERVICING STRATEGY

## 10.1 POTABLE WATER

Each lot is to provide its own potable water. The water is to be sourced from roof runoff and stored in rainwater tanks. The tank storage is to be a minimum of 120KL.

## 10.2 LOT GROUNDWATER BORE

There is the possibility of on lot bores from the superficial or Leederville aquifer for domestic/stock uses only. These will be subject to DWER licencing procedures and availability at the time of application

## 10.3 LANDSCAPING

**Drainage Reserve Landscaping**

The landscaping within the Drainage Reserve areas will be minimal in nature and the streetscape will predominately use suitable native species. This will minimise the need for watering. The roadside drainage systems will also direct extra water to the basins and their associated plants, assisting with their growth. Some hand watering may be utilised to establish the POS areas in the initial 2 years. Water will either be sourced from the onsite soak/dam or via tanker truck.

The objective of POS landscaping is to implement strategies that minimise the quantity of irrigation required within the subject land, including no lawn area, mulching, and regular maintenance. Details regarding water supply of particular POS areas will be outlined within the future rehabilitation plan that contains the POS area.

**Road Landscaping**

The landscaping of the road and associated stormwater system will have a strong focus on native waterwise species. It is proposed that the street trees and stormwater basin systems will be irrigated during the 2 year establishment phase. This is to be via a water tanker truck as required.

Direct irrigation using stormwater runoff will be utilised where possible, to assist with establishing grass in the swales and native plants in the detention basins.

## 10.1 HARVEY WATER IRRIGATION

Areas of the subject land have historically been used for flood irrigation. The subject land is at the end of the irrigation line, and there is no traversing of irrigation water across the subject land to downstream users. Irrigation of the small holding subdivision area using Harvey Water derived water will cease with the change in land use.

## 10.2 FIREFIGHTING

There are no dedicated firefighting tanks proposed within the development. On lot tanks, specifically for firefighting are encouraged. This is in addition to strategic firefighting water tanks maintained by the Shire for the locality. Details on the exact requirements will be as per the approved Bushfire Management Plan.

## 10.3 WASTEWATER MANAGEMENT

The site is to utilise onsite effluent disposal in accordance the Site and Soil Evaluation report, to manage wastewater. It is noted that the site is in an identified sewage sensitive area due to being within 2km of the Preston River (which drains to the Leschenault Estuary). The recommended management options assist with minimise the risk of nutrients and other contaminants entering the Estuary

**Zone 1 – Sands (Lots 1008-1011 and Lot 1019)**

- The land application areas should be placed on the highest, flattest part of the lot where practicable to maximise separation to the groundwater.
- The Category 1 free draining sands have a limited nutrient retention ability and therefore require amelioration using imported fill to create an effective category 2 soil. The in-situ sands should be mixed with a loam/clay toachieve a blend with a 10-20% clay content and achieve a minimum PRI of greater than 30 for a depth to at least 0.5 m below the effluent distribution point. The blending or mixing of the soils should not adversely affect the effective drainage of the soils.
-

**Zone 2 – Clayey Sands to Clays (Lots 1001-1007, Lots 1012-1018, Lots 1020-1037)**

- Portions of the lots within Zone 2 were noted to have shallow groundwater/perched water within the September 2021 investigation. The groundwater was encountered between 0.25 m and 1.0 m below existing ground levels. Therefore, to achieve the required minimum vertical setback of 1.5 m, the application areas of the lots within this zone need to be elevated with a sandy loam which has an approximate clay content between 10-20% and achieves a minimum PRI of greater than 30. This soil should be able to be classified a Category 2 soil in accordance with AS 1547
- Lots 1001-1004, 1007, 1012-1018, 1020-1037 require the import of approximately 1.5 m of suitable fill to create a vertical separation between the effluent discharge point and the ponding/groundwaterof 1.5 m.
- Lots 1005, 1006, 1008 require the import of approximately 1.0 m of suitable fill to create a vertical separation between the effluent discharge point and the ponding/groundwater of 1.5 m.
- The western half of Lots 1009-1011 and the north-western portion of Lot 1019 also require approximately 1.0 m of suitable fill to create a vertical separation between the effluent discharge point and the ponding/groundwater of 1.5 m.

