

**DRAINAGE, NUTRIENT, IRRIGATION AND
WATER QUALITY MANAGEMENT PLAN -
CYGNIA COVE ESTATE, WATERFORD
MINISTERIAL STATEMENT NO. 692
CONDITION NO. 7 AND PROPONENT
COMMITMENTS NO. 5 AND 7**

Prepared for:

The Trustees of the Christian Brothers of Western
Australia Inc.
c/- Richard Noble and Company
Level 1, 189 Hay Street
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Report Date: 6 November 2008
Project Ref: 2007/259, V2

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6 November 2008

The Trustees of the Christian Brothers of Western Australia Inc.
c/- Richard Noble and Company
Level 1, 189 Hay Street
SUBIACO WA 6008

Attention: Mr Alex Gregg

Dear Alex,

RE: Drainage, Nutrient, Irrigation and Water Quality Management Plan for Cygnia Cove Estate, Waterford

Enclosed is Version 2 of the Drainage, Nutrient, Irrigation and Water Quality Management Plan for the Cygnia Cove Estate, Waterford. This Management Plan has been prepared in accordance with Coffey Environments' understanding of the requirements of Condition No. 7 and Proponent Commitment No. 5 contained in Ministerial Statement No. 692.

Coffey Environments will submit copies of this plan to the Department of Environment Conservation, the City of South Perth, the Swan River Trust and the Department of Water for approval.

Please contact the undersigned on (08) 6462 7900 if you have questions regarding the content of this report.

For and on behalf of Coffey Environments Pty Ltd



Paul Zuvela
Manager (Environmental Planning)

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1 INTRODUCTION

1.1 Background

The Trustees of the Christian Brothers in WA Incorporated (the Proponent) propose to develop their land at Waterford for a residential subdivision to be known as Cygnia Cove Estate.

The development of Cygnia Cove (formerly known as East Clontarf) has been planned as part of the Proponent's strategy to generate funds for the on-going maintenance of the Clontarf Campus as well as other community services provided by The Christian Brothers in both Western Australia and South Australia.

The site is located approximately 8km south east of the Perth Central Business District and is bound by Manning Road to the north, Centenary Avenue to the east and the Clontarf Campus to the west (Figure 1).

Clontarf Bay on the Canning River forms the southern boundary of the site, and approximately 30% of the site comprises a Resource Enhancement category wetland that trends east-west along the northern central portion of the site. The wetland drains to Clontarf Bay along a narrow drainage line situated near the western edge of the site.

The site has historically been used for farmland (grazing and market gardens), pine plantation and building infrastructure. Drainage channels were also created and maintained to assist in reducing groundwater levels. More recently, rubble in the form of brick fragments, concrete blocks, glass, ceramic tiles, metal sheets, rods and asbestos cement sheeting fragments had been dumped on the site.

The site has been mostly cleared as a result of past land uses and contains relatively few native and introduced trees and shrubs.

The subdivision has been formally assessed (Public Environmental Review (PER)) by the Environmental Protection Authority (EPA) and approval was granted by the Minister for the Environment. The Ministerial approval for the subdivision of the subject land was granted subject to a number of conditions as outlined in Ministerial Statement No. 692 (a copy is provided in Appendix A). Condition 7-1 requires the proponent to prepare a *Drainage, Nutrient, Irrigation and Water Quality Management Plan* (DNIWQMP) for the site.

1.2 Purpose and Scope

The Proponent has commissioned Coffey Environments (formerly ATA Environmental) to prepare a DNIWQMP for Cygnia Cove Estate. This DNIWQMP has been prepared in accordance with the Department of Water's (DoW, 2006) *Water Quality Protection Note (WQPN) No. 33 Nutrient and Irrigation Management Plans*, which outline the requirement for a Nutrient Irrigation Management Plan where potential land use activities may impact on the quality of nearby important water resources. This management plan fulfils the requirements under Condition No. 7 and Proponent Commitments No. 5 and 7 as outlined in the following section.

1.2.1 Ministerial Statement No. 692 Condition No. 7: Water Quality

Ministerial Statement No. 692, Condition No. 7 states:

7-1 Prior to ground disturbing activity, the proponent shall prepare a Drainage, Nutrient, Irrigation and Water Quality Management Plan to the requirements of the Minister for the Environment on advice from of the Environmental Protection Authority (EPA).

This Plan shall address the following environmental quality objectives as described in *Riverplan – An Environmental Management Framework for the Swan and Canning Rivers* (SRT, 2004) to protect, restore and maintain:

1. Ecosystem health
2. Biological diversity
3. Natural landscape
4. Recreation; and
5. Water supply.

7-2 The proponent shall implement the Drainage, Nutrient, Irrigation and Water Quality Management Plan required by condition 7-1.

7-3 The proponent shall make the Drainage, Nutrient, Irrigation and Water Quality Management Plan required by condition 7-1 publicly available.

1.2.2 Proponent Commitment No. 5: Drainage, Nutrient, Irrigation and Water Quality Management

Objective

1. To maintain acceptable water quality within the wetland and the Canning River in keeping with the Riverplan framework of management and best practice in urban stormwater management.
2. To ensure that no road surface run-off directly enters the wetland.
3. To ensure that there is provision for contaminant spillage entrapment.

Action

Prepare and implement a Drainage, Nutrient, Irrigation and Water Quality Management to the satisfaction of the DoE, the SRT and the City of South Perth, which will include:

1. Design and construction of the detention/infiltration basin;
2. Periodic monitoring of the infiltration basins (post-construction) to ensure continued function and maintenance required;
3. Quarterly sampling of surface water body for a 12-month period;
4. Maximising infiltration of uncontaminated stormwater at sources to recharge the groundwater system;
5. Water conservation principles;

6. Nutrient control;
7. Prescribed fertiliser applications for areas of public open space;
8. Determination of flushing requirements, associated impacts and management options;
9. Treating uncontaminated stormwater via gross pollutant and sediment traps;
10. Directing treated stormwater into the Canning River along the south-eastern corner boundary of the site (as per DoE advice);
11. Monitoring criteria to determine the success of the plan;
12. Develop and implement contingency measures to be implemented in the event that monitoring criteria are exceeded;
13. Progress and compliance reporting; and
14. Timing and implementation schedule.

Timing

Preparation prior to construction and implementation to be as determined within the DNIWQM Plan.

Advice

The Swan River Trust (SRT) and the City of South Perth (CoSP)

1.2.3 Proponent Commitment No. 7: Water Conservation Principles

Objective

To conserve water.

Action

Water Conservation measures will be applied within the development. These include:

1. Promoting the use of plant species which have low water and fertiliser requirements;
2. Utilising local native plant varieties in landscaping;
3. Promoting landscape treatments sympathetic to climatic conditions and prevailing site conditions – soil types, topography, environment, wetlands etc.;
4. Utilising “cluster or clump” plantings to provide useable shade areas and better use of reticulated water in preference to single item or symmetrical planting regimes;
5. Irrigating public open space areas at appropriate times so as to reduce evaporative loss and minimise transpiration losses; and
6. Ensuring that the irrigation regime applied to areas of public open space is responsive to prevailing weather conditions.

Timing

To be considered within the preparation of the Foreshore Management Plan, Groundwater Management Plan and the DNIWQMP (Commitments 3 and 9).

Advice

The Swan River Trust and the City of South Perth.

1.2.4 Public Availability of Documents

Extensive community and stakeholder consultation was carried out during the PER process, which included the opportunity for the public to make submissions on the PER documentation.

All management plans prepared to meet the requirements for Ministerial Statement No.692 (Appendix A), including this plan, will be made publicly available in accordance with EPA requirements. Notification of the availability of all management plans will be advertised through relevant media outlets (e.g. local newspapers), and copies of all management plans being lodged with:

- DEC Library – 2 copies;
- City of South Perth library – 2 copies;
- City of South Perth – 2 copies; and
- JS Battye Library – 2 copies.

1.3 Plan of Subdivision

The Cygnia Cove Estate development will include residential lots, group housing, public open space, drainage and roadways as shown in Figure 2. The total area of the site is approximately 32ha.

Clontarf Bay on the Canning River forms the southern boundary of the site, and approximately 30% of the site comprises a Resource Enhancement category wetland that trends east-west along the northern central portion of the site. The wetland drains to Clontarf Bay along a narrow drainage line situated near the western edge of the site.

2 EXISTING ENVIRONMENT

2.1 Climate

The area has a Mediterranean climate with mild wet winters and hot dry summers. The average annual maximum temperature is 23.3°C and the average annual minimum temperature is 13.3°C (all climate data provided is based on Bureau of Meteorology's Perth Regional Station, 1880 to present). The hottest months are January and February when the average maximum monthly temperatures recorded were 29.7°C and 30.0°C respectively. The cooler months July and August have recorded average minimum temperatures were 9°C and 9.2°C respectively.

Rain falls primarily in the winter months. Long term average rainfall is approximately 860mm with average maximum rainfall of 1338.8mm and average minimum rainfall at 508.7mm. The annual average rainfall has decreased significantly since the mid-1970s.

Seasonal wind patterns consist of a moderate south-easterly wind flow during the mornings in summer, with a moderate south-westerly wind flow in the afternoon. The winter wind flow pattern reflects synoptic flow. For example, north-westerly winds would be expected following a cold front.

2.2 Topography

The site contains two different landforms. The higher northern part of the site adjacent to Manning Road comprises a Bassendean dune formation, with a maximum elevation of approximately 9mAHD (Australian Height Datum) which slopes down to the peat wetland on the flat plain, 2mAHD-3mAHD, lying adjacent to the alluvial soil along the river 1mAHD. A small sand dune exists to the south of the wetland near Centenary Avenue. The eastern boundary of the site, with the adjacent former City of Canning landfill comprises a steep 5m embankment due to the presence of the built-up landfill material. The elevation also rises on the western boundary of the wetland near the Clontarf Campus.

2.3 Geomorphology and Surface Geology

A large part of the site is considered part of the Canning River floodplain (Jordan, 1986). The natural surface geology over the majority of the site (excluding the wetland) is mapped by Jordan (1986) as comprising Unit S₈, Bassendean Sand (of the Superficial Formation). Unit S₈ is described as fine- to medium-grained sub-rounded quartz sand which is very light grey at surface and yellow at depth (Jordan, 1986) and is highly porous.

Natural soils encountered during site investigations included sands consistent with the description of Bassendean Sand by Jordan (1986) over large areas of the site. Extensive areas of peat were also identified (described as sandy to clayey peat) extending beneath the current wetland, along the drainage line near the western margin of the site. Geotechnical investigations at the site were used to infer the extent of peat across the site. However, instead of peat adjacent to the foreshore, ATA Environmental identified clayey and silty soils matching the description of Guildford Formation (Jordan, 1986) at shallow depth beneath the Bassendean Sand unit (ATA Environmental, 2002).

The wetland in the north central portion of the site is mapped as comprising Unit S₁₄, Alluvium, which is described as white to pale grey, medium- to coarse-grained quartz sand with abundant shell fragments (Jordan, 1986). The soils of the wetland are predominantly peat and peaty sands extending from the surface to approximately 1m depth. The peaty soils overlie sand and silty sand at shallow depths.

According to Coffey Geosciences (2000), the approximate thickness of peat in the wetland area is 3m, decreasing in thickness towards the Canning River.

