# Lot 2349 Guara Drive, Sunset Beach

## LOCAL WATER MANAGEMENT STRATEGY

# DOCUMENT QUALITY CONTROL

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# 1 EXECUTIVE SUMMARY

The Lot 2349 Guara Drive Sunset Beach, Geraldton Local Water Management Strategy (LWMS) has been developed to accompany the rezoning and structure planning for the subject land.

The subject land is composed solely of Lot 2349 , Guara Drive, Sunset beach. This site is bound by recreational uses to the north (Lot 2599) as well as a decommissioned Water Corporation site in the north east corner. On the eastern side is the North West Coastal Highway road reserve. To the south east is Reserve 17001/2589, which falls towards the Chapman River. The western side is generally bordered by residential lots. In the middle of the western boundary is the Public Open Space Reserve (Lot 2488).

Guara Drive also contacts the western boundary as a turnaround, while Nyrang Road also contacts the site as a turnaround.

The LWMS also considers POS 2488 as part of the stormwater management.

The site location is shown in Figure 1.

The subject land is a very gently undulating sand flat, which generally falls to the north/ north west. There are isolated patches of regrowth acacia and other shrubs, with the majority of the site being introduced grass and other pasture species.

Groundwater is not known to be within 2m of the surface. There are no major drainage lines within the subject land, however the Chapman River is located directly to the South. The site is not within the floodplain of the Chapman River.

There is little surface run-off from the site, except during large storm events as the majority of rainfall infiltrates rapidly into the sandy soils.

Ther is no active use of the site at the current time.

The objective of this LWMS is to detail the best management practices approach to water management that will be undertaken for this development. This will include managing, protecting and conserving the total water cycle of the local environment and the greater catchment. The practices will involve:

- Stormwater management that incorporates water sensitive urban design practices;
- Flood protection from localised and regional flood levels;
- Groundwater resource management;
- Protection of ecosystems dependent on water resources from the subject land; and
- Sustainable water servicing

The effectiveness, efficiency and benefits provided by the best management practices require a collaborative effort between local governments, developers and relevant regulatory authorities. The developers are committed to the concepts and outcomes outlined within the approved LWMS for the subject land. This includes the implementation, monitoring and maintenance of the best management practices for stormwater designed specifically for this site.

## 1.1 PLANNING SUMMARY

This LWMS has been produced to support the structure planning process for the subject land. The land comprises 1 landholding.

The subject land is currently zoned Urban Development under the City of Geraldton's Local Structure Plan1. The proposed development is for residential lots of R20 – R30 as well as POS areas.

The proposed development layout can be seen in Figure 2.

## 1.2 SUPPORTING DOCUMENTATION

This LWMS has been compiled using information contained within the detailed assessments and reports undertaken for the subject land as part of the application process. For further information relating to the water management on the subject land please refer to these supporting documents:

- *Bua Bua Consulting* (2023), Preliminary Engineering Services Report. Lot 2349 Guara Drive, Sunset Beach, Geraldton, WA 6530

*Subject land from end of Guara drive, showing undulating landform and open grass.*


Figure 1 Location Plan

# 2 KEY ELEMENTS PLAN

Water management strategies for the subject land are based on best practice water sensitive urban designs that integrate sustainability and the provision of attractive communities. The strategies will be achieved through the synthesis of planning and designs to manage, protect and conserve the total water cycle. The plans and designs for the development are appropriate for the subject land's proposed residential development, surrounding environment and local drainage characteristics.

A summary of the WSUD elements that will be implemented within the development to achieve best management practices are outlined below:

**Water Conservation and Servicing**

- The site is to be serviced with potable water from the Water Corporation.
- Sewer is to be gravity fed to the Water Corporation sewer main.
- Landscaping is to be partially watered via direct stormwater runoff and via water infiltrated into the groundwater.
- Any top up summer landscaping irrigation requirements are to be provided from the Water Corporation or from groundwater sources as determined in consultation with the City of Geraldton.

**Stormwater Management**

- 1EY treatment of road stormwater is achieved through bioretention basins/swales.
- On lot detention systems are to be installed to store and infiltrate stormwater to City of Geraldton guidelines.
- The bioretention basins/swales provide detention for the 20%AEP, reducing flows below predevelopment rates
- Flows off site to the Chapman River in events up to and including the 1%AEP will be at or below pre development rates and off the same land area.
- All flows to the north are to be held on site and infiltrated for all events up to and including the 1% AEP.

**Flood Protection**

- All finished floor levels will be designed to be a minimum 300mm above the internal road gutter line and top water levels of the basins.
- All finished floor levels will be designed to maintain a minimum separation clearance of 500mm between the habitable floor levels and the 1% AEP flood levels of the Chapman River.
- Minor discharge to the Chapman River will not appreciably raise flood levels in the Chapman River and flows are in line with the predevelopment flow rate.

**Ecosystem Protection**

- Water sensitive urban designs (WSUD) will utilise bioretention systems a to capture sediments, large debris and nutrients from all water runoff from impervious surfaces, reducing impacts on downstream systems.
- The landscaping will utilise nutrient and waterwise practices to minimise contamination of the groundwater.
- The landscaping of the bioretention systems will act as ephemeral wetland systems, providing habitat for generalist species.

**Groundwater Management**

- Inflows to the groundwater will be treated through bioretention basins.
- The depth to groundwater is such that, there is no requirement for fill or include subsoil networks to achieve separation.