**General Recommendation**

- It is recommended that the generated wastewater is treated to a secondary level with a Department of Health approved Secondary Treatment System (STS) with nutrient removal utilising a sub-surface application system.The final selection of the system should be undertaken by the client from the list of approved Department of Health Secondary Treatment Systems and should achieve a minimum nutrient output of:
  - 20 mg/L of Biochemical Oxygen Demand (BOD)
  - 30 mg/L of Total Suspended Soils (TSS)
  - 10 cfu/100mL of Escherichia (E) coli
- For a typical 6-person residential household, a land application area of 180 $m^2$ is required based on the in-situcategory 2 soil. This calculation is based on the conversion factors provided in Section 2 of Schedule 2 of the GSP19.
- Setback buffer distances from effluent land application areas and treatment systems are required to help prevent human contact, maintain public amenity and protect sensitive environments. The setback for the subject land have been based on a sub-surface application system disposing of a secondary treated effluent through a category 2 soil.
- The majority of the available land application areas achieve a 100 m setback from Gavin's Gully Drain. However, for proposed lots 1006 and 1027, the separation distance is at least 50 m. It should be noted that Lot 1006 comprises an existing dwelling, which will be retained. It is recommended that for these two lots high levels of nutrient management and reduced irrigation rates be applied.

The setbacks and the areas set aside as land application areas for treated effluent can be seen in Figure 13.