Previous investigations at the site have identified deposits of uncontrolled fill in several areas at the site, including several areas to the south and north of the wetland and areas in and around the foreshore reserve (ATA Environmental, 2003a). It is estimated that the uncontrolled fill covers approximately 2ha of the site and varies in thickness between 0.1m and 1.5m (ATA Environmental, 2003a). Contaminants identified in fill material include Asbestos, Zinc, Lead, Arsenic and Dieldrin.

Investigations undertaken by Coffey Environments (as ATA Environmental) identified that acid sulfate soils are present at the site, triggering the preparation of an *Acid Sulfate Soil Management Plan* (ATA Environmental 2003b, Coffey Environments, 2008a). Acid sulfate soils were encountered within the east-west portion of the wetland and extending from the wetland to the foreshore along the western edge of the site. Acidity is primarily associated with black peaty material as well as grey silty sands (ATA Environmental, 2003b).

2.4 Hydrology and Water Resources

2.4.1 Surface Water

The DEC's Geomorphic Wetlands of the Swan Coastal Plain Dataset, indicates that a kidney shaped wetland extends east-west across the central to northern portion of the site (Figure 3) and covers an area of approximately 4ha. ATA Environmental conducted site specific investigations into the extent and nature of wetlands at the site, and has designated a modified wetland boundary which have been accepted by DEC, as shown in Figure 3.

This wetland has been assigned a management category of Resource Enhancement. Resource Enhancement wetlands are partly modified but still support substantial functions and attributes (Hill *et al.*, 1996). Management priorities for Resource Enhancement wetlands should aim at wetland restoration through the maintenance and enhancement of wetland functions and attributes (Hill *et al.*, 1996).

JDA (2004) reported that approximately 12.2ha of the 18.5ha pre-development site is estimated to drain to the wetland (including the wetland area itself) and 6.3ha is estimated to drain directly to the Canning River.

The site also receives surface drainage from external catchments (Figure 4) as follows:

- Manning Road and Conlon Street catchment of approximately 6.9ha which discharges into the north western area of the wetland via piped drainage. The extent of this catchment area is indicative only as it is based on topographic data.
- Centenary Avenue catchment (26.0ha), which includes urban areas to the east of Centenary Avenue and north of Manning Road. These areas discharge into the site via piped drainage under Centenary Avenue into the eastern region of the wetland.
- Two smaller catchments to the west (1.0ha) and south east (1.5ha), which may discharge into the site from impervious areas as diffused overland flow.

On this basis, JDA (2004) estimated that the total upstream area draining into the site is 35.4ha, of which 33.9ha drains into the existing wetland and is discharged to the Canning River through a 750mm diameter culvert from the wetland into an overgrown trapezoidal channel. The flow rate discharging

from the wetland was estimated by JDA during fieldwork on 10 November and 31 December 2002 to be in the order of 20 litres/sec. Fieldwork completed by JDA in February 2007, measured the discharge flow rate from the wetland at approximately 10 litres/sec. These flow rates represent baseline flows, and do not take into account seasonal variations. To determine seasonal variation in flow rates, Coffey Environments has commenced monthly flow rate monitoring at this culvert. This monitoring commenced in April 2008 and is due to be completed in March 2009. The recorded flow rates so far have been:

- April 2008 - 22.46 litres/sec;
- May 2008 – 24.23 litres/sec;
- June 2008 – 24.23 litres/sec;
- July 2008 – 40.85 litres/sec;
- August 2008 – 35.63 litres/sec;
- September 2008 – 23.82 litres/sec; and
- October 2008 – 23.96 litres/sec.

Assuming 35% rainfall run off from the 46.1ha catchment and 790mm/year rainfall, the estimated annual average runoff is approximately 127,000m³/year, corresponding to 4 litres/sec, which is far less than the observed discharge. It is therefore, considered unlikely that surface drainage is sustaining the observed discharge from the wetland to the Canning River.

The wetland functions as a flow-through wetland (JDA, 2004). It is understood that the inflow to the wetland is diffuse groundwater discharge from the Superficial Formation along the wetland's northern boundary, and that due to the proximity of the Canning River, the outflow comprises surface water at the Canning River (rather than recharge to the aquifer down-gradient of the wetland (JDA, 2004).

2.4.2 Groundwater

The site lies on the northern bank of the Canning River within the Cloverdale groundwater flow area of the superficial formation aquifer (Davidson, 1995). Groundwater within the superficial formation is located between 1mAHD to 10mAHD, and discharges to the Swan-Canning River system. JDA (2004) calculated the estimated average annual maximum groundwater level (AAMGL) to range from 4.5mAHD at the northeast of the site to 0.5mAHD at the river edge. The AAMGL (Figure 5) was calculated by JDA (2004) using groundwater level data collected from on-site monitoring bores. The AAMGL was used to set the proposed controlled groundwater level to enable the finished lot levels (Figure 2) to be determined.

Groundwater flow is typically in a southerly direction towards the Canning River. Field observations indicate that a water table gradient of approximately 1.5m exists across the wetland within the Superficial Aquifer (JDA, 2004).

The water table gradient for the northern part of the site is typical of that of the region. Within the wetland and south of it to the Canning River, the gradient is far less, due to it being a zone of groundwater discharge with the water table effectively at the natural surface. In this area because of the low gradient of the natural surface, the water table, which is virtually coincident with the natural surface, also has a lower gradient than north of the wetland. There is no evidence that the peat

deposits beneath the wetland are less permeable than surrounding soil materials or that they form a barrier to groundwater flow.

The superficial formation extends down to approximately 25m below AHD. The 'through-flow' through the site from this aquifer is expected to be 200m³/day (JDA, 2004). The direction of groundwater flow in the superficial formation is essentially south towards the Canning River.

The superficial aquifer is underlain by the Leederville Formation which is approximately 300m thick.

Davidson (1995) indicates an upward head between the two aquifers indicating that the area is one of groundwater discharge from the Leederville to the superficial aquifer. However a confining layer of shale within the site creates a boundary between the two aquifers so that leakage is negligible.

Figure 6 is a conceptual model of the groundwater and surface water flows occurring within the site with associated influencing features. A hydrological investigation by JDA (2004) concluded that the constant water levels in the Resource Enhancement wetland at Cygnia Cove are largely due to the wetland being in a region of groundwater discharge and functioning as a through-flow wetland with some off-site generated stormwater inputs (these inputs only account for a minor percentage of water in the wetland).

Groundwater salinity beneath the site is described by Davidson (1995) as fresh (<1,000mg/l) although salinity increases along the Canning River foreshore due to mixing with higher salinity river water.

2.4.3 Water Quality

Coffey Environments has installed and monitored, seven groundwater bores across the site (Figure 5) as part of a quarterly baseline groundwater monitoring program. These results have been compiled into a *Baseline Groundwater Monitoring and Management Plan* prepared by Coffey Environments (2008b) in accordance with the requirements of Proponent Commitment No. 4. A summary of the groundwater quality results are provided in Appendix B. It should be noted that an additional six groundwater monitoring bores have been installed for purposes of acid sulfate soils investigations and monitoring during the construction phase. The following is a brief overview of the contents of the *Baseline Groundwater Monitoring and Management Plan* (Coffey Environments, 2008b).

Samples have been analysed for the following suite of parameters and results compared to *Fresh Water Guidelines (FWGs) for Aquatic Ecosystems* (utilising Lowland Rivers values where available, from ANZECC/ARMCANZ, 2000):

- A suite of metals (As, Ba, Cd, Cr, Cu, Fe, Hg, Mn, Ni, Pb, Se, Zn);
- Organochlorine (OC) and organophosphate (OP) pesticides;
- Total Petroleum Hydrocarbons (TPHs);
- Benzene, toluene, ethylbenzene, and xylenes (BTEX);
- Polycyclic aromatic hydrocarbons (PAHs);
- Inorganic parameters (pH, conductivity, total suspended solids (TSS), acidity, alkalinity, carbonate, hydroxide, chloride, sulfate, and hardness); and
- Nutrients (ammonia-N, NO_x-N, total Kjeldahl nitrogen, total nitrogen, and total phosphorous).

Appendix B contains a summary of groundwater quality and levels data collected from the seven monitoring bores at Cygnia Cove Estate. These results indicate that groundwater at the site is slightly

degraded with respect to the *FWGs for Aquatic Ecosystems* criteria, although there is no evidence to suggest that contaminant concentrations are greater in down-gradient bores than in up-gradient bores. Accordingly, it is concluded that the uncontrolled fill present at the site does not appear to have had a negative impact on groundwater quality. Provided below is a summary of the baseline water quality monitoring results:

Metals

The following analytes were found to exceed the *FWGs for Aquatic Ecosystems* criteria on one or more sampling occasions: Aluminium, Arsenic, Chromium, Copper, Nickel, Selenium and Zinc.

Organics

- No OP pesticides, OC pesticides, BTEX compounds, TPHs or PAHs were detected.

Inorganics

- Monitoring by Coffey Environments recorded groundwater salinity readings between 0.5mS/cm and 1.2mS/cm.
- Samples from all the bores except MW5 fell outside the recommended range of pH on one or more monitoring occasions.
- Concentrations of ammonia-N ($\text{NH}_3\text{-N}$), and oxidised-N ($\text{NO}_x\text{-N}$), and/or total nitrogen in all bores exceed guideline values in one or more rounds.
- Total phosphorus concentrations exceeded the *FWGs for Aquatic Ecosystems* criteria value at all locations in one or more rounds. The overall trend is one of decreasing concentration throughout the March to December period.

These results show metals and nutrient levels are the main water quality contaminants within groundwater at the site.

Surface and ground water tests were undertaken by ATA Environmental in March 2004, in order to determine any effect of the wetland on water quality entering Canning River (Coffey Environments 2008b). The bores sampled in the monitoring were the same as those used in the baseline groundwater monitoring excluding two which were damaged and had to be replaced.

Three superficial bores up gradient of the wetland were sampled for a range of metals, nutrients and pesticides. In addition, a sample of surface water was taken from the wetland at the culvert between the wetland and the drainage channel. The results indicate that the surface water is similar to the groundwater in quality for a range of analytes but lower in concentration for Nox-N, TKN, TN, FRP, TP, Aluminium and Dieldrin.

The results indicate that these elements are either being absorbed in the sediments and plant matter of the wetland or that significant dilution was occurring with water of lower concentration. The groundwater investigations conducted by JDA (2004) revealed that the outflow from the wetland probably represented the whole of the superficial formation which extends down to about 25m below natural surface. As the impacts of past land use are most likely to be concentrated in the top sections of the superficial aquifer, it is highly likely that the remainder of the aquifer has lower concentrations of these elements and is not affected by land use immediately over or near the site.

The lower concentrations in the water from the outlet drain are considered to be due primarily to dilution effects. This is associated with surface discharge of regional groundwater from the superficial formation

to the wetland which discharges via the drain to the Canning River. Results from surface water samples taken on the 28 March 2006 at two sites discharging from the wetland are also indicative of dilution occurring.

No measurements have been made of the ability of the wetland sediments to absorb nutrients and pollutants in the in-flowing groundwater, as dilution (described above) is considered to be the main process affecting water quality in the wetland outflow. However, most wetlands have some ability to bind phosphorous, metals and pesticides, mainly in sediments, particularly where the sediments are peaty and under anaerobic conditions, as is most likely the case in the existing wetland at Cygnia Cove.

The residence time of groundwater flow into the wetland prior to discharge to the Canning River is not known. Residence times are expected to alter post-development, due to a reduced storage area. However, it is anticipated that changes to residence times due to infilling of the eastern portion of the wetland should not affect water quality due to the dilution effects.