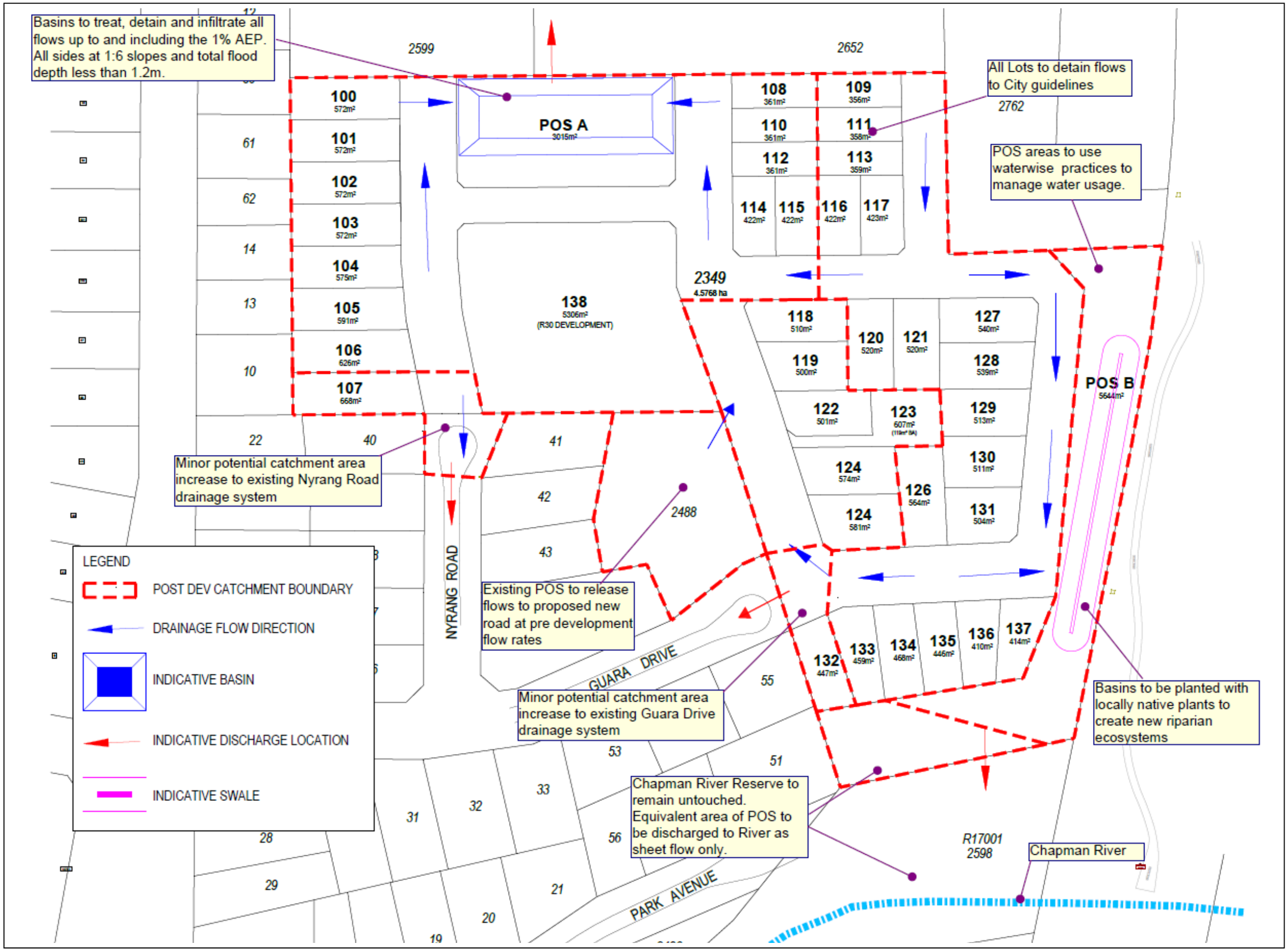


Figure 2 Key Elements Plan

# 3 GEOTECHNICAL

No geotechnical investigation has been undertaken specifically for the subject land. Broadscale mapping shows the subject land to be in the soil category of 'Limestone Hills. This is characterised by grey, yellow or red sand over limestone, deep and shallow soils. The soils tend to be a mix of alkaline and neutral pH, as well as being water repellent.

Observations on site show a red to yellow – brown sand on the surface, as can be seen in the photos below.

*Red sandy soil*

*Yellow brown sandy soil*

## ACID SULPHATE SOILS

Acid Sulphate Soils (ASS) mapping suggests that the risk of ASS being present within 3m of the surface of the subject land is low. There may be a risk of ASS within the adjoining reserve associated with the Chapman River. The mapping can be seen in Figure 3.

If any ground disturbing works are to be undertaken in the adjoining reserve to a level that would require an ASS investigation, it is recommended that a suitable ASS study be undertaken to fully delineate the nature and extent of ASS material at the site. This is to be determined as part of future detailed design.

## CONTAMINATED SITES

The Department of Water and Environmental Regulation (DWER) contaminated sites database was searched for known contaminated sites (sites classified as Contaminated-restricted use, remediated for restricted use or Contaminated-remediation required) in proximity to the site. The site has not been reported to DWER as a known or suspected contaminated site either prior to or after the commencement of the *Contaminated Sites Act* 2003.

There is also no recorded contamination on any adjoining land.

## PERMEABILITY TESTING

No permeability testing has been undertaken. Due to the sandy nature of the soil. A conservative infiltration rate of 2.5m/day has been assumed. If areas of limestone are located under the surface, then there may be localised lower infiltration rates.

Detailed testing will need to be undertaken as part of detailed design at subdivision.

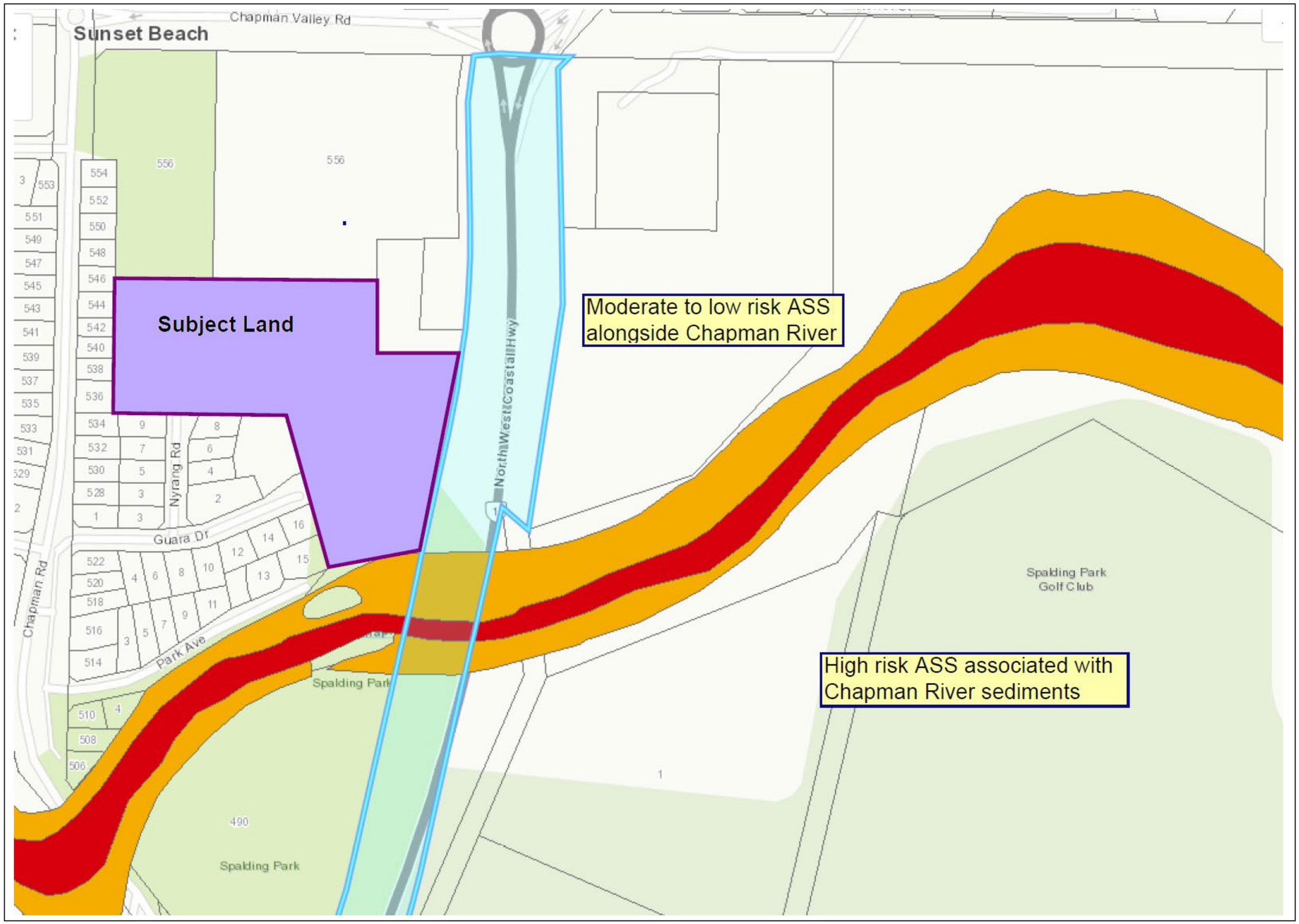


Figure 3 ASS mapping

# 4 LANDFORM AND ENVIRONMENTAL CONDITIONS

## 4.1 LANDFORM

The development is effectively a relatively flat sandplain with very low sand rises. While the subject land generally falls towards the north and west, there are some isolated trapped lows associated with the interdunal areas of the sand rises. The site falls from approximately 11.5mADH in the south east corner to 9.8mAHD on the north west boundary. There is a small catchment that also falls to the south west corner.
The main trapped low sits towards the middle of the site, near the eastern boundary. The base of the trapped low is approximately 9.6mAHD, with the top over height at approximately 10.23mAHD. The main trapped low can be seen in Figures 4 and 5.