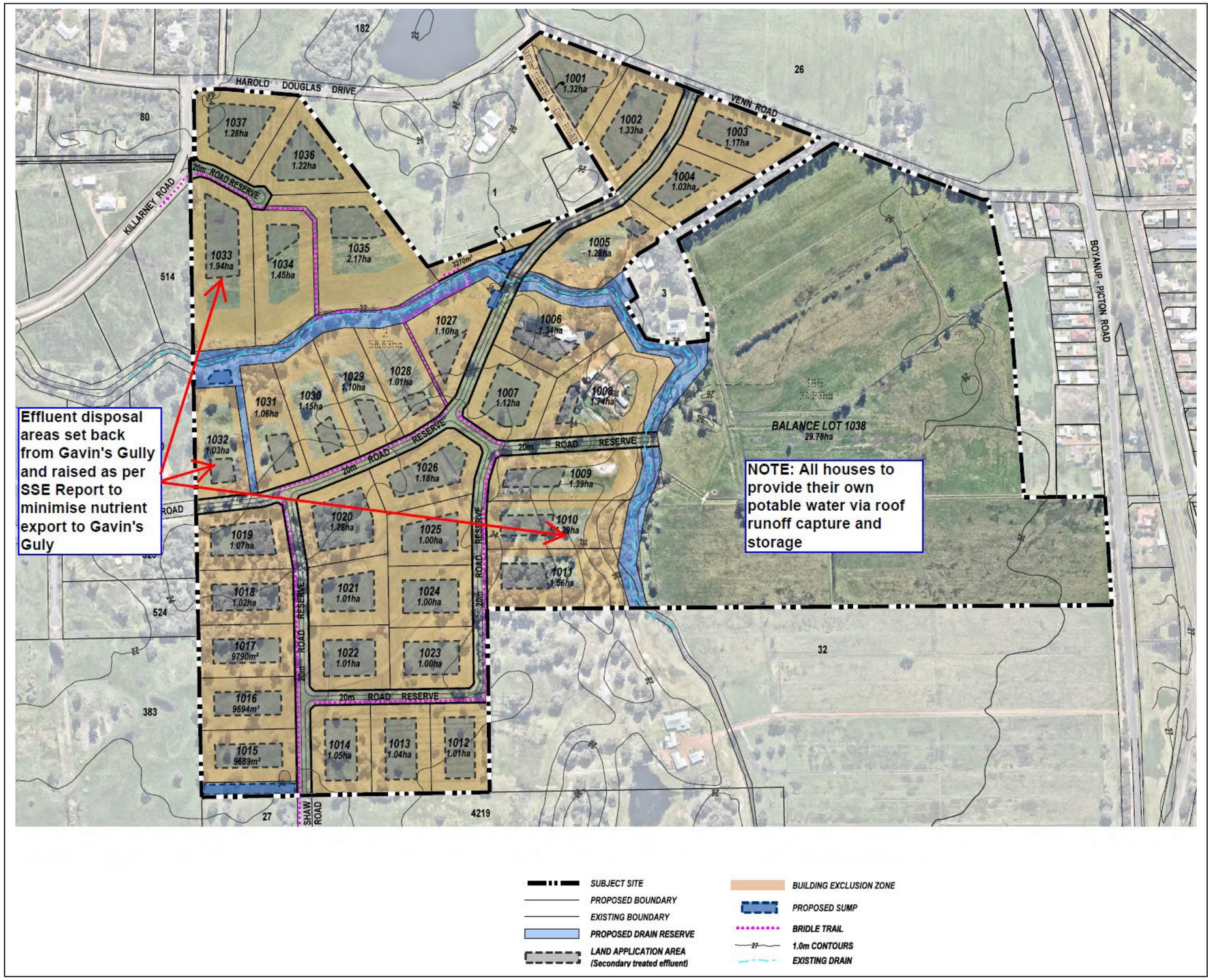



Figure 13 Land Application Setback from waterway

# 11 WATER DEPENDENT ECOSYSTEMS MANAGEMENT STRATEGY

There are three main focuses for the management of water dependent ecosystem (WDE) as part of the subject land's future development. These are:

- to treat water prior to discharge into the onsite waterway and downstream ecosystems
- creation of new WDE habitat within the stormwater basins
- rehabilitation of Gavin's Gully

The overall ways in which the WDE impacts will be managed can be seen in Figure 14.

## 11.1 WATERWAY PROTECTION THROUGH WATER QUALITY AND FLOW MANAGEMENT

The main natural Water Dependent Ecosystem that the site discharges to is the degraded waterway (Gavin's Gully) that traverses the site, with this eventually discharging to the Preston River and Leschenault Estuary. The surface and groundwater management plans detail out the techniques that will be used to control flows and quality into Gavin's Gully. All flows up to the 1EY off road reserves will be treated for nutrients and pollutants prior to entering the waterway. This system will also help treat flows above the 1EY as well. The impact therefore on the waterway from surface water and groundwater generated on site, will be minimal. The management options outlined in the SSE Report will also manage nutrients and other contaminants from wastewater disposal systems. The removal of stock and high nutrient input agriculture (especially associated with the flood irrigation agriculture) will also assist with reducing the overall nutrient and animal waste entering Gavin's Gully.