Bores located slightly down gradient of the former City of Canning landfill area (MW4, MW5) had elevated results for nutrients, arsenic and zinc. Due to the topography at the boundary of the former landfill site to the south-east, it is possible that run-off from the former landfill may flow in a north-westerly direction, and possibly introduce some component of north-westerly groundwater flow in this area of the site due to the porous nature of the Bassendean Sand.

An additional six groundwater monitoring bores have been installed at the Cygnia Cove development (see Figure 5 for indicative locations). These additional bores have been located in areas that can be protected against damage from machinery during the bulk earthworks program. The proponent's Contaminated Sites Auditor has requested that these groundwater monitoring bores are installed prior to the commencement of remedial works on the site. Further information relating to the monitoring of these bores is provided in Section 5.1.1.

2.4.4 Water Supply

Advice from Clontarf College indicates there are two extraction bores (extracting from the superficial aquifer) located to the west of the development site which are used for irrigation of the College grounds. Extraction rates from these two bores combined are estimated as 14L/s maximum (1,200m³/d). Recent information from Clontarf College indicates salt water intrusion is affecting one of these bores (located closer to Canning River) and a lowering of the water table is affecting extraction rates in the other (located in the northern portion of the campus closest to Manning Road).

Groundwater quality investigations suggest that the groundwater is of suitable quality for irrigation of public open space areas. The DoW has recently approved a bore licence (CAW165404(1) – Appendix C) for the extraction of no more than 14,625 kilolitres per annum. The bore will be located adjacent to Manning Road in the north of the subdivision (Figure 5) to avoid saltwater intrusion as experienced by other bores on the Clontarf campus that are located adjacent to the River.

The site is not located within an Underground Water Pollution Control Area.

2.4.5 Existing Wetland Values

The existing wetland has been assigned a management category of Resource Enhancement. This indicates the wetland is partly modified but still supports substantial functions and attributes. However, the current condition of the wetland is considered degraded due to the dominance of exotic species resulting from a long history of wetland modification and land use practices.

Typical wetland functions may include providing a habitat for native fauna and flora; provide a biologically productive and genetically diverse natural environment; maintain ecological processes; provide a recreational aspect of the natural landscape; form part of the natural hydrology, surface and groundwater drainage system; and serve as a scientific resource.

The existing wetland at the site was once used as a water supply for the Clontarf Orphanage for irrigation and domestic consumption. Beside this past use, it does not appear to serve many significant functions other than it is a part of a drainage system to Canning River. The drainage channel into which this wetland discharges has been artificially created, although it is likely to have been a natural drainage discharge point prior to construction as a drain. The wetland is completely covered in vegetation (native and non-native reeds and sedges), with no areas of open water. The portion of the wetland to be retained consists mostly of dense Bulrush (*Typha orientalis*) and Lake Club-rush (*Schoenoplectus validus*) Sedgeland. The presence of these reeds contributes to maintaining water quality within the wetland and discharge to Canning River.

The wetland currently provides a low diversity of habitat, lacks open water, and therefore may be considered to have limited value for fauna.

In its current condition, the wetland does not currently appear to provide any recreational function and there is no information suggesting it is a site for scientific or educational resource.

A *Wetland Management Plan* has been prepared to meet the requirements of the CoSP and the DEC (Coffey Environments, 2008c). A summary of the *Wetland Management Plan* for the 'Retained' Wetland is provided in Section 3.4.5.

2.4.6 Canning River and Foreshore

The Foreshore Reserve adjacent to Cygnia Cove Estate comprises a narrow linear wetland varying in width from 55m to 115m at the eastern end and comprises part of Bush Forever Site 333 (Canning River Foreshore, Salter Point to Wilson) and is linked to Bush Forever Site 227 (to the west) and 224 (to the east). The Reserve has an approximate 240m frontage onto the Canning River and contains various elements mostly in a degraded state including remnant woodland, reed beds and salt marshes.

The eastern section of the foreshore contains a unique salt marsh system with sand bar islands and contains a native grass (*Sporobolus virginicus*). The remainder of the foreshore along the northern boundary, on the higher ground has been highly modified, contains uncontrolled fill and is dominated by introduced grasses and weeds.

A *Foreshore Management Plan* (Coffey Environments, 2008d) has been prepared to meet the requirements of the Department for Planning and Infrastructure (DPI), DEC, CoSP and SRT. A summary of the *Foreshore Management Plan* is provided in Section 3.4.7.

2.5 Vegetation

2.5.1 Vegetation Description

Most of the site has been cleared of native vegetation as a result of past land use activities including cattle grazing, community farm, orchard and infilling to potentially create a sports field.

The absence of native vegetation around the wetland has enabled weed species such as Kikuyu (*Pennisetum clandestinum*) and lupins (*Lupinus sp.*) to become well established.

The drain from the wetland to the river in the south-west corner of the site consists of planted *Eucalyptus* trees including River Red Gum, Swamp Mahogany and Lemon-scented Gum. An examination of historic aerial photographs indicates that these trees were planted between 1968 and 1978.

The Canning River foreshore area contains a narrow zone of *Juncus kraussii* ranging in width from 10m to 30m from the edge of the river. Low Samphire (*Halosarcia halocnemoides*) shrubland also occurs in patches along the foreshore.

No Declared Rare or Priority flora species were recorded on the site during the flora surveys undertaken by ATA Environmental in 2003 for the purposes of the PER.

2.5.2 Vegetation Condition

Using the vegetation condition rating as developed by Keighery and used in *Bush Forever* (Government of Western Australia, 2000), the condition of the wetland vegetation is variable, ranging from Degraded to Very Good.

The upland area associated with the wetland buffer is classified as Completely Degraded as the basic vegetation structure has been lost and is almost completely without native species.

The foreshore vegetation is of variable condition with large areas considered to be Completely Degraded and some areas up to Very Good condition.

The remainder of the site is classified as Completely Degraded as the basic vegetation structure has been lost and it is completely without native species.

2.5.3 Vegetation Significance

Bush Forever (Government of Western Australia, 2000) identifies regionally significant vegetation for protection on the Swan Coastal Plain within the Perth Metropolitan area. The Foreshore Reserve vegetation has been included in Bush Forever Site No.333 "Canning River Foreshore, Salter Point to Wilson".

The native vegetation on the remainder of the site has not been identified as a Bush Forever site. The vegetation present in Cygnia Cove Estate would not belong to any Threatened Ecological Communities listed under the Commonwealth list of Endangered Communities and the DEC's TEC list.

2.6 Fauna

2.6.1 Habitats

The main fauna habitats on the site are considered to be the wetland dominated by Bulrush and other sedges, grassland surrounding the wetland and the Canning River including the adjoining foreshore.

The wetland is limited in its value to fauna due to the lack of open water sections, which thereby restricts its use by many species of waterfowl. It does support a variety of frogs and possibly the Long-necked Tortoise. The presence of the long-necked tortoise is based on identification of discarded tortoise shells along the Canning River foreshore several years ago. It is not known if there is an extant population at the site or not.

The sheltered cove of the adjacent Canning River is important for a range of waterbirds. This is probably due to several factors, including the outflow of freshwater from the site that may attract Black Swans, Musk Ducks, and other species that need to drink freshwater regularly, to the location.

The small area of salt marsh on the river foreshore together with the other largely well vegetated sections of foreshore is attractive to a range of fauna. The foreshore area forms a part of a largely continuous riparian habitat for fauna moving along the Canning River. The main faunal groups considered likely to inhabit the site are terrestrial and aquatic birds and amphibians.

2.6.2 Species

A brief fauna survey has been conducted between Clontarf and Mount Henry on the Canning River foreshore in autumn of 1993 (City of South Perth, 1993). The survey included areas of *Juncus kraussii*, which are typical of the foreshore vegetation found on the site. In areas representative of the subject site several species of skink, frogs, bush crickets and orb weave spiders were found. Black Swan (*Cygnus atratus*), Coot (*Fulica atra*) and Musk Duck (*Biziura lobata*) were identified on the river.

Additional information regarding the fauna of the site has been obtained through a series of site surveys undertaken at various times throughout the year. The surveys were undertaken by ATA Environmental in association with Bamford Consulting Ecologists. The results of this survey were documented in the PER document (ATA Environmental, 2003c). The surveys were designed to determine the value of the habitats on the site for fauna.

Frogs

Six species of frogs were recorded during the surveys. One of these species, the Pobblebonk (*Limnodynastes dorsalis*), was recorded only from nearby sites. Frogs were recorded within portions of the wetland, drainage lines, in a highly disturbed pit or sand quarry on the site and along the river. Within the wetland, records of frogs were restricted to the western portion, the drainage line extending to the river and within the drain that passes under Centenary Avenue.

Litoria moorei was recorded only within the marsh areas adjacent to the river although the habitat within the wetland also appears suitable for this species.

The low numbers of frogs calling from the majority of the wetland was unexpected. Conversely, the records of *Crinia georgiana* were unexpected as this species is patchily distributed on the coastal plain.

It is possible that frog diversity and abundance at the site has been adversely affected by past land uses and contamination. While the water within the wetland and drain is generally of good quality and the Bulrush provides a biofilter, past land use and contamination of the sediment and groundwater may be impacting on frogs within the wetland.

Reptiles

A small number of reptile species were recorded during the surveys. This can generally be attributed to the disturbed and highly modified nature of the habitats. The species found included the long necked tortoise (*Chelodina oblonga*), 3 species of skink lizards (*Acritoscincus (Bassiana) trilineatum*, *Cryptoblepharus plagiocephalus*, *Lerista elegans*) and two species of snakes (Tiger (*Notechis scutatus*) and Dugite (*Pseudonaja affinis*). All of the species are typical of the habitats and often persist in modified areas. Tortoise shells were found on two occasions suggesting that the species may occur in the wetland or may access the site from the river to lay eggs.

Birds

Six waterbird species were observed or heard within the wetland area on the site. The wetland area provides habitat for three species, the Spotless Crake (*Poizana tabuensis*), Clamorous Reed-Warbler (*Acrocephalus stentoreus*) and Little Grassbird (*Megalurus gramineus*), which were not recorded along the river. The Spotless Crake was recorded in rushes of the wetland from calls only, so identification is tentative. Other small crakes, such as Baillon's Crake (*Poizana pusilla*), could possibly occur in the wetland.

Mammals

No native mammals were recorded during the site survey. The survey revealed that foxes, rabbits, feral or semi-domestic cats and at least one species of introduced rat occur within the site.

Other

The introduced Mosquito Fish (*Gambusia holbrooki*) is present within the wetland. Gilgies (*Cherax quinquecarinata*) also occur within the wetland, especially where it flows from the wetland to the river. This record was not expected, as Gilgies are not known from other wetlands in South Perth.

2.6.3 Significant Species

Given the habitat condition and type at the site, it is expected that development of the Cygnia Cove Estate is unlikely to have a significant impact on any Specially Protected (Threatened) Fauna.

3 LAND USE

3.1 Historic

3.1.1 Aboriginal Heritage Values

The Canning River is a recognised heritage site which includes the entire length of the Canning River and associated creeks, tributaries and springs. Consultation and on site meetings with representatives of the local Aboriginal community confirmed that the Canning River is a site of major cultural and spiritual significance to traditional and contemporary Nyungars. The site was identified as part of hunting, collecting and fishing grounds significant to the Nyungar people.