Slopes range from less than 1% to approximately 5% for short sections on the undulations.

Directly to the south of the subject land, the land falls away rapidly to the Chapman River. The river is effectively estuarine at this location, noting that it is regularly cut from the ocean by a temporary sand bar.

## 4.2 ENVIRONMENTAL

No dedicated environmental studies have been undertaken for the subject land. The land has been cleared of native vegetation, with some remaining/regrowth acacia shrubs present. The dominant vegetation is grass and pasture species which have been slashed.

There is a dense shrub layer of native vegetation in the Chapman River Reserve to the south. Previous foreshore assessments of the Chapman River did not specifically cover the section of river that adjoins the subject land. The focus was for upstream areas that were subject to agricultural pressures.

The degraded nature of the site means that it provides very limited habitat for riparian species.

## 4.3 WETLANDS

There are no wetlands within the subject land or within 50m of the boundary.

## 4.4 WATERWAYS

No defined natural waterways occur on the subject land. The Chapman River occurs approximately 50m – 65m to the south of the southern border. This river is estuarine in this area and provides an ecological corridor for aquatic fauna.

# 5 GROUNDWATER (PRE DEVELOPMENT)

The following is a summary of the current groundwater characteristics of the site.

### SUPERFICIAL GROUNDWATER LEVELS

There is no publicly available groundwater data for the subject land. Given the deep incision of the Chapman River directly to the south, it is likely that any groundwater present would flow towards this. The Chapman River is effectively tidal at this location, meaning groundwater is conservatively 1.5mAHD or lower. The sandy soil means that any groundwater is likely to move freely through it. If there is limestone rock at depth, this may affect localised flow or hinder broad transmission.

The vegetation on site shows no signs of being wetland in nature or having groundwater accessible close to the surface. Based on this, it is assumed that groundwater is at least 2m below the subject land.

### GROUNDWATER ALLOCATIONS

There are 2 main aquifers under the subject land. These are:

- Perth – Superficial Swan, Arrowsmith area and Dongara subarea
- Perth – Cattamarra Coal, Arrowsmith area and Dongara subarea

Both of these have allocation available as of October 2023.

### GROUNDWATER QUALITY

Groundwater quality sampling has not been undertaken to date. It is likely that the groundwater will be typical of the Arrowsmith area, which often is brackish or saline.

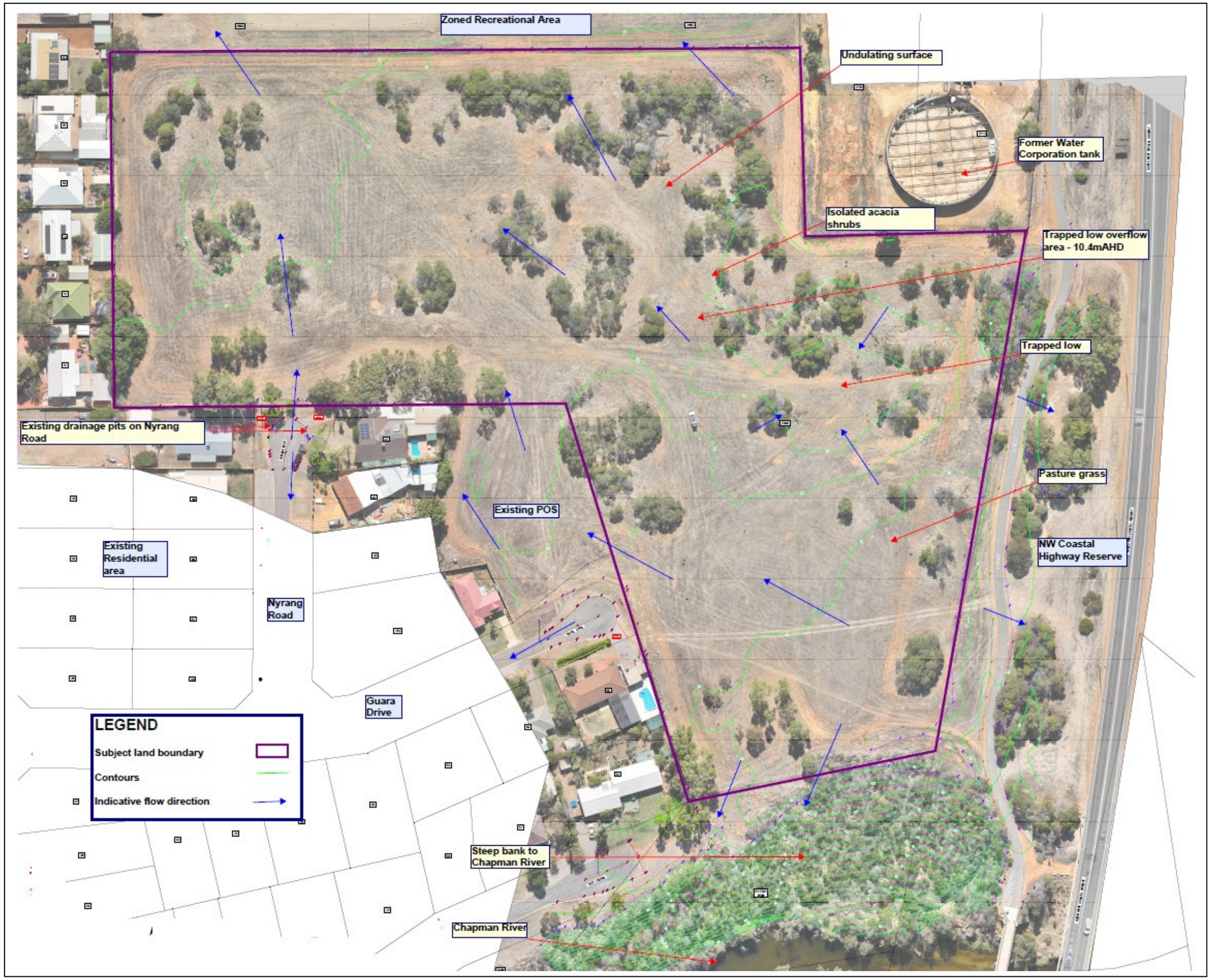


Figure 4 Current landform and general characteristics

# 6 PRE DEVELOPMENT SURFACE WATER SITUATION

## 6.1 GENERAL SURFACE WATER CHARACTERISTICS

There are no defined significant watercourses on the subject land. There are some shallow interdunal type depressions that hold surface water and may assist with directing water northward.

Flows generally leave the site as sheet flow.

Figure 5 shows the general flow of surface water on the subject land and subcatchments.

## 6.2 EXTERNAL CATCHMENTS

There are no significant flows from external adjoining areas on to the subject land other than the existing POS on Guara Drive. This has an area of 0.5789ha and flows into Catchment A (see below) in events above the 20% AEP.

In extreme events, the northern end of Nyrang Road may not be able to store and drain its flows through the existing pit and pipe network. The flows may then tip onto the subject land. A catchment area (Ext 1) has been added into the predevelopment model to reflect this, with the pipe flow still heading southward, away from the subject land.

## 6.3 INTERNAL CATCHMENTS

The subject land has been divided into 2 catchments. A summary of these can be seen in Table 1 and Figure 5.