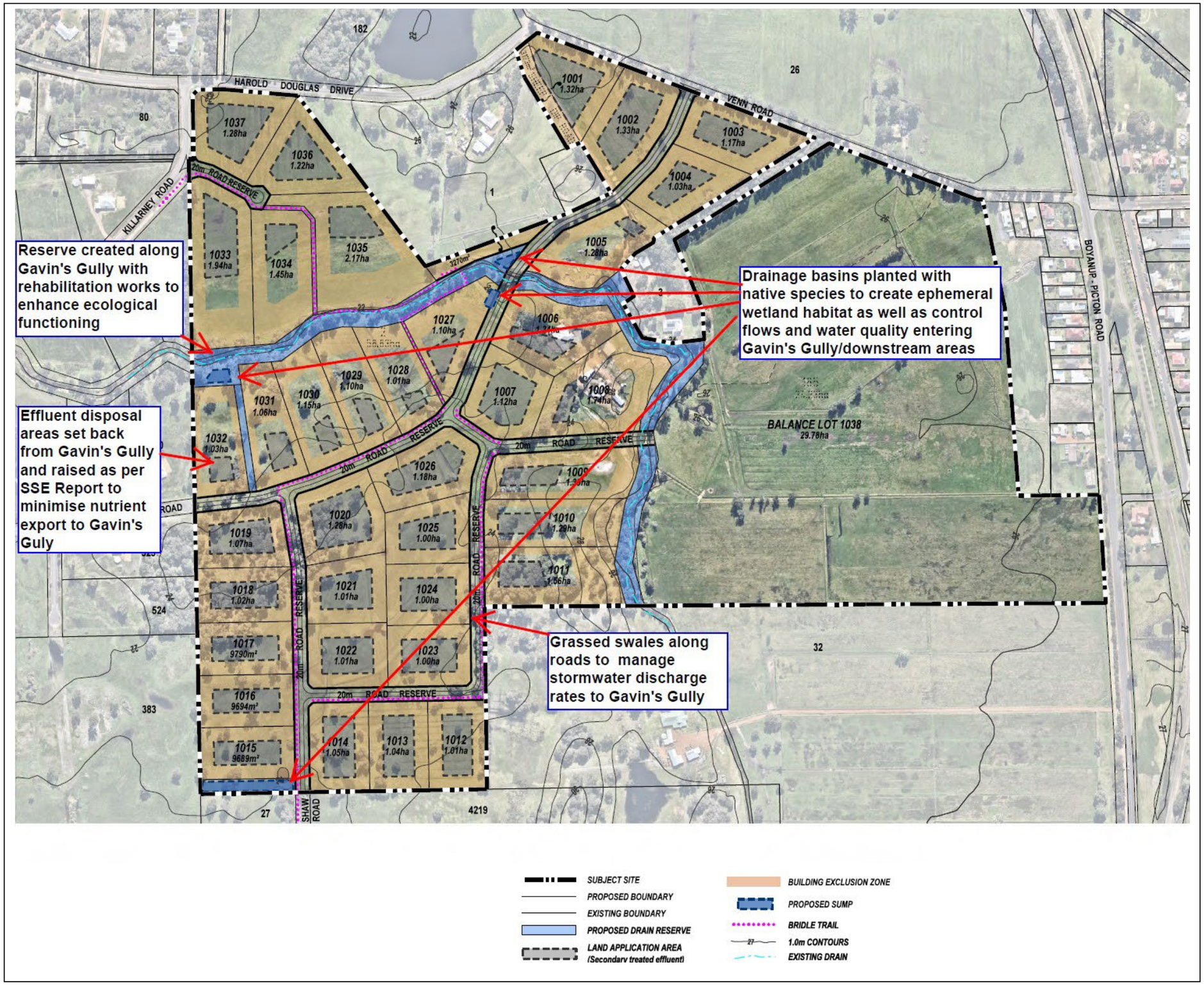
## 11.2 WATERWAY REHABILITATION

The reserve that is to be created along Gavin's Gully provides an opportunity to assist with rehabilitation of this degraded waterway. By removing stock, there is an opportunity to replant native species along the reserve and allow vegetation to establish on the banks. This will both increase habitat and help to stabilise the current erosion. Within this reserve, weed control and revegetation works using appropriate locally native species will be undertaken to improve the ecological functioning of the waterway and surrounds. The revegetation works will be compliant with the relevant recommendations of the Bushfire Plan and requirements of both the Shire and Water Corporation. More details will be produced through the subdivision process.

## 11.3 CREATION OF NEW WDE

The stormwater detention basins will also provide further habitat for water dependent species that utilise ephemeral wetland systems. The systems will be planted with locally native species to enhance their habitat values. By also being placed alongside the vegetated reserve, these systems will likely form small habitat pockets for fauna within the local area.

Figure 14 Water Dependent ecosystem plan



# 12 MONITORING & MAINTENANCE

The following section provides information on both pre and post-development undertaken and required. Table 11 also provides a summary of the monitoring requirements.

## 12.1 PRE-DEVELOPMENT GROUNDWATER

Pre-development superficial groundwater level monitoring for the subject land has been undertaken as part of previous investigations. No further monitoring is required due to the extensive testing.

## 12.2 PRE-DEVELOPMENT SURFACE WATER

Surface water monitoring for water quality is not considered necessary, given the degraded nature of the waterway present, as well as the low density of the development proposed.

## 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, swales 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.

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.

It is recommended that vegetated WSUD elements are monitored by personnel with floristic knowledge and/or qualifications and be capable of identifying invasive species within the natively vegetated WSUD systems. Furthermore, personnel in charge of monitoring should have a good understanding of principles and the functional design of the WSUD elements and the treatment system.