The proponent has received a Section 18 clearance under the *Aboriginal Heritage Act 1972*. Section 18 clearance is required where there is potential for an activity to disturb a recorded site.

3.1.2 European Land use

Historical land use for the site based on air photo interpretation, Clontarf historical documents, and anecdotal information received from the Clontarf Brothers O'Doherty and Tuppin, is presented below in the context of changes in water management within the site:

- 1901 -1940.** Establishment of Clontarf orphanage, and associated clearing of wetland vegetation in the western wetland and establishment of vegetable gardens, orchard and grazing using the spring as water supply. Drain dug to reduce waterlogging of this land, draining to the Canning River. This land use would have lowered the water in the wetland water table and reduced water logging, allowing for the garden, and resulted in oxidation of the peat soils in the wetland, with consequent lowering of the natural surface.
- 1940-1945.** Christian Brothers and orphans evacuated and the buildings occupied by RAAF personnel. Gardens fell into disuse during this period and wetland vegetation re-established.
- 1946-1986.** Christian Brothers re-occupied the buildings and re-established the gardens, although not to the extent of pre 1940. By 1959 the aerial photographs indicate the gardens are no longer used and the wetland vegetation re-established. 1968 aerial photography suggests a deepening of the drain to the Canning River to allow part of the wetland to be filled for use as a sports oval. This again would have lowered the water table, leading to further oxidation of the peat and further lowering of the natural surface.
- 1970's.** Installation of the current pipe culvert and access track which has probably obstructed the improved drainage necessary for the operation of the garden, thereby raising the water level in and around the wetland.

Previous investigations by ATA Environmental (2003b) at the site have identified deposits of fill in several areas at the site, including several areas to the south of the wetland and two areas on the northern margin of the wetlands. It is estimated that the uncontrolled fill covers approximately 2ha of the site (Figure 7) and varies in thickness between 0.1m and 1.5m (ATA Environmental, 2003b).

Land to the south east of the site was previously used by the City of Canning for refuse disposal purposes, and has since been capped and vegetated with grass.

Groundwater quality monitoring has shown elevated results for parameters such as $\text{NH}_3\text{-N}$, TKN, chloride, sulphate, conductivity and zinc in bores MW4 and MW5 (Figure 5) which is not considered to be sourced from the uncontrolled fill that is present on-site, and are indicative of leachate from landfill. The leachate could be moving in a north westerly direction into the site due to the topography and porous nature of the landfill. To manage the risks associated with the former landfill site located adjacent to the Cygnia Cove Estate, no groundwater abstraction bores will be permitted on lots in 'private' ownership within the development and groundwater monitoring will continue during and after remedial works are completed at Cygnia Cove (further details of groundwater monitoring are available in subsequent sections of this Management Plan). Each lot sold in the Cygnia Cove Estate will have a 'Memorial on Title' prohibiting groundwater extraction.

3.2 Recent Land Use

The site consists of a wetland in the central region, a former community-based market garden along the northern boundary (last used in 2002-2003), evidence of uncontrolled fill between the wetland and Canning River (land previously planned as a sports oval, since abandoned), and the channel draining the wetland from its south west corner to the Canning River.

3.2.1 Recreation

There appears to be little use of the site for recreational purpose as there is limited access to the site. Some pedestrian access along the river foreshore, and unauthorised off-road vehicle access occurs on some occasions.

The wetland does not provide any recreational function and there is no information suggesting it is a site for scientific or educational resource.

3.3 Land Use Changes

3.3.1 Subdivision Design

It is proposed to develop the site for residential use with public open space. Street layouts and landscape treatments are directed towards views of existing local landscape features. These include existing wetland areas, the Canning River and the Clontarf Campus Chapel. Ecological zones of the River and Wetlands become the centre of the public open space system.

The residential development will include approximately 200 residential lots, group housing, public open space, drainage and roadways, with associated construction and building requiring bulk earthworks, establishment of concrete and bitumen surfaces, drainage systems and other infrastructure, as shown in Figure 2.

Remedial works will be required prior to development to remove geotechnically unstable material (uncontrolled fill) which locally exceeds the DEC's EIL guidelines for metals and contains some asbestos sheeting. During site remediation activities, a large volume of soil and waste material will be excavated and stockpiled, prior to removal to an approved landfill facility. It will be necessary to backfill areas where contaminated or geotechnically unsuitable soil has been removed. In addition it may be necessary to add fill to areas where existing elevations need to be raised to achieve finished levels and sufficient freeboard (1.5m) above groundwater levels. Details for these works are contained in the *Site Remediation and Validation Management Plan* (Coffey Environments, 2008e).

Bulk earthworks will be carried out as part of the site remediation works and during construction of the residential sub division. Specifically, the residential subdivision proposal involves:

1. Creating up to 200 residential allotments.
2. Setting aside approximately 4ha of rehabilitated and re-contoured wetland area in addition to approximately 8,000m² of public open space (approximately 24% of the developable area of the site).
3. Improving the riparian environment along the Canning River foreshore interface by removing uncontrolled fill and re-creating habitat that previously existed in the area.
4. Constructing a Paperbark wetland adjacent to the Canning River to encourage Black Swan breeding.
5. Ensuring that the link between the Canning River foreshore and the Resource Enhancement wetland is maintained.
6. Providing additional protection of the existing Canning River foreshore area by widening the river flats/ foreshore by approximately 6,000m².
7. Protecting a stand of significant Marri trees on the site.
8. Revegetating and integrating some upland native vegetation between the wetland and the Clontarf Campus buildings.

Earthworks will be conducted in accordance with the *Dust and Asbestos Management Plan* (Coffey Environments, 2008f), the *Acid Sulfate Soils Management Plan* which includes the dewatering strategy (Coffey Environments, 2008a) the *Site Remediation and Validation Management Plan* (Coffey Environments, 2008e) and the *Construction Environment Management Plan* (Coffey Environments, 2008g). A summary of each of these documents is provided in Section 3.4. Combined these plans detail management practices designed to protect wetland vegetation, surface water and groundwater quality during construction activities.

3.3.2 Landscaping Approach

The proponent's consultant landscape architect (Plan E) has developed a Landscape Concept Master Plan for the site (Figure 8).

Development of the Cygnia Cove Estate will result in the retention of 1.52ha of the existing wetland in Public Open Space with the balance (2.48ha) being drained and filled. The remainder of the wetland to be retained will be rehabilitated. This will result in the removal of peat soils and the re-contouring of the existing landform with batters tapering from the finished lot levels back towards the northern portion of the wetland to a level of 2mAHD. Batters will be landscaped and vegetated using local species.

As an offset to the loss of a portion of the existing wetland, the proponent has committed to constructing a wetland suitable for Black Swan breeding habitat. The details for the constructed wetland are contained in a *Wetland Management Plan for the Constructed Wetland* (Coffey Environments, 2008h), with a summary of the constructed wetland design provided in Section 3.4.6.

A range of interface treatments is proposed between conservation areas and the development. These treatments include direct lot frontage interface involving a boardwalk structure extending over the rehabilitated wetland up to the lot boundary, road frontage, a natural transition to the Canning River

foreshore and a steep rise embankment to Clontarf Campus. The dimension of setback of lots from the Foreshore Reserve boundary is approximately 26.1m along the western lots and 41.426m on the eastern side, subject to survey. This will add 6,000m² of public open space adjacent to the Foreshore Reserve. This area of public open space comprises remnant native vegetation which will enable increased protection and expansion of salt-marsh vegetation in this portion of the Canning River.

Revegetating with native plant species will create a variety of habitat types including closed sedgelands, *Melaleuca* woodlands, heathlands and open *Eucalyptus* woodlands. A diversity of forage species is essential to the long term success of a diversity of fauna on the site. Habitats are to provide year round foraging for nectar and insect eating animals, nesting and lookout sites and areas that are fenced will provide isolated areas that are protected. *Banksia* and *Grevillea* species are included to supplement the nectar requirements of the New Holland Honey Eater.

Specific areas for revegetation include the foreshore reserve, existing wetland, constructed wetland, detention storage areas, road reserves, entries and public access areas. In keeping with water conservation principles, mulch will be used on all revegetated areas. Less than 15% of public open space areas will have turf, and the use of native species in the revegetation program will minimise the need for irrigation. Further detail on irrigation is located in Section 4.4.

The degraded wetland buffer on the western side will be revegetated with native species with a particular emphasis on bush tucker species. A bush tucker garden will be planted closest to the path network in the wetland buffer area as part of a heritage walk trail. The bush tucker garden will relate the landscape to the Aboriginal Campus and serve as an educational feature.

Drawing inspiration from the site's ecology and history (both European and Aboriginal), hard landscape features, local streetscapes and public art will be integrated within the development. Natural products such as timber, stone and endemic vegetation form the basis of the design.

3.3.3 Potential Hydrological Impacts

The possible impacts associated with the development of Cygnia Cove Estate on site hydrology include:

- Altering the hydrology of the wetland and discharge through the drainage outlet due to removal of peat and infilling of the eastern portion of the wetland;
- Alteration to the fresh water flow volumes and/or quality in the wetland and to the stream and river;
- Pollution of the wetland, stream and river ecosystem by sediment, nutrients and organochlorine and heavy metal compounds that may be released from the wetland sediment during earthworks associated with wetland modification and construction activities; and
- Pollution of the wetland, stream and river ecosystem by acidic water as a result of acid sulfate soil reactions associated with the wetland modification and construction activities.

3.4 Management Plans

3.4.1 Dust and Asbestos Management Plan

The *Dust and Asbestos Management Plan* (Coffey, Environments, 2008f) presents strategies to ensure that nuisance and contaminated dust, including asbestos fibres, are controlled during the remediation, bulk earthworks and construction phases at the Cygnia Cove site.

Of 289 samples analysed for asbestos, fibres were only detected in four samples from the upper soil profile. It is considered likely that the identified asbestos fibres are derived from the weathering and disintegration of asbestos cement products which were previously identified during geotechnical investigations of the areas of uncontrolled fill.

In order to manage dust and asbestos issues, some of the key strategies to be employed include:

- Controlling site access through the installation of perimeter fencing, and use of signage.
- Asbestos containing fill, when excavated will be segregated (and sign-posted) from other asbestos-free materials.
- Remediation areas to be delineated prior to commencement of remedial works, with areas potentially containing asbestos identified to the civil works contractor.
- Implementation of site inductions and completion of visual inspections prior to commencement of site works.
- Asbestos fibre monitoring to be conducted in areas of the site which may potentially contain asbestos products.
- Dust suppression measures to be implemented.
- Installation of signage and barriers to be installed on-site.
- Use of appropriate personal protective equipment during earth working.
- Excavation of asbestos containing material to be excavated directly into trucks in a moist state, and the trucks to be covered with tight-fitting tarpaulins.
- Isolated fragments of asbestos to be hand-picked by workers with appropriate level of personal protective equipment.
- Implementation of decontamination procedures.

Dust may be created during construction due to vehicular movement on unsealed roads and ground disturbing construction activities. As the majority of the disturbed areas of the site will be landscaped and paved following construction, significant dust generation post construction is unlikely.

Dust management will comprise:

- Wind fencing;
- Surface stabilisation;
- The use of dust suppression in the form of water trucks and sprinklers; and
- Use of air quality monitoring equipment to monitor asbestos fibres, total suspended particulates, fine particulates, and heavy metals and pesticides. In addition, visual assessments will be undertaken.