Catchment A is the major catchment. It includes the largest trapped low as well as numerous small depressions. To reflect these, this area was divided into 2 sub catchments, with A2 being the area that flows to the main trapped low, and A1 being the remainder. The trapped lows are likely to assist with infiltrating the majority of the water for the areas that feed them. Catchment A eventually discharges into the reserve areas to the north, which is currently a relatively level and flat paddock.

Catchment B discharges into the southwestern corner, were it flows into the reserve adjoining the Chapman River and the unmade portion of the Park Avenue road reserve. From here it travels southward and down the steep incline to the Chapman River.

As there are no drains or clear flow paths within the site, it is likely that the majority of the water leaves from all catchments as sheet flow.

## 6.4 CHAPMAN RIVER FLOODING

The subject land is above the Chapman River floodplain. The flood level of the river next to the subject land falls westward from approximately 6.22mAHD to 5.99m AHD. The subject land is between 11.5mAHD and 10.88mAHD along this boundary. A map of the flood plain and subject land can be seen in Figure 6.

## 6.5 PRE-DEVELOPMENT MODELLING FOR THE SUBJECT LAND

A predevelopment model was constructed in DRAINS. 5 sub catchments were assumed, as detailed above. The assumed catchments can be seen in Figure 5. It is noted that the catchments are indicative, as once water enters the flat plain area, it will tend to sheet as a broad flow that is influenced by minor variations in the terrain or thickness of the grass/surface vegetation.

The key modelling assumptions included:

- Horton/ ILSAX drainage modelling method used.
- ARR 2019 methodology and rainfall figures used.
- To reflect the sandy soils with water repellence characteristics, a soil factor of 2 was applied.
- A retardance coefficient of 0.1 was used to reflect the rough vegetated surface.
- A retardance coefficient of 0.01 was used to reflect the paved surfaces on Nyrang Road.
- To represent the trapped lows in Catchment A1, a shallow basin has been modelled up to the 10.4m AHD contour, which is the tipping point, with a permeable percentage used in the 1% AEP to represent the area flooded.

The storms modelled were the 5min,10min,15min, 20min,25min, 30min, 1 hr, 2hr, 3hr, 4.5hr, 6 hr, 9hr and 12hr. Longer events were not modelled as the peak events were generally less than 30 min. These were modelled for the 20% AEP and 1%AEP.

The results are outlined in Table 1.

Table 1 Table 1: Predevelopment Catchment and Flow summary

| Catchment | Area(ha) | 20% AEP ($m^3$/sec) | Critical Storm | 1%AEP ($m^3$/sec) | Critical Storm | Discharge Location / Comments |
|---|---|---|---|---|---|---|
| A1 | 2.5879 | 0.003 | 30min | 0.292 | 20min | Major catchment. Discharges as sheet flow to northern boundary. Values include other contributing catchment flows over boundary |
| A2 | 2.0 | 0 | NA | 0.43 | 25min | Major catchment. First flows to a trapped low, then once filled (10.4mAHD), discharges as sheet flow to subcatchment A1 |
| Existing POS | 0.5789 | 0.001 | 15min | 0.088 | 15min | Major external catchment. Flows to A1. |
| B | 0.1322 | 0 | NA | 0.029 | 15min | Minor Catchment. Discharges as sheet flow to south west corner, then Chapman River. |
| Ext 1: Nyrang Rd | 0.0545 | 0.006 | 5 min | 0.015 | 5min | Possible flow to A1 once Nyrang Road pipe flows and ponding on road exceeded. |