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.

There is some overlap between the stormwater and rehabilitation works along the foreshore reserve. This includes the outlet structures and associated planting. Any future foreshore plans should be referred to for detailed management of the vegetation within this zone. It will include weed control, replanting as required and management of any pests.

Table 11 Monitoring requirements

| Function | Item to Monitor | Purpose of Monitoring | Trigger for Immediate Action | Maintenance Action Required | Monitoring Frequency | Responsible Authority |
|---|---|---|---|---|---|---|
| **PRE - DEVELOPMENT** | | | | | | |
| **Water monitoring** | Groundwater | Determine maximum groundwater levels | Nil | Nil | Winter/spring, prior to detailed design - Completed | Developer |
| **CONSTRUCTION PHASE & POST-DEVELOPMENT** | | | | | | |
| **Drainage Management Systems (includes traditional and WSUD systems)** | 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 |

# 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 subdivision process, complete detailed design as required
- Updated modelling of all stormwater management systems as part of detailed design
- Updating of Geotechnical assessments if required.
- 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 stormwater systems with appropriate locally native plants and maintenance of the plants until handover to the Local Authority.
- Implementation of the foreshore rehabilitation to enhance the onsite waterway.
- Undertake post-development monitoring as required.
- Provide Design Guidelines to lot purchasers with regards to their on-lot obligations including water supply, stormwater detention and effluent management.
- Produce an Urban Water Management Plan/detailed engineering plans as part of the subdivision process as required.

### DEPARTMENT OF WATER AND ENVIRONMENTAL REGULATION REQUIREMENTS

- Review and approve the LWMS.
- Provide guidance on the detailed drainage and other water management aspects at subdivision as requested by the Local Authority.
- Provide guidance on the foreshore rehabilitation plan as requested by the Local Authority/Water Corporation.

### SHIRE OF DARDANUP REQUIREMENTS

- Approval of LWMS and future detailed designs.
- Responsibility for the maintenance of the internal stormwater system, after handover.
- Following handover from Water Corporation, maintenance of the proposed drainage reserve area containing the waterway after handover, so that the 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
- Review and approval of on-site effluent disposal systems (with Department of Health guidance)
- Review and approval of the UWMP as required

### WATER CORPORATION REQUIRMENTS

- Provide guidance on drainage and rehabilitation works related to Gavin's Gully in conjunction with the Local Authority.
- Management of Gavin's Gully until handover to the Shire

# 14 REFERENCES


- Australian and New Zealand Environment and Conservation Council (ANZEEC), 2000, Australian and New Zealand Guidelines for Fresh and Marine Water Quality, Volume 1: The Guidelines
- Department of Environment Regulation, 2009, Identification and Investigation of Acid Sulfate Soils and Acidic Landscapes, Perth
- Department of Water, 2007, Stormwater Management Manual for Western Australia, Perth Loh, M. and Coghlan, P (2003) Domestic Water Use Study In Perth, WA 1998 – 2001. Water Corporation.
- Western Australian Planning Commission, 2008, Better Urban Water Management. Perth
- Lushfire & Planning (2021) Dardanup Park Bushfire Management Plan
- Accendo Australia (2021) Environmental Assessment Report Lot 2 Harold Douglas Drive and Lot 185 Venn Road Dardanup
- WML Consulting Engineers (2021) Dardanup Park Lot 2 Harold Douglas Drive and Lot 185 Venn Road Dardanup West Site and Soil Evaluation
- WML Consulting Engineers (2021) Dardanup Park Lot 2 Harold Douglas Drive and Lot 185 Venn Road Dardanup Preliminary Geotechnical Investigation
- Oversby Consulting (2012) Lot 2 Harold Douglas Drive and Lot 185 Venn Road Dardanup Groundwater Monitoring Report

# Appendix A GROUNDWATER REPORT

# Appendix B DRAINAGE REPORT

## *CONTACT US*


**Oversby Consulting**

*Water and Environmental Management*

**Brendan Oversby**
Director

0447 614 411
brendan@oversbyconsulting.com.au
www.oversbyconsulting.com.au
PO Box 369 DARDANUP WA 6236