Dust suppression binding agents may be used to enhance the dust suppression effectiveness of water sprays.

Earthworks will be undertaken in stages to avoid the creation of large areas of disturbance. Internal access tracks will consist of a hard surface, and wash down facilities for equipment will be provided.

3.4.2 Acid Sulfate Soils Management Plan

The *Acid Sulfate Soils Management Plan* (Coffey, Environments, 2008a) presents strategies to manage the acid-generating potential of soils at the Cygnia Cove site. A preliminary acid sulfate soils investigation for the site was conducted in 2003 with an additional investigation undertaken in 2007.

Field test results identified one soil interval with $pH_f < 4$. Soils with $pH_{fox} < 3$ were identified at six locations. Based on laboratory analytical results, samples from seven locations exceeded the DEC action criterion of 0.03% S. Acidity is primarily associated with black peaty material as well as grey silty sands, although there are intervals where such soils are found but no acidity is identified.

The soils with maximum net acidity concentrations above the 'acid sulfate soils management plan trigger value' encountered during the site investigations were the soils located within the east-west portion of the wetland and along the drainage line extending from the wetland to the foreshore along the western edge of the site.

To minimise the generation of acidity due to the disturbance of soil horizons with potential acidity, it will be necessary to follow soil and groundwater management strategies as outlined in Section 3 of the *Acid Sulfate Soils Management Plan* (Coffey Environments, 2008a). Some of these strategies include:

- Where soils exceeding the DEC's action criteria of 0.03% S are to be disturbed, they will require treatment to ensure that are limed with sufficient alkalinity to neutralise both any actual or potential acidity.
- Where excavation of acid sulfate soils material is required, the excavation work will be undertaken as rapidly as possible to minimise both the dewatering period (if required) and the exposure of soils at the edge and base of excavations to the atmosphere.
- Excavated acid sulfate soils material will be stockpiled on a bunded treatment pad pending treatment, or pending being trucked offsite for treatment (in order to allow it to dewater sufficiently). The bunded pad will be constructed of alkaline material of not less than 300mm thickness. The pad shall be graded to ensure good drainage and all sides shall be bunded with limestone or similar alkaline material to a minimum height of approximately 300mm above the surface of the pad to prevent lateral migration of acidic runoff.
- The preparation and submission of a Dewatering Management Plan prior to commencement of dewatering activities.
- Using a dosing tank to treat dewatering effluent, providing rapid and reliable neutralisation of extracted water, and to minimise the area required for treatment (in contrast to treatment ponds).
- Monitoring at the inlet and outlet of the dosing tank in accordance with Section 4.2.

It is anticipated that dewatering may be required when excavating organic-rich soil from the eastern portion of the wetland, which will subsequently be filled and developed. Excavations and dewatering will be undertaken in a staged fashion to minimise widespread ASS exposure during works.

The Contractor's Dewatering Management Plan must include the following information:

- The method of dewatering (e.g. dewatering spears, wellpoint dewatering etc.);
- The commencement date, duration, anticipated quantity, and frequency of dewatering;
- Description of the dewatering effluent treatment (see Section 3.3.2) the Contractor proposes to use;

- Proposed size and approximate location of storage or infiltration ponds;
- The alkaline material to be used in the neutralisation pond, the method of application and contingency measures in the event that the pH criterion (6 at the outlet) is not being met; and
- Contact details should complaints be received.

Groundwater modelling information will also be required to be undertaken.

It is anticipated that dewatering may be required in order to remove geotechnically unsuitable (organic-rich) soil from the eastern lobe of the wetland area, which will be developed. Under the existing hydrological regime, water in this area enters the site from the north and flows through the wetland before discharging to Clontarf Bay. During dewatering, this and any groundwater encountered will be diverted from the area of active excavation and run through a dosing tank and settling tank. Treated dewatering effluent may be allowed to infiltrate on-site, or may be used for dust suppression or discharge into the remaining wetland area.

3.4.3 Site Remediation and Validation Plan

The *Site Remediation and Validation Report* (Coffey Environments, 2008e) describes the management strategies that will be adopted to ensure that remedial earthworks for the Cygnia Cove development achieve an acceptable standard of soil rehabilitation consistent with the proposed future residential use.

Comparison of laboratory results for samples collected at the Cygnia Cove development site were compared to the EIL criteria. This comparison indicated that only limited soil contamination was identified, comprising samples which exceed the criteria for metals (12 samples) or equal the criteria for organochlorine (OC) pesticides (1 sample). Of 289 samples analysed for asbestos, fibres were only detected in four samples from the upper soil profile.

It is proposed to remediate the soil by excavation of the contaminated material. Validation samples will be collected in order to verify that residual soil in the walls and base of the excavations do not contain contaminant concentrations of the parameter of concern.

3.4.4 Construction Environment Management Plan

The *Construction Environment Management Plan* (Coffey Environments, 2008g) will be a compendium of all the environmental management plans prepared for the Cygnia Cove development. This document will form a single reference point for civil works contractors, and be a key component of the site induction practices. The *Construction Environment Management Plan* will be finalised and submitted to the DEC, once all supporting management plans have been finalised.

3.4.5 Wetland Management Plan – Retained Wetland

Coffey Environments (2008c), has prepared a Wetland Management Plan for the western portion of the Resource Enhancement wetland. This half of the wetland will be retained within the Cygnia Cove development, and rehabilitated to improve its ecological values. The following wetland management objectives are designed to achieve an improvement in the retained wetland values:

- Ensure that endemic native vegetation, wetland ecological values and functions are restored, maintained and protected through appropriate management of the site.

- Implement rehabilitation techniques to restore degraded areas (with particular reference to surrounding wetland buffer areas).
- Implement specific management and maintenance actions and schedules required to ensure the restoration and maintenance of ecological function.
- Protect the community from nuisance mosquito and midge events.

Earthworks in the wetland area around its margins will be necessary for the removal of peat and replacement with clean fill to enable the construction of a boardwalk/trafficable path. Similarly construction in the northeast portion of the remaining wetland will also be required to enable the construction of a small earth bund in the wetland area. The boardwalk structure will be constructed over the top of the earth bund to minimise disturbance. To ensure minimal damage to the portion of the wetland being retained, earthworks will be restricted to outer margins of the retained wetland area. Areas of the wetland disturbed during the construction process will be rehabilitated using native species.

The revegetation of the fringing wetland areas will include clumped plantings of tree species as well as other wetland species. Dryland species will be planted on higher ground. The wetland is densely vegetated with bulrush (*Typha orientalis*) and other rushes and sedges, with no areas of open water. The removal and replacement of the bulrushes in the wetland area will be undertaken by the proponent. To minimise the risks associated with the possible mobilisation of sediment during the removal process, the proponent will implement a spray program using Round-up Bi-active® to kill the bulrush. A trial completed in December 2007 has demonstrated that this method is effective in killing the bulrush. The treated area will be rehabilitated using plants salvaged from the eastern lobe of the wetland as well as native species from specialist nurseries. This approach will substantially reduce the risk of discharging sediments into the Canning River.

The bulrushes currently perform an important function with respect to maintenance of water quality. The bulrushes enhance nutrient take up from the water column as well as perform a filtering function aiding the removal of suspended solids. However, the replacement of bulrush with perennial native species will ensure that this water quality maintenance function is maintained.

The proposed improvements to the wetland include the creation of fauna habitat between the wetland and the river providing greater wildlife corridor value, removal of uncontrolled fill from the site, and treatment of stormwater within the wetland system.

3.4.6 Wetland Management Plan – Constructed Wetland

As part of the development of Cygnia Cove Estate, the proponent will construct a wetland as an off-set to the filling of the eastern portion of the existing wetland present on the site. The constructed wetland will be located on the western side of the existing drainage channel to the southwest of the proposed subdivision (Figure 8). A Wetland Management Plan for the constructed wetland has been prepared by Coffey Environments (2008h) providing details of the wetland design as well as prescribing a management and monitoring regime for the wetland.

The constructed wetland will include:

- Black Swan breeding habitat;
- Revegetation with local indigenous species;

- Landform re-contouring;
- Establishment and maintenance of wetland connection to Clontarf Bay and the Canning River;
- Weed control measures;
- Water quality and quantity monitoring; and
- Contingency measures to maintain or improve water quality of water flowing into Clontarf Bay and the Canning River.

The proposed wetland design is based on re-diverting some of the existing water flow from the upstream wetland through the constructed wetland in order to maximise the hydraulic flow path and optimise interaction of flows with the various functional treatment components. Water flowing into the wetland will be split at the junction of the existing drainage channel and the wetland inlet using weir structures at the inlet and outlet zones of the constructed wetland. The weirs will consist of a drop-in (bolt in place) metal plate that will enable the water level in the wetland to be altered. Stone pitching will be constructed at the inlet and outlet zones for scour protection. The stone pitching which will act like a riffle system to increase the quality and habitat values of the inflow. Storm events will by-pass the wetland and discharge via the drainage channel to Clontarf Bay.

JDA (2006) determined that a design top water level for the constructed wetland of 0.4mAHD would be feasible and would not interfere with the outflow from the culvert (at 0.53mAHD) upstream of the proposed constructed wetland. However, at 0.4mAHD, there would be an estimated 5% exceedance whereby tidal inflows from the Canning River would enter the constructed wetland. To eliminate potential impacts associated with tidal inflows from the Canning River into the constructed wetland, a design top level of 0.85mAHD was proposed. This would require the upstream culvert to be raised to 0.98mAHD. Testing by JDA (2007), determined that this re-adjustment would not alter flow rates and would marginally increase the area of inundated upstream by approximately 40m². Therefore, the proposed constructed wetland has been designed with a top water level of 0.85mAHD. This water level will be controlled through the use of two weir structures (one at the wetland inlet and one at the wetland outlet).

To accommodate Black Swan habitat requirements, the depth of the wetland will vary. However the base of the wetland at its deepest point will be -0.35mAHD. Therefore, excavation and dewatering for the constructed wetland has the potential to intersect ASS. Therefore, construction and dewatering activities will need to consider acid sulfate soils management. Coffey Environments (2008a) details the proposed approach for the management of acid sulfate soils at the Cygnia Cove Estate.

Water moving through the wetland will pass through densely vegetated areas prior to being discharged as a method of pollutant removal. The primary objective for the constructed wetland is to create Black Swan habitat, the wetland has not been primarily designed as a stormwater treatment wetland. It is expected that the rehabilitation of the wetland upstream from the proposed wetland will assist in the treatment of water entering the constructed wetland.

The quality of the wetland water will initially be determined by the quality of the water flowing into the wetland. The water quality for the constructed wetland could potentially be influenced by additional inputs into the existing wetland from other sources. However, the treatment function provided by the wetland will assist in water quality maintenance or improvement.

The creation of waterbird habitat may result in increased nutrient input arising from bird excrement and food sources. The extent of the potential impacts on water quality of the wetland is not known.

A monitoring program will be implemented to determine whether the wetland is meeting its intended objectives, to identify problems and to provide information for improving the wetland design process and operation.

Regular inspections will be needed to check that all components in the wetland are functioning correctly. Inspections will inform the maintenance program by identifying areas that need modification or repair. The maintenance program should be responsive to undesirable wetland changes.

3.4.7 Foreshore Management Plan

Generally the foreshore vegetation adjacent to the Canning River and contained within the Bush Forever Site No. 333 will be protected and an additional 8,350m² of public open space that will adjoin the Bush Forever Site will be added to the Foreshore Reserve and will act as a buffer between the proposed residential development and the Bush Forever Site (Figure 2).