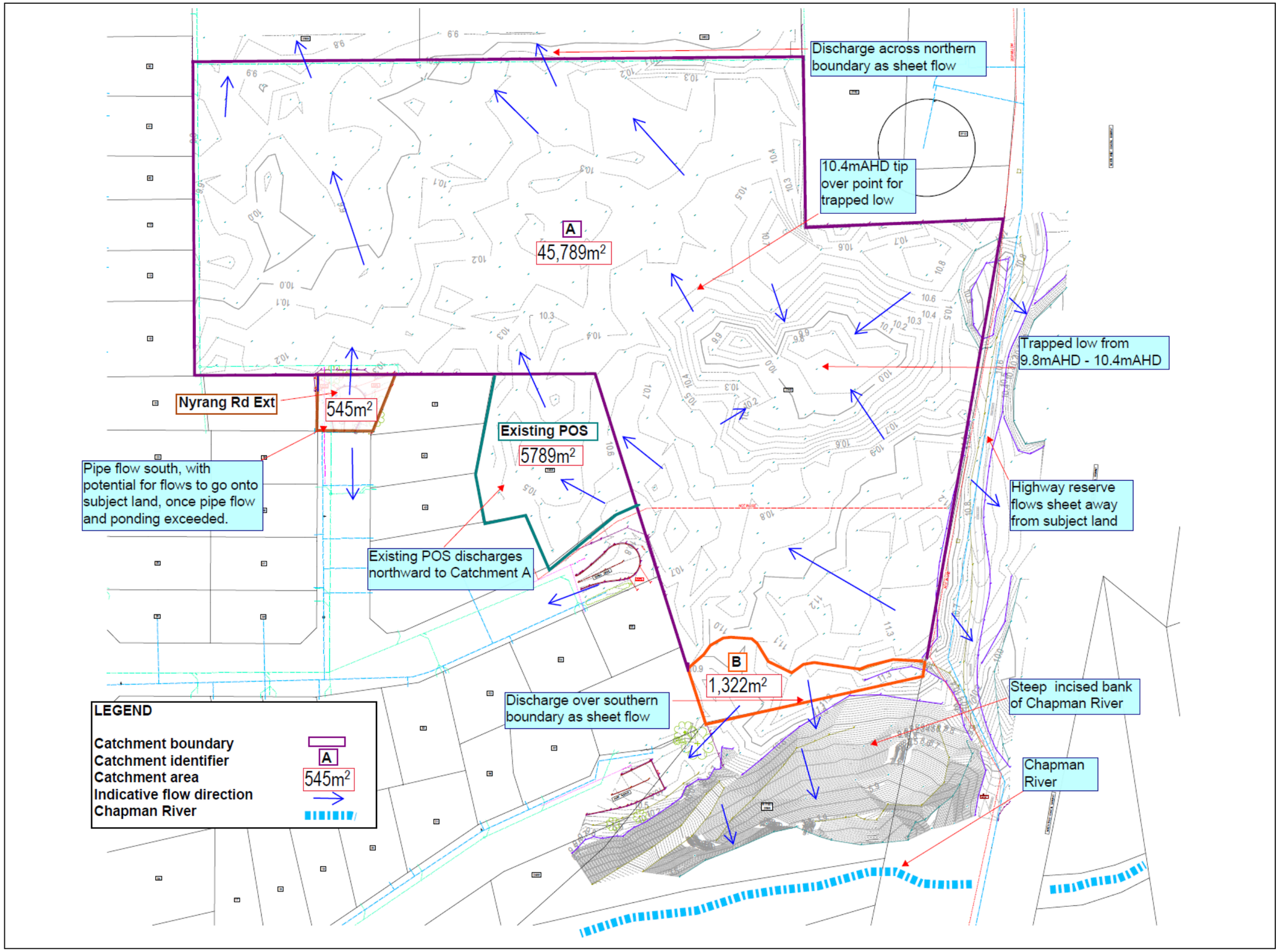


Figure 5 Existing surface water characteristics and pre development catchments

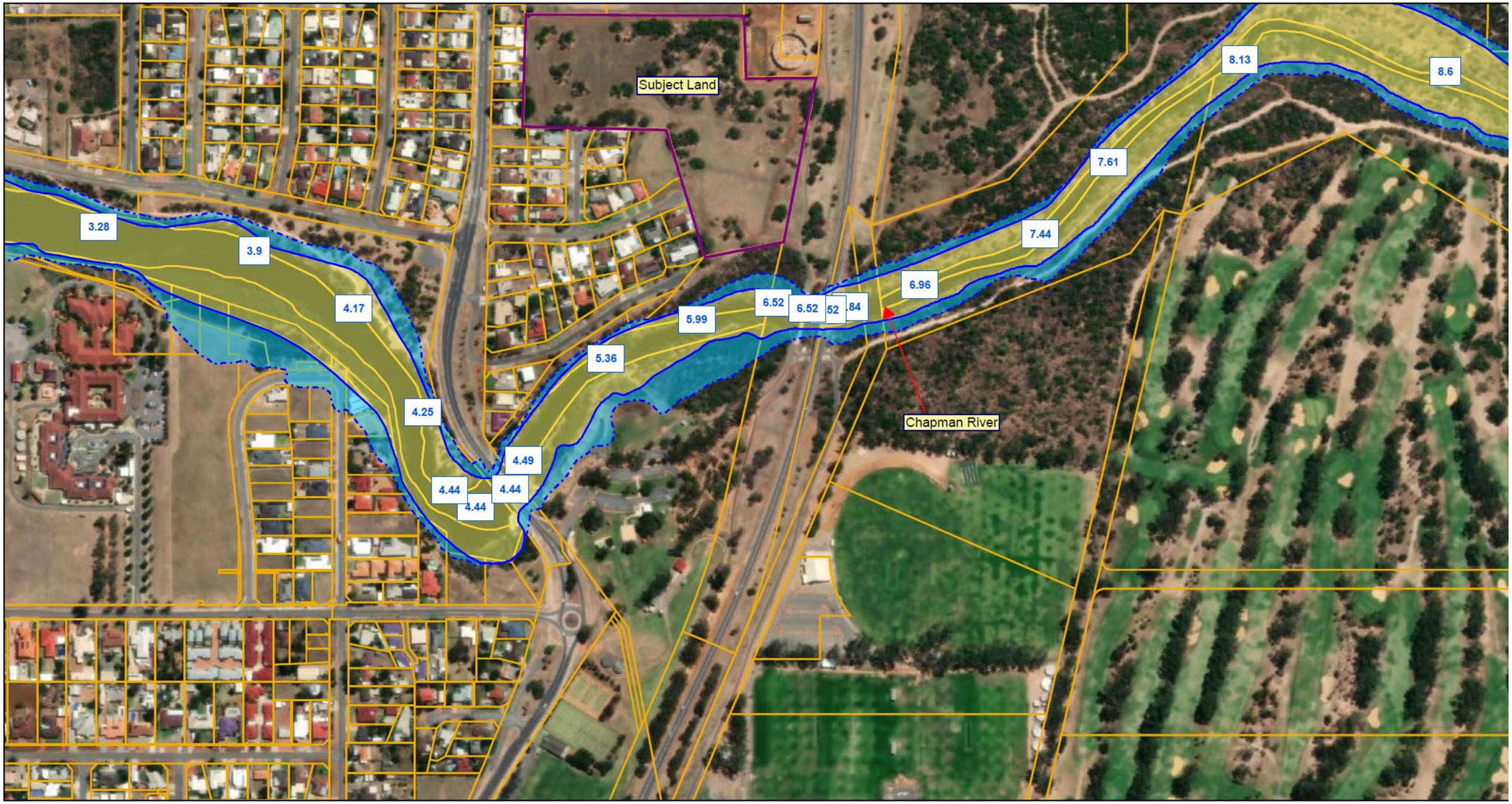


Figure 6 Chapman River floodplain

# 7 DRAINAGE MANAGEMENT STRATEGY OVERVIEW

The aim of Drainage Management for the subject land is to generally manage the water flows so that water treatment is achieved and that the major storms are controlled prior to release.

All flows up to the 1EY are to be treated to reduce nutrients, sediments and other contaminant prior to infiltration. Above the 1EY, the main function is to control the flow of drainage water throughout the subject land and its release from the subdivision. This water will predominately be captured and infiltrated while protecting lots from internally generated flooding.

Figures 7 shows the catchment boundaries. The following sections provide more detail on the overall stormwater managements.

## 7.1 MODELLING

The post development modelling for the development has been split into 5 internal sub catchments. The following is a summary of each catchment:

Post 1:
Flows north to POS A, with flows detained in a 1.2m deep basin. Discharge is via a broad spreader weir to the adjoining northern lot in the approximate location of predevelopment flows. There is no discharge in the 1% AEP or smaller events. The catchment is further divided into the northern section which includes POS A, roads, residential lots and a R30 group housing site. The southern section contains residential lots and road. The existing POS (Lot 2488) outside of the subject land also discharges into the road drainage network for the southern section. This is assumed to discharge as overland flow at predevelopment rates.

Post2:
Flows south a 1.20m deep detention basin in POS B. Discharge is via a broad spreader weir to the Chapman River in the approximate location of predevelopment flows (Only flows above the 1% AEP). There is no discharge in the 1% AEP or smaller events. The catchment contains POS B, residential lots and roads. There is no external flow entering the catchment.

Post 3 (minor catchment):
Contains short section of the proposed Guara Drive extension and 1 residential lot. Flows west via existing drainage pipe and overland flow (once pipe capacity exceeded) along Guara Drive.

Post 4 (minor catchment):
Contains short section of existing and proposed Nyrang Road and 1 residential lot. Flows south via existing drainage pipe with potential for overland flow (once pipe capacity exceeded) to flow into Catchment 1.

Post 5 (minor catchment):
Flows south to Chapman River. Contains a small section of POS B only. The area matches the predevelopment area that flows to the Chapman River (1332m$^2$). There is no detention and the pervious surface remains essentially unchanged. All flow is to be via broad overland flow with no pipes.

The catchments can be seen in Figure 7. More details of the catchments can be found in can also be found in Table 2.

Table 2 Catchment details

| Catchment | Area (ha) | Comments |
|---|---|---|
| **Post 1** | 2.3957 | Flows to POS A then out through northern boundary in events above the 1% AEP. |
| **Post 2** | 1.2477 | Flows to POS B then out to Chapman River reserve in events above the 1% AEP. |
| **Post 3** | 0.0929 | Flows to Guara Dr pipe network with overland flow west along Guara Dr. |
| **Post 4** | 0.1632 | Flows to Nyrang Rd pipe network until pipe and ponding is exceeded then assumed to flow to Post 1 catchment. Includes 0.0545ha of existing Nyrang Road. |
| **Post 5** | 0.1332 | Flows to Chapman river with no detention. |

Each subcatchment has been further divided to reflect the roads and lots as different entities. This allows for modelling of the lot detention and particular characteristics of the road network.

The key modelling assumptions and characteristics are as follows:

- Horton/ ILSAX drainage modelling method used.
- ARR 2016 methodology and rainfall figures used.
- Catchments were designed to be logical areas of stormwater capture and discharge.
- All roads were assumed to conservatively be 80% impervious, with 10% of this indirectly connected.
- Lot impervious were as per City guidelines and were assumed as follows:
    1. Lots greater than 700m$^2$ = 60% impervious,
    2. between 600 and 700m$^2$ = 70% impervious
    3. between 500 and 600m$^2$ plus R30 group dwelling = 80% impervious
    4. less than 500m$^2$ = 85% impervious
    5. 10% of Lot impervious areas were considered partially disconnected, eg impervious areas flowed over pervious areas to the on lot soakage systems.
- Lots have been modelled with the majority of the lot flowing to on lot storage. The lot storage is as per the City of Geraldton's guidelines of 1m$^3$ of storage for every 67m$^2$ of impervious area. Overflow from the soakwells/detention was assumed to flow to the street as overland flow.
- 30m$^2$ per lot was assumed to be impervious and discharge directly to the road network (treated as a separate micro catchment).
- Impervious areas had an assumed retardance coefficient of 0.01, while pervious surfaces (eg areas of grass or landscaping) were assumed to have a retardance coefficient of 0.1.
- Total flood depth in the basins is to be less than 1.2m in the 1% AEP. The sides are assumed to be sloped at 1:6. (See Table 3)
- The Detention basins were assumed to have bioretention media and suitable planting in the base.
- On lot infiltration was assumed to be 2.5m/day from the base only. On lot infiltration was assumed to be in 1m deep 'soakwells'.
- Basin infiltration was assumed to be non existent during storm events in line with City requirements, noting that the infiltration will conservatively be 2.5m/day from the base and sides to allow for drainage after the storm event.
- The final storms modelled were the 5min,10min,15min, 20min, 25min, 30min, 1 hr, 2hr, 3hr, 4.5hr, 6 hr, 9hr and 12hr. Longer events were not modelled as the peak events were generally between 2 and 4.5 hours These were modelled for the 1EY, 20%AEP and 1%AEP.

Table 3 Basin Details

| POS Basin | Basin depth | Basin Base | | | Basin Top | | | Available storage | Side slope |
|---|---|---|---|---|---|---|---|---|---|
| | | Length (m) | width (m) | Area (m2) | Length (m) | width (m) | Area (m2) | | |
| A | 1.2 | 61 | 15 | 915 | 26.9 | 75.4 | 2028.26 | 1614 | 1 in 6 |
| B | 1 | 100 | 1 | 100 | 112 | 13 | 1456 | 646 | 1 in 6 |

## 7.2 LOT BASED STORMWATER MANAGEMENT

Lot based stormwater detention is to be in accordance with the City's stormwater management policies. In general, all water draining from roofs, driveways, communal streets and other impermeable surfaces shall be directed to garden areas, sumps or rainwater tanks within the development site.

The modelling has assumed a total of 30m$^2$ of impermeable area (driveway) does discharge to the road directly, to make sure that the overall street drainage network is compliant and able to handle some direct lot flows in smaller events.

In line with the sites sandy soils and City's policy, a rate of 1m$^3$ of storage volume for every 67m$^2$ of impervious area has been assumed. When the capacity of this system is exceeded, the flow is assumed to enter the road network. Lots are to be levelled to facilitate flows discharging to the road network.

On lot stormwater management is to be reviewed for each lot by the City as part of the building application to make sure that it is compliant with the City's current Stormwater Management Local Planning Policy

## 7.3 1EY STORM EVENT AND WATER QUALITY

There is no outflow from the 2 main catchments in the 1EY, with all water infiltrated on site. The 1EY detention and treatment will predominately utilise bioretention basins to treat stormwater from the road network. The design parameters for treatment and attenuation of minor storms up to the 1EY event will be to provide treatment area within the bioretention gardens.

The treatment areas have been maximised and exceeds the 2% minimum area for bioretention areas per effective impervious catchment for the road network.

The base of these structures will be layered with bioretention media and planted with appropriate species to assist with treatment of low flows. These species will be composed of suitable native species that occur on the edge of wetland systems in the Geraldton area.

The bioretention areas are to be designed according to the latest FAWB Adoption Guidelines for Filter Media in Biofiltration Systems and the Stormwater Management Manual for WA design guidelines. The design for the gardens is composed of a filter media of amended soils to 500mm below the surface, with an average particle size of 0.5mm. The plants will also assist with nutrient absorption because of the surface area provided by their roots for the formation of bio-films and nutrient uptake.

In summary the media will:

- have a hydraulic conductivity of 100-300mm/hr
- have the top 100mm to be ameliorated with appropriate organic matter and trace elements to assist plant establishment (see table 1 in the attachment)
- have a transition layer to be a washed sand (100mm deep)
- have impermeable side barriers eg plastic to stop water flowing sideways preferentially and not being treated.

The bioretention areas should only require sporadic tankering irrigation during the initial 2 to 3 years of establishment if there is extended dry weather. They should require no fertiliser application and irrigation demands should generally be met by stormwater alone, after this initial establishment period. The gardens will be designed to assist in the removal of nutrients, sediments and other potential contaminants from stormwater as the water infiltrates through to the groundwater.

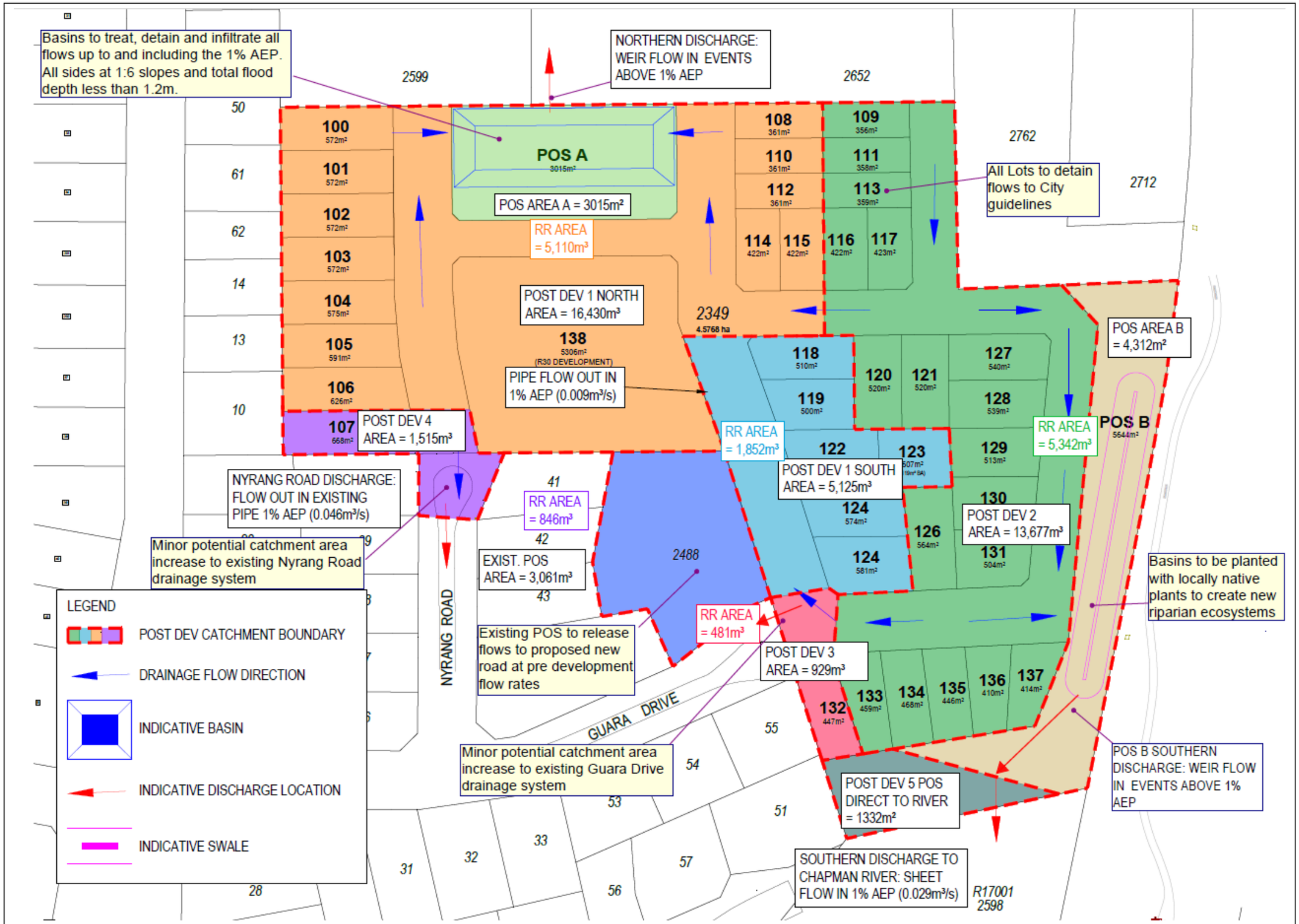


Figure 7 Post Development Drainage Plan

## 7.4 DRAINAGE MANAGEMENT PLAN – 20%AEP

As the entire site is a residential development, a 20%AEP management strategy has been applied to the subject land.