The existing riparian vegetation along the foreshore of the Canning River is currently of variable condition with large areas considered to be Completely Degraded and some areas up to Very Good condition which require protection from any further disturbance. Public access to the Foreshore Reserve will be prevented through the construction of a limestone retention wall/batter and fence to delineate the subdivision from the Foreshore Reserve. Clearing of native vegetation will be avoided and only where necessary localised clearing may occur as part of remediation of contaminated soil. It should be noted that remediation works will generally be required on the proponent's land being ceded to the Crown and not in the existing Foreshore Reserve.

All contaminated soil will be removed from the additional Foreshore Reserve area, and clean soil brought in prior to any rehabilitation works. Clean fill will be imported from *Phytophthora* (dieback) free sources and filled back to pre-development levels. The depth of excavation will generally be 1m, although this will vary according to site conditions and the extent of contamination.

The restoration of the riparian zone will involve restoring the capacity of the native vegetation to regenerate. Weed control is necessary for long-term sustainability of the riparian system and the recovery of native vegetation function. A weed control program will be implemented prior to revegetation.

Dryland species of plants will be planted in late autumn to early winter to take advantage of the following winter rainfall and reduce the irrigation requirements. However, estuarine and wetland species may be planted up until early spring.

Public access into the Foreshore Reserve will be discouraged through the provision of fencing. The fencing will be also constructed to discourage access to the Foreshore Reserve by dogs.

4 DRAINAGE, NUTRIENT, IRRIGATION, WATER QUALITY MANAGEMENT

4.1 Management Objectives

The objective of the Drainage, Nutrient, Irrigation and Water Quality Management Plan is to address the following environmental quality objectives as described in “Riverplan – An Environmental Management Framework for the Swan and Canning Rivers (SRT, 2004). To protect, restore, and maintain:

1. ecosystem health;
2. biological diversity;
3. natural landscape;
4. recreation; and
5. water supply.

The following sections detail how development of the Cygnia Cove Estate will be undertaken in order to meet these environmental quality objectives.

4.1.1 Guidance Documents

The following documents provided guidance in the preparation of this Drainage, Nutrient, Irrigation and Water Quality Management Plan:

- DE4 Stormwater Disposal (Swan River Trust, 1999);
- City of South Perth Integrated Catchment Management Plan (CoSP, 2004);
- Stormwater Management Manual for Western Australia (DoW, 2004); and
- Water Quality Protection Note No. 33: Nutrient and Irrigation Management Plans (DoW, 2006).

4.2 Surface Water Management and Drainage Design

4.2.1 Design Approach

The post-development drainage system at Cygnia Cove Estate is required to accommodate surface drainage from urban areas and sub-soil drains, while preventing the deterioration of wetlands, the eutrophication of the Canning River, the control of peak flows into downstream water bodies and maintaining pre-development drainage lines on site.

The proposed urban water management system is consistent with water sensitive urban design practices as prescribed in the *Stormwater Management Manual for Western Australia* (DoW, 2004). In line with the manual, a main objective of the drainage system is to minimise the “effective imperviousness” of sections of the site.

The stormwater management system has been designed using a major/minor approach to infiltrate or convey and detain stormwater. **Wherever possible, stormwater will be infiltrated to replenish groundwater supplies.** However, in larger storm events where overland flow occurs, stormwater generated from the proposed development will be conveyed to detention storage areas to be constructed within the retained wetland and in the south-eastern area of the Cygnia Cove Estate.

Currently stormwater from the 26ha Centenary Avenue catchment discharges into the eastern region of the Resource Enhancement wetland. As this area of the wetland is to be drained and filled, the stormwater from the Centenary Avenue catchment to the east of the Cygnia Cove Estate will be conveyed to Detention Storage Area 1 (Figures 2 and 4, and Appendices E and F).

Stormwater from the Manning Road catchment to the north of the Cygnia Cove Estate also discharges into the western part of the Resource Enhancement wetland. This stormwater input will continue to discharge to the wetland.

In comparison, the volume of stormwater entering Detention Storage Areas 1 and 2 from the Cygnia Cove Estate is minor, as the drainage system has been designed to infiltrate the frequent storm events.

Stormwater generated from within the Cygnia Cove development will not discharge directly into the Foreshore Reserve with the exception of localised surface runoff from the dual use path. All surface runoff generated for storm events up to the 1 in 100 year Annual Recurrence Interval (ARI) in the catchment area of Detention Storage Area 2 will be retained on-site.

Pre-development freshwater discharge will be maintained in the drainage channel linking the wetland to the river. The continuous flow of water (from groundwater sources) will be split (using a weir) between the existing drainage channel and the constructed wetland. Based on a minimum flow rate of 5 litres/sec diverted to the constructed wetland, the exchange period will be less than four days. The constructed wetland will then discharge back into the drainage channel prior to discharging to the Canning River.

The proposed urban development will be connected to the Water Corporation's main sewer.

4.2.2 Minor System

The minor system consists of a series of kerbs and gutter pits, side entry and bubble up pits, underground pipes soakwells and infiltration cells, designed to carry and/or infiltrate runoff generated by low frequency (1 year) ARI storm events. A design plan for the minor drainage system is provided in Figure 9.

Each side entry pit will contain an infiltration cell consisting of "Atlantis" drainage cells which have the capacity to infiltrate the runoff from 1 year ARI events (Appendix D). The "Atlantis Cells" will be fitted with a removable geo-fabric around the inlet unit (Appendix D). These inlet cells will be easily removed as they will require maintenance at the beginning of the wet season (May), after rainfall events and at the end of the Wet Season (November). This will allow sediments and other pollutants to be trapped and removed easily.

The Cygnia Cove Estate is located in the Waterford Drainage Precinct as defined in the City of South Perth's (2002) *Management Practice M415 Stormwater Drainage for Proposed Buildings*. The requirements for this precinct state: "new developments will not be permitted to use soakwells for their stormwater drainage requirements in the Waterford Drainage Precinct other than for temporary detention purposes". The infiltration cells and soakwells are part of the minor system of the drainage design. As such they will be used to infiltrate low frequency stormwater events (>1 year ARI) and won't be used for detention purposes. It should be noted that the finished lot levels will be raised above existing ground levels to maximise opportunities for the infiltration of frequent storm events.

Any overflow from the minor system will be directed to the major system.

4.2.3 Major System

The major system is defined as the arrangement of pipes and detention areas planned to convey the stormwater run-off from extreme events that exceed the capacity of the minor system. A design plan for the major system is provided in Appendix E.

Sub-soil drains will be installed along the northern margin of the eastern portion of the Resource Enhancement wetland (this section will be excavated and backfilled as part of the site works). These sub-soil drains will intercept groundwater flows that currently enter the eastern part of the wetland, and direct the groundwater towards the western portion of the wetland (the section that is being retained), thereby maintaining the existing hydrological regime. The sub-soil drains will be installed to create a controlled groundwater level at or above the AAMGL, with the addition of clean fill to provide adequate separation between the finished lot levels and groundwater. This approach will ensure that there is no damage to buildings post-construction.

The stormwater overflow from the minor system will be directed to two detention storage areas (further details in Section 4.2.4). Gross pollutant traps (with oil baffles installed) will be incorporated prior to stormwater discharge points to the detention storage areas to trap and remove gross pollutants (such as litter, leaves etc). These gross pollutant traps will require maintenance prior to the winter rainfall season and after rainfall events to remove accumulated debris to ensure optimal performance and reduce the risk of these devices being used for mosquito breeding. The gross pollutant traps to be used in the Cygnia Cove Estate will be subject to approval by the City of South Perth prior to installation. The proposed gross pollutant traps to be used are the Rocla CDS® Unit gross pollutant trap. These traps will be fitted with the oil baffle, eliminating the requirement for the installation of hydrocarbon interceptors within the drainage system. Further information about the Rocla CDS® Unit gross pollutant trap is available from www.rocla.com.au.

4.2.4 Detention Storage Areas

The detention storage areas to be constructed will improve stormwater water quality from >10year ARI events prior to discharge to the retained wetland or the Canning River. This will be achieved by detaining water within the detention storage areas, which will function as bio-retention/infiltration areas, removing nutrients, sediments and other pollutants from the stormwater.

Both detention storage areas should be viewed as the last step in an integrated stormwater management system for the Cygnia Cove Estate. ***These will only receive stormwater inputs from the Cygnia Cove Estate when the infiltration and storage capacity of the minor drainage system has been exceeded during large storm events.*** The detention storage areas (in particular detention Storage Area 1) will continue to receive stormwater inputs generated from off-site catchments. However, gross pollutant traps will be installed by the developer to provide some end-of-pipe treatment for stormwater generated from outside of the Cygnia Cove development.

Construction of the detention storage areas may require earthworks which may intersect with the identified acid sulfate soils horizon. Construction and dewatering activities will need to consider acid sulfate soils management in accordance with the *Acid Sulfate Soils Management Plan* prepared by Coffey Environments (2008a).

4.2.4.1 Detention Storage Area 1

Detention Storage Area 1 will be located in the retained wetland (Figure 2 and Appendix F). This storage area will be created by constructing an earth bund which will be permeated with a centrally

located culvert of 225mm diameter (refer to Appendix F). This design will retard the stormwater to increase residence time and enable the rushes and sedges to filter the stormwater prior to it entering the wetland. Based on preliminary estimates, with existing groundwater inputs, off-site generated stormwater inputs and overflow inputs from on-site generated stormwater, the residence time in Detention Storage Area 1 will vary between 5 hours and 15 hours (Appendix F). However, when considering the combined Detention Storage Area 1 and the portion of the Resource Enhancement wetland being retained as a single system, residence time will vary between 11 hours and 30 hours (Appendix F).

Due to the existing hydrology of the wetland and with the off-site stormwater inputs, Detention Storage Area 1 will be permanently inundated and function as a bio-retention system, consistent with the pre-development function of the existing wetland. A gross pollutant trap will be installed ensuring that stormwater is treated before entering Detention Storage Area 1. If operated effectively (including regular maintenance in accordance with the manufacturer's instructions), the risk of sediments entering Detention Storage Area 1 is considered minimal.

The portion of the wetland where Detention Storage Area 1 is to be created is currently a closed sedgeland dominated by *Typha orientalis* (Bulrush). The proponent will implement a Bulrush control program and revegetate the detention storage area with native species. The control program will consist of spraying the Bulrush with Round-up Bi-active®. A trial using this control method was successfully implemented around the northern margins of the wetland in December 2007.

4.2.4.2 Detention Storage Area 2

Detention Storage Area 2 (Figure 2 and Appendix F) is located in the southeast portion of the site. It will receive and treat stormwater runoff from a small portion of the development, as well as minor inputs from the Centenary Avenue catchment. Detention Storage Area 2 will retain all stormwater generated in its catchment for storm events up to the 1 in 100 year ARI storm event. Therefore, it is anticipated that there will not be any direct discharge of stormwater into the Foreshore Reserve, eliminating the risk to the salt marsh communities (Figure 2) in the Foreshore Reserve.

A designated sedimentation area is not considered necessary for Detention Storage Area 2 as a gross pollutant trap will be installed prior to the stormwater inlet. If operated effectively (including regular maintenance in accordance with the manufacturer's instructions), the requirement for on-going sediment removal from Detention Storage Area 2 is considered minimal. The stormwater outlet structure in Detention Storage Area 2 will be a bubble up pit (Appendix F).