There is no flow from the development's 2 main catchments in the 20%AEP. The depth of water in the detention basins can be seen in Table 4.

As there is no assumed infiltration within the basins, the peak storms are generally the long duration storms that still exceed on lot infiltration capacity. Peak basin levels generally occur in the 4.5hr storm. With 2.5m/day infiltration, the peak storms are generally in the 2hr – 3hr range.

The peak minor flow for Nyrang was modelled as 0.015m$^3$/s in the from the 20min storm.
The peak minor flow for Guara Dr was modelled as 0.008m$^3$/s in the from the 20min storm.
There was no peak minor flow for the POS that drains to the Chapman River.

Further details can be seen in Table 4 and 6.

### Quality

It is not an objective of managing 20%AEP events to treat for quality, but the bioretention systems will treat the entire events for the 3 main catchments. All water infiltrating through the basin bioretention media during the 20%AEP event will receive treatment.

Table 4 20% AEP Basin and discharge summary

| POS Basin | POS Area (m$^2$) | Surface water area (m$^2$) | Water depth (m) | Volume (m$^3$) | Discharge flow rate (m$^3$/s) | Critical event | Comments |
|---|---|---|---|---|---|---|---|
| A | 3015 | 1190 | 0.53 | 488.4 | 0 | 4.5hr | All water held within basin |
| B | 5644 | 1104 | 0.76 | 352.5 | 0 | 4.5hr | All water held within swale |

## 7.5 DRAINAGE MANAGEMENT PLAN – 1%AEP

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

All floor levels will be more than 500m above the relevant adjoining 1%AEP flood level of the Chapman River (5.99 – 6.22mAHD).

All finished floor levels are to also be above the adjoining flood level of the ponding and flowing water within the development, with finished floor levels to be 0.3m above the top of the road gutter/road flood levels and POS basin top water levels.

There is no outflow from the 2 major catchments in the 1% AEP, with all flows detained and infiltrated in the 2 POS areas. This is in line with the City's requirements. POS 5 will discharge as sheet flow to the Chapman River at xx/ls which matches the predevelopment flow rate. This means there should be no adverse impacts on the downstream ecosystems or infrastructure.

The peak major flow for Nyrang was modelled as 0.020m$^3$/s in the 1% AEP from the 20min storm.
The peak major flow for Guara Dr was modelled as 0.013m$^3$/s in the 1% AEP from the 20min storm.
The POS flow to the Chapman River from Catchment 5 was 0.029m$^3$/s from the 15min storm

Table 6 provides a comparison of the pre development and post development flows for the subject land.

As there is no assumed infiltration within the basins, the peak storms are generally the long duration storms that still exceed on lot infiltration capacity. Peak basin levels generally occur in the 4.5hr storm. With 2.5m/day infiltration, the peak storms are generally the 1.5hr storm. All water will infiltrate in less than 72 hours after the storm has past, due to the conservative infiltration rate of 2.5m/day.

As part of detailed design, a suitable discharge structure is to be developed to facilitate flows from both basins via spreader weir systems. The discharge point is to be as close as possible to the existing discharge areas. The indicative locations can be seen on Figure 7. The final locations are to be determined in consultation with the City and generally be in the location of current sheet flow discharge.

Table 5 1% AEP Basin and discharge summary

| POS Basin | POS Area (m2) | Surface water area (m2) | Water depth (m) | Volume (m3) | Discharge flow rate (m3/s) | Critical event | Comments |
|---|---|---|---|---|---|---|---|
| A | 3015 | 3018 | 1.20 | 1157 | 0 | 4.5 hr | POS contains entire 1% flood storage, once basin full |
| B | 5644 | 4257 | 1.19 | 1120 | 0 | 4.5hr | Entire 1% flood storage contained in swale |

Table 6 Pre vs Post development flow summary

| Discharge Point | 20% AEP flow rate (m$^3$/s) | | 1% AEP flow rate (m$^3$/s) | |
|---|---|---|---|---|
| | Pre | Post | Pre | Post |
| **North (Recreation area)** | 0.003 | 0 | 0.246 | 0.0 |
| **South (Chapman River)** | 0 | 0 | 0.029 | 0.029 |
| **Nyrang Road** | 0.006 | 0.02 | 0.015 | 0.0230 |
| **Guara Drive** | 0 | 0.008 | 0 | 0.013 |

# 8 GROUNDWATER MANAGEMENT STRATEGY

The focus of groundwater management for the subject land is to maintain groundwater as close as possible to existing levels, while maintaining adequate separation from infrastructure. Furthermore, inflows to the groundwater will be managed to achieve a high water quality.

## 8.1 INFRASTRUCTURE SEPARATION

Due to the depth of groundwater being more than 2m below the natural surface, and on site earth works generally not changing levels by more than 1m, suitable separation to groundwater is able to be achieved without importing fill. Some fill may be used to achieve suitable grades for sewer. Any fill is to be free draining with a permeability at least as high as the insitu sand.

No subsoil network is envisaged, however this may be reviewed as part of detailed design. There may be a need for a subsoil network under the bioretention swales/basins, if lower permeability soils are encountered at depth.

## 8.2 QUALITY MANAGEMENT

Water off the road network will be directed to the bioretention swales/basins for treatment prior to infiltration. This will minimize nutrients and other contaminants from entering the groundwater.

Fertiliser use for landscaping areas will be minimize and will utilize slow release products, as necessary. This will reduce the total load of nutrients applied to the development area and minimse the risk for nutrient movement into the groundwater.

# 9 WATER SERVICING AND SUSTAINABLE USAGE STRATEGY

## 9.1 POTABLE WATER

The site is to be connected to the Water Corporation's potable water supply. The existing water network will have to be upgraded to DN 150 along the existing lengths of Gurara Drive and Nyrang Road. The Water Corp has designated two tie in points for this development each at the existing ends of Guara Drive and Nyrang Road.

## 9.2 WASTEWATER MANAGEMENT

The site is to be connected to the Water Corporation's wastewater system. The Water Corporation has an adjacent existing sewer network in place which they have indicated does have the capacity to cater for the approximate lot yield which is proposed. There are ample opportunities to join into the existing sewer network, those being along the Northern border, at the ends of Nyrang Road, Guara Drive and Park Avenue. The proposed internal sewer network and connection points will be determined at time of detailed design, once finished levels of roads and lots are finalised.

## 9.3 LANDSCAPING

Landscaping will use suitable native species and other waterwise species throughout. The objective of the landscaping is to implement strategies that minimise the quantity of irrigation required including mulching, low use of slow release fertilisers, retention of native trees where possible and new plantings of native species.

The stormwater management has been incorporated into the landscaping, with a focus on shedding stormwater to planted bioretention swales/basins. This will provide a significant portion of the irrigation requirement for the landscaping. Top up water and irrigation of other key minimal green landscaping will utilise either groundwater or mains water as a back up supply. Investigation into the suitability of a bore is to be undertaken as part of detailed design, noting that there is allocation available in 2 aquifers below the subject land currently. The investigation will include liaison with the City of Geraldton as to suitable long term POS landscaping.

## 9.4 FIREFIGHTING WATER SUPPLY

Fire hydrants will be provided throughout, as per the relevant regulations.

# 10 WATER DEPENDENT ECOSYSTEMS MANAGEMENT STRATEGY

The main water dependent ecosystem (WDE) that the site interacts with is the Chapman River. The on site water management has been undertaken to protect and enhance this ecosystem WDE. The following provides a summary of how water will be managed to protect the Chapman River as well as the creation of onsite WDE's.

## 10.1 CREATING NEW WDE

The creation of new WDEs are expected to provide benefits to the overall ecosystem functioning in the natural environment. The bioretention basins and swales will serve as ephemeral wetlands and provide some habitat for generalist species. To maximise the potential of the systems for habitat values and migration, the landscaping utilises locally native species, especially within the bioretention systems. The bioretention systems will increase the foreshore habitat and provide an ecological corridor to the north. The indicative locations of these systems can be seen in Figure 7.

Due to the ability of the insitu soils to infiltrate water and the considerable depth to groundwater, there will be no permanent water within the basin systems. All water will infiltrate in less than 72hours after rain has ceased. This will negate any potential for mosquito breeding habitat within the basins.

## 10.2 TREATMENT FOR PROTECTION OF DOWNSTREAM ENVIRONMENTS

The water quality treatment and detention structures will manage flows off the site so that the Chapman River receive clean water. The flow rates to the River are to be kept to the same as the pre development rate so this is not deemed to have any appreciable negative effect. Furthermore, any subject land peak flow rates will happen significantly prior to the main peak flow of the greater upstream catchment of the Chapman River.

All outlet structures are to be subject to a Bed and Banks permit as part of detailed design, so that a suitable structure is installed with minimal impact on the banks. The proposed landscaping will also utilise nutrient wise practices and native vegetation to minimise any potential runoff of nutrients.

# 11 MONITORING & MAINTENANCE

## 11.1 PREDEVELOPMENT

There has been no pre-development groundwater monitoring for the subject land due to the depth of the groundwater. Future geotechnical investigations will also check for groundwater as part of their pit investigations.

No surface water monitoring was undertaken due to the absence of any surface water bodies or waterways within the subject land.

## 11.2 CONSTRUCTION PHASE

Installation of sediment and stormwater control structures is to be undertaken ahead of the construction phase of the subdivision development where required. This will include the use of water sensitive urban design techniques such as sediment curtains, hydromulching and temporary detention basins to maintain the quality of the water leaving the development area during construction. The basins and pipe/pit network will be monitored for any damage, including sediment build up and litter accumulation during, and at the completion of, construction to ensure their effectiveness is not diminished post-development.

If deemed necessary, details are to be provided in a sediment and erosion control plan, which is to be undertaken prior to on-ground works foreach stage.

## 11.3 POST-DEVELOPMENT

Routine monitoring will focus on the functionality of the WSUD elements compared to their specified design requirements.

This 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; and
- excessive hydrocarbons are not present in the system.

Monitoring of the established WSUD elements operations can provide important insights on the likely performanceof them in pollution reduction and stormwater management functionality. Inspection of the WSUD elements will be undertaken by the developer until an agreed upon time between developers and the City (a minimum of 12 months afterthe completion of works) inspections should occur every three months. Table 7 summaries the particular items to monitorand the purpose of monitoring, the trigger signs that require immediate action and the maintenance action required.

The vegetated WSUD elements will only require minimal routine maintenance and these are generally of a landscape maintenancenature. 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.

It is recommended that vegetated WSUD elements are monitored by personnel with floristic knowledge and/or qualifications, as they will be capable of identifying evasive species within the 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 maintenance activities prompted through monitoring activities will generally require coordination between landscape and civil services.

Maintenance inspections should be scheduled to be conducted after a significant storm event. Inspections should focus on ponding time for the different systems, unequal surface flow distribution, sedimentation and scouring, vegetation removal, as well as deposition of coarse litter.

Table 7 Proposed Monitoring and Maintenance Schedule

| Function | Item to Monitor | Details Monitored | Trigger for Immediate Action | Maintenance Action Required | Proposed Monitoring Frequency | Responsible Authority (Timeline) |
|---|---|---|---|---|---|---|
| CONSTRUCTION PHASE & POST-DEVELOPMENT | | | | | | |
| Drainage Management Systems (includes traditional and WSUD systems) | Structural Design | Systems are constructed to engineer detailed design specification | Systems constructed differs to design specifications. | Remedial work to rectify systems 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 systems for any erosion related issues. | Monthly | Developer 1 year (ongoing by City) |
| | 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. | Monthly | Developer 1 year (ongoing by City) |
| | 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 Local Government 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 1 year (ongoing by City) |
| | Compaction | Inspection of filter media for compaction, could include being driven on. | 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. | Monthly | Developer 1 year (ongoing by City) |
| | 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. | Monthly | Developer 1 year (ongoing by City) |
| | 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 planting may be required. | Monthly | Developer 1 year (ongoing by City) |
| | 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. | Monthly | Developer 1 year (ongoing by City) |
| | 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 1 year (ongoing by City) |
| | 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 1 year (ongoing by City) |
| | Road sediment and litter | Determine level of sediment and litter build up on roads. | Visible litter and sediment that is in quantities that could have a detrimental impact on downstream WSUD systems | Sweeping of roads to remove sediment and litter | As required. | Developer 1 year (ongoing by City) |

# 12 IMPLEMENTATION PLAN

The developer is committed to undertaking the water management strategies outlined in this report. The following details the actions and works to be undertaken by the developer and relevant authorities as part of the development of the subject land.

### COMMITMENTS BY DEVELOPER

- Production of engineering drawings at the development of each stage of development.
- Water sensitive urban design techniques such as sediment curtains, hydro-mulching and temporary detention basins will be used to maintain the quality of the water leaving the development area during construction as required.
- Construction and ongoing maintenance of the stormwater drainage systems and infrastructure for 12 months.
- Appropriate earthworks employed across the site.
- Planting of native vegetation within bioretention swales/basins and maintenance for agreed timeframe.
- Planting of suitable landscaping species to minimize the requirement of non-stormwater irrigation.
- Production of UWMP's as relevant
- Updated modelling of all stormwater management systems as part of detailed design
- Produce and implement Construction and Sediment Control reports if required.
- Implement all servicing and drainage infrastructure in accordance with the LWMS and future detailed design.
- Apply appropriate fill and groundwater control structures on site as required.
- Undertake post-development monitoring as required.

### COMMITMENTS BY THE CITY OF GERALDTON

- Review and approval of the LWMS and future UWMP's
- Responsibility for the maintenance of the stormwater system after handover
- Approval of drainage design and other water management works.
- Approval of on lot stormwater detention systems as part of the individual building licenses

### COMMITMENTS BY DEPARTMENT OF WATER AND ENVIRONMENTAL REGULATION

- Review and approval of LWMS.
- Provision of advice to assist with approvals of the UWMP's, especially in relation to regional flood management.

### WATER CORPORATION

- Review and approval of water servicing designs.
- Manage the potable water service to the development post handover.
- Manage the wastewater servicing for the development post handover.

# 13 REFERENCES

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# Appendix A SERVICING REPORT

# Appendix B CLICK TO ENTER APPENDIX HEADING

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