The detention storage areas will act as an bio-retention system for stormwater in which nutrients and other pollutants are concentrated. These pollutants will be removed via the native rushes and sedges which will be planted in the detention storage area (excluding the sedimentation area). A list of recommended plant species is provided in Appendix G. However, it should be noted that frequent storm events (e.g. the 1 in 1 year ARI event) will be infiltrated within the development, and that detention storage areas will treat larger storm events which typically have better water quality than smaller storm events. The flow-path of stormwater will be broken and spread evenly across the width of the detention storage area through the use of rushes and sedges.

The resultant batters of the detention storage areas will be at a maximum slope of 1 in 6. The bank and base of the detention storage areas will be reinforced with limestone at the inlet. An outflow grated pit will be installed in Detention Storage Area 2 (Appendix F) to allow storm events greater than the 1 in

100 year ARI events to discharge to the Canning River foreshore area. The outflow headwall structure will be reinforced to prevent scouring and erosion should overflow from Detention Storage Area 2 occur.

Downstream of Detention Storage Area 2 is a salt marsh ecosystem (Figure 2). As Detention Storage Area 2 has sufficient capacity to detain up to the 1 in 100 year ARI event, it is anticipated that there will not be any adverse impacts to the salt marsh community.

4.2.5 Maintenance of Detention Storage Areas

Both detention storage areas will require some level of on-going maintenance throughout the construction period and after storms to ensure they continue to function as required. This maintenance will include range from visual inspections to ensure structural integrity following a storm through to infrequent removal of sediments (if required). Sediment removal from the Detention Storage Areas 1 and 2 is considered to be an infrequent management requirement as each Detention Storage Area will have a gross pollutant trap installed to treat inflowing stormwater. If operated effectively (including regular maintenance in accordance with the manufacturer's instructions), the risk of sediments entering Detention Storage Areas 1 and 2 is regarded as minimal.

Monitoring for the establishment of weeds within and around the detention storage areas is required as gardens within the urban catchment draining to the detention storage areas are likely to include exotic species that have the potential to become invasive weeds.

4.3 Groundwater Management

As outlined in Section 4.2 water sensitive urban design principles will be applied throughout the development with preference for infiltration of stormwater at source to recharge local groundwater systems. This will occur through the minor drainage system as described in Section 4.2.2.

Filling of the eastern portion of the Resource Enhancement wetland will reduce the length of the area in which groundwater discharges by approximately 20% (JDA, 2004). Groundwater from the superficial aquifer that currently discharges along this perimeter will be captured by sub-soil drains and directed to the Detention Storage Area 1, thereby replicating the existing hydrological regime.

To manage the risks associated with the former landfill site located adjacent to the Cygnia Cove Estate, no groundwater abstraction bores will be permitted within the development and groundwater monitoring will continue during and after remedial works are completed at Cygnia Cove (further details of groundwater monitoring are available in subsequent sections of this Management Plan). Each lot sold in the Cygnia Cove Estate will have a 'Memorial on Title' prohibiting groundwater extraction.

Groundwater levels will be controlled in selected areas to maintain groundwater levels at approximately or just above the defined AAMGL for the site. A large portion of the site will be filled (following completion of remedial works) to ensure that final lot levels have sufficient freeboard (minimum of 1.2m) above groundwater levels.

4.4 Irrigation Management

In keeping with the requirements of Proponent Commitment No. 7 (Water Conservation Principles) of the Ministerial Statement, a variety of water conservation measures have been used to guide the landscaping plan for the site so that the long-term reliance on bore water is minimised. For example, the proponent will be undertaking most plantings in winter to minimise irrigation requirements. Plantings will rely heavily on the use of native species as well as minimising grassed areas. Manual

watering will be implemented in non-irrigated areas to assist with plant establishment. This approach will limit the need for ongoing irrigation and it is proposed that any irrigation will be temporary until plants have established. The planted areas will be mulched to reduce water loss through evaporation and improve the moisture retention capacity of the soil.

The irrigation schedule is provided in Table 1. The main areas of planting which will require irrigation include the bush tucker garden, small public open space areas, entries, public access areas and streetscapes along Manning Road and Centenary Avenues, as shown in Figure 10.

Table 1
Irrigation Schedule

Area	Plant type	Water source	Irrigation rate	Frequency
Bush Tucker Garden	Variety refer to Wetland Management Plan (Coffey Environments, 2008c)	Dry or install a domestic type bore	Drip irrigation for 75 minutes	Summer – Weekly (every 6 days) Winter – Fortnightly to monthly
Public Open Space Areas	Native trees and shrubs	Install domestic bore	Drip irrigation for 75 minutes	Summer – Weekly (every 6 days) Winter – Fortnightly to monthly
Streetscapes - Manning Road	Native trees	Existing Bore	Drip irrigation for 75 minutes	Summer – Weekly (every 6 days) Winter – Fortnightly to monthly
Streetscapes - Centenary Avenue	Native trees	Dry	Drip irrigation for 75 minutes	Summer – Weekly (every 6 days) Winter – Fortnightly to monthly
Streetscapes - Internal	Native trees and shrubs	Install domestic bore	Drip irrigation for 75 minutes	Summer – Weekly (every 6 days) Winter – Fortnightly to monthly

A calculation of the water requirements for 1.81ha of native planting and 357 trees indicates that a water supply of approximately 6 litres/sec is required to meet peak irrigation demand. Planting will mostly be undertaken during winter months (except for wetland species which can be planted up to early Spring), and therefore minimal irrigation is recommended for plant establishment. Deep watering (longer watering periods less often e.g. 1 hour and 15 minutes every 6 days) is recommended for native species.

It is recommended that the dryland plants are watered weekly to fortnightly during the summer months and then fortnightly to monthly during the cooler months to reduce plant deaths at least during their first year following planting.

Groundwater quality investigations suggest that the groundwater is of suitable quality for irrigation of public open space areas. From a sustainability perspective, it is preferential to utilise groundwater resources than using water from potable supplies.

The DoW has approved a bore extraction licence (CAW165404(1) – Appendix C). The bore will be located adjacent to Manning Road in the north of the subdivision (Figure 5) to avoid saltwater intrusion as experienced by other bores on the Clontarf campus that are located adjacent to the Canning River.

At the request of the City of South Perth, the proponent's consultant landscape architect or nominated irrigation designer will liaise with the City prior to design approval for the irrigation system.

4.5 Water Quality Management

EPA Objective

"To ensure that emissions do not adversely affect environmental values or the health, welfare and amenity of people and land uses by meeting statutory requirements and acceptable standards."

Managing sources of water quality pollutants during and post-construction is important to ensure that the environmental objectives are protected, restored and/or maintained.

Water Quality is a specific term used to describe the quality of water required for a particular purpose. The environmental objective of this plan is to ensure water entering receiving environments (i.e. the Canning River) is of a quality to protect, restore and maintain ecosystem health, biological diversity, recreation and water supply as described in *RiverPlan* (SRT, 2004). The water quality pollutants relevant to the site are described below.

4.5.1 Nutrients

Nutrients come from a wide range of sources but are generally a form of either nitrogen or phosphorous. They are naturally occurring and essential to the productivity of a waterway however excess loads under the right conditions can cause eutrophication leading to algal blooms and proliferation of pest and vector species. Nutrients should be minimised at the source or via non-structural controls as recommended as the most effective method of management in the *Stormwater Management Manual for Western Australia* (DoW, 2004-2007). Source controls have been identified as a very cost effective and potentially significant means of addressing stormwater quality, thus reducing the reliance on components of the drainage system for removal.

Potential sources of nutrients into the drainage system and waterways of the site come from both on-site and off-site, due to surrounding catchments discharging into the area, as well as groundwater inflows from off-site.

The *Healthy Rivers Action Plan* (Swan River Trust, 2008) has established short and long-term nutrient concentration targets for Total Nitrogen and Total Phosphorous for catchment tributaries of the Swan-Canning River System. These targets are shown in Table 2.

Table 2

Nutrient Concentration Targets for Median Total Nitrogen and Total Phosphorous in Catchment Tributaries of the Swan-Canning River System

Target	Total Nitrogen	Total Phosphorous
Short-term	2.0mg/L	0.2mg/L
Long-term	1.0mg/L	0.1mg/L

ANZECC/ARMCANZ (2000) guideline values for Aquatic Ecosystems for Total Nitrogen and Total Phosphorous are:

- Total Nitrogen – 1.2mg/L
- Total Phosphorous – 0.065mg/L

Pre-development groundwater monitoring (for summary of results refer to Appendix B) has found levels of ammonia, total nitrogen, oxidised-N and total phosphorus above ANZECC/ARMCANZ (2000) guideline values on more than one sampling occasion across the majority of bores tested.

In comparison to the *Healthy Rivers Action Plan* targets, the results for Total Nitrogen and Total Phosphorous were variable across the six bores with some groundwater monitoring results recording exceedances in short and/or long-term targets. On some occasions, monitoring results were below target values. In general, the bores located closer to the Canning River recorded fewer exceedances than those bores closer to Manning Road with the exception of monitoring bores MW4 and MW5 (see Figure 5 for monitoring bore locations). It is probable that these two bores are influenced by the former Centenary Park landfill located adjacent to the Cygnia Cove site.

Off-site Sources

The surrounding catchments areas which discharge into the site consist of main roads and urban areas. Both these land use types contribute to pollutant levels in stormwater. Currently the majority of these areas discharge into the existing wetland. The dense reeds present in this wetland provide some nutrient stripping benefits, however it is probable that inflowing groundwater provides a dilution effect. Rehabilitation of this wetland should aim to preserve this nutrient stripping function to maintain this wetland's capacity for stormwater treatment prior to discharge to the constructed wetland and the Canning River.

Fertiliser

The need for fertiliser application across the site is minimal and only slow release fertilisers will be used. This is in keeping with the *Guidelines for Fertiliser Use on the Swan Coastal Plain of Western Australia* (SRT, 2000). The application of fertilisers will be limited to plantings in the entry ways, road reserves, public access ways, small public open space areas and the bush tucker garden. Refer to Figure 8 for areas of public open space. It should be noted, that fertiliser application rates in public open space areas will be kept to a minimum. It is estimated that less than 15% of the public open space areas will be planted with turf.

Post-construction it is assumed fertilisers will be applied by landholders on private lots to establish gardens and lawns. However, information relating to waterwise gardening practices (including

information about nutrient application) will be provided in the land sales office for prospective land purchasers.

Due to the high porosity of the soils and the depth of the ground water table there is a high possibility for the application of fertilisers to pollute groundwater sources and the receiving environments of wetlands within the site and the Canning River.

Fertilisers will be applied to landscaped areas using fertiliser tablets (slow release to the manufacturer's specified rates) and limited to the plantings at the entries, the small public open space areas, public access way, and the 'Bush Tucker Garden'. All plantings around the existing and constructed wetland, detention storage area and Foreshore Reserve will not be fertilised.

The fertiliser regime provided in Table 3 (see Figure 11 for fertiliser application areas) will be followed for all fertiliser applications for the development of the Cygnia Cove Estate. This regime is in keeping with the fertiliser wise guide provided by the Swan River Trust.

Table 3
Fertiliser Application Regime

Plant type	Fertiliser Type	Fertiliser Rate	Stage of growth
Native Trees	Sub surface fertiliser tablet (Langleys Typhoon)	8 tablets	Initial planting
Tube stock		1x10g tablet	
140mm pots		2x 10g tablet	
200mm pots		4x 10g tablet	
	Macrocrete Grey 8-9month slow release	10g per plant	Maintenance after 1yr Late winter/early spring

Relatively small residential lot sizes throughout the estate will limit the amount of private gardens and lawns, thereby minimising nutrient inputs to the groundwater from fertiliser application.

Information relating to efficient fertiliser application practices will be provided to prospective purchasers at the land sales office during the sales period. Brochures are available from the Swan River Trust. The City of South Perth has expressed its interest in providing input into the design of education and awareness signs or brochures.

Organic Waste

Various sources of organic matter that could accumulate in the wetlands and drainage systems may occur within the site post-development. Sources and proposed management actions are provided below.

Wetland plants will remove available nutrients from the rehabilitated wetland, constructed wetland and detention storage area. Plant matter and accumulated sediment may be periodically harvested and removed from the detention storage area. However, the effective operation of the gross pollutant traps will significantly reduce the requirement for on-going sediment management in Detention Storage Areas 1 and 2. In addition, periodic harvesting of plant matter from the constructed wetland will also be

required to maintain areas of open water for Black Swans to move in the wetland. This approach will help prevent the accumulation and recycling of nutrients within the system.

It is preferential to utilise local native tree species in the streetscapes so that irrigation and nutrient requirements are minimised. There is a small amount of area within public open space (less than 15% of public open space areas) in the development that is to be grassed. When this grass is mowed clippings will be removed off site.

There is the potential for pet waste to be a source of pollution, particularly on the dual use paths around the existing wetland and foreshore area, therefore waste disposal bags and bins will be provided at these locations.

The potential for the practice of feeding water birds in and around the wetlands and foreshore areas could introduce excess amounts of nutrients into the waterways through wasted feed and excess animal waste. As part of the overall interpretive signage, information will be displayed on the environmental and fauna health effects of this practice discouraging people from feeding the birds.

The creation of waterbird habitat may result in increased nutrient input arising from bird excrement and food sources. If the constructed wetland is a successful swan breeding habitat and numerous birds are utilising the site nutrients inputs may increase. The continual flushing of the wetland through the treatment function provided by the wetland should provide adequate water quality maintenance or improvement.

Generally, the peak number of Black Swan nests occurs in late winter (ATA Environmental *et. al.*, 2000), however breeding is not likely to occur for at least five years post construction. Based on the outcomes of the Black Swan monitoring program described in the Wetland Management Plan for the constructed wetland (Coffey Environments, 2008h), it is recommended that water quality monitoring of water entering and discharging from the wetland be implemented. This approach will determine whether there are nutrient inputs from within the constructed wetland.

4.5.2 Sediments

Sediments affect water quality in numerous ways affecting the health of aquatic organisms, in stream processes and aesthetics. Pollutants such as heavy metals and phosphates enter waterways through being attached to clay particles. Development works on the site with the potential to disturb soils include site remediation, removal and management of acid sulfate soils and bulk earthworks associated with construction.

There is limited potential for surface water at the site to be affected by remedial works, primarily in terms of loose soil being mobilized in surface water, and potentially increasing the turbidity of the drainage and the Canning River (Coffey Environments, 2008e). However, the site works required for the construction of a new wetland, construction of the earth bund in the retained wetland as well as the construction of a perimeter retaining wall around the wetland, and filling of the eastern lobe of the wetland have the potential to result in the discharge of sediments to the receiving environment.

It is anticipated that remedial earthworks at the site will commence during the summer months, when the Perth area does not experience significant rainfall thereby minimising risks associated with runoff occurring from the site. For this reason, it is considered that the stockpiles will not require bunding for containment of soil or surface runoff. However, in order to reduce the potential impact of stockpiles on surface water quality, all stockpiles will be placed at least 30m from surface water. In the event of a

forecast for significant rainfall during remedial works, the contractor will be responsible for establishing earth bunding around the stockpiles to contain any potential runoff.

Sediment control measures include the use of silt curtains in the outlet of the wetland, and installation of sediment traps at the end of the urban drainage system prior to bulk earthworks occurring. The development will be progressed in stages which will limit the amount of soil disturbance occurring at any one time.

Due to the promotion of at source treatments within the Cygnia Cove development the amount of sediment entering receiving environments, post-construction should be minimal.

Street sweeping will be carried out quarterly through the urban development to remove particulate build-up from the road surface.

Significant weed control activities will be occurring during the rehabilitation of the Foreshore Reserve. If mechanical methods of weed removal are used, precautions to not increase soil erosion should be implemented.

Gross pollutant traps (with oil baffles) will be installed as pre-treatment devices to screen stormwater from the urban area for litter and large sediments, prior to treatment in the detention storage area. The proposed gross pollutant trap design will be subject to the approval of the City of South Perth. The gross pollutant traps will be cleaned and maintained regularly during construction. Post-construction it is recommended that they be maintained prior to the wet season, after major storm events and also quarterly. Regular maintenance will ensure the traps are working effectively and help prevent the breeding of mosquitoes.

Wetland vegetation will be planted in the detention storage area, constructed wetland, existing wetland and Foreshore Reserve to maximise the amount of fine sediments removed from overland flow prior to entering the Canning River.

4.5.3 Hydrocarbons

Hydrocarbons including petrol, oil and grease are considered toxic in aquatic environments. Potential sources of hydrocarbons include the Manning Road and Centenary Avenue catchments which directly discharge (via piped drainage) stormwater into the Resource Enhancement wetland.

The extent of hydrocarbons in the stormwater run-off generated from the Cygnia Cove development is expected to be minimal due to the scale of the development and the low traffic volumes. A residential layout traffic review prepared by Riley Consulting Traffic and Transportation Consultants (2006) concludes that the traffic flows on all streets within the development are less than 3,000 vehicles per day (and in the case of the street fronting the Foreshore Reserve traffic volumes are expected to be less than 100 vehicles per day) and access streets are used. For these reasons, oil and grease traps are not proposed.

The laying of bitumen during the construction of roadways has the potential to affect water quality. Where practicable, these activities should be undertaken in the summer when rainfall is less likely.

Gross pollutant traps will be incorporated at drainage discharge points to the detention storage areas. The gross pollutant traps to be used in the Cygnia Cove Estate will be subject to approval by the City of South Perth prior to installation. However, the proposed gross pollutant traps to be used are the Rocla CDS® Unit gross pollutant trap. These traps will be fitted with the oil baffle, eliminating the requirement

for the installation of hydrocarbon interceptors within the drainage system. Further information about the Rocla CDS® Unit gross pollutant trap is available from www.rocla.com.au.

4.5.4 Acid Sulfate Soils

Acid sulfate soils can reduce the pH of surface water runoff and create acidic conditions in receiving environments. Most aquatic organisms require a stable and relatively neutral (6.5-8.5) pH. Changes to pH levels can result in fish kills and low pH levels can cause contaminants bound in sediments to be released resulting in further pollution.

Works with the potential to directly disturb acid sulfate soils include enhancement of the wetland and non-wetland public open space areas, excavation of uncontrolled fill and geotechnically unsuitable material from the remainder of the site, and linear trenching to install buried services. Indirect disturbance (via dewatering) may be required during both bulk earthworks and subdivision works.

An *Acid Sulfate Soils Management Plan* prepared by Coffey Environments (2008a) details the proposed approach for the management of acid sulfate soils at the Cygna Cove Estate. Earthworks will be conducted as quickly as possible to minimise the duration of dewatering and to minimise the opportunity for oxidation of acid sulfate soils present at the site. Management options include the removal and treatment (liming) of acid sulfate soil material with treated material reused elsewhere in the Cygna Cove Estate (subject to testing of material), or appropriate disposal of acid sulfate soil material.

A Dewatering Management Plan will be prepared and submitted with a dewatering license application prior to the commencement of earthworks. However, it is proposed that dewatering using spears with effluent being pumped to a dosing tank and then infiltrated. It is not anticipated that extensive periods of dewatering will be required.

4.5.5 Pesticides and Herbicides

Pesticides and herbicides can have toxic effects on aquatic ecosystems especially on aquatic plants and insects. These organisms are crucial to maintaining healthy aquatic systems as they cycle nutrients, and provide food habitat and oxygen.

Weed control is required along the Foreshore Reserve, around the proposed constructed wetland and in the retained portion of the Resource Enhancement wetland. Various weed control methods may be employed at the site including manual removal and the use of herbicides.

Chemical control of weeds adjacent to waterways/water bodies requires careful application. Issues that must be considered prior to any type of chemical control include the effects of the herbicides on native flora and fauna and water quality. Most weeds can be controlled by regular spot-spraying or removal by hand. This can be done periodically over several years. Care should be taken not to spray over open water or disturb the natural vegetation unnecessarily as this will encourage further weed invasion. Herbicide use should be in accordance with the recommendations contained in *'Herbicide Use in Wetlands'* – Water Note WN22 (Water and Rivers Commission, 2001).

4.5.6 Litter and Other Gross Pollutants

Sources of litter may also occur through the stormwater runoff discharging into the site from offsite areas, e.g. Centenary Avenue and Manning Road. However, the installation of gross pollutant traps will treat incoming stormwater, reducing litter and gross pollutants discharging to Detention Storage Areas 1 and 2.

The provision of fauna proof rubbish bins in the BBQ area should reduce the potential for this type of pollutant.

The soakwells within the drainage system will capture litter and gross pollutants prior to stormwater discharging to the detention storage area.

4.5.7 Other

Pollutants generated during building and constructions have the potential to affect water quality and in-stream biota.

The development of the site will involve the removal (down to natural surface) of geotechnically unsuitable material (uncontrolled fill) which locally exceeds EIL guidelines for metals and contains some asbestos sheeting. The movement of this material should be managed to ensure the material is not transported to waterways. Details of this are provided in the *Site Remediation and Validation Management Plan* prepared by Coffey Environments (2008e).

The removal of uncontrolled fill should result in an improvement to the water quality of groundwater and the existing wetland. This may result in an increased capacity for the wetland to support a greater diversity of fauna species, including frogs and macro invertebrates.

Remedial works are not expected to cause a negative impact to groundwater quality; however, on-going groundwater monitoring will allow an assessment of the groundwater quality post-remedial works. At the completion of remedial works, it is proposed to undertake three-monthly groundwater monitoring for a period of six months (i.e. two rounds) to assess the impact of remedial works on groundwater. At this point, the need for further groundwater monitoring will be evaluated.

The use of surfactant detergents when washing cars can lead to these materials polluting the waterways, along with a range of other pollutants from cars. As most of the lot sizes are limited the ability for cars to be washed on private lawns as recommended in the *Stormwater Management Manual for Western Australia* (DoW, 2004) may not be practicable. Information on the location of car washing facilities for public use could be included in the land sales office.

4.5.8 Groundwater Contamination Associated with Centenary Park Landfill

The Centenary Park landfill site is vested in the City of Canning, and therefore the proponent has little control over the impacts associated with the former landfill site. In order to manage the risks associated with the leachate, no groundwater abstraction bores will be permitted within the development. This will be managed by requiring each lot sold to have a 'Memorial on Title' prohibiting groundwater extraction. In addition, the proponent will undertake on-going groundwater monitoring to determine if groundwater quality continues to decline further.

4.6 Mosquito Management

All features of the stormwater drainage system which could potentially support mosquito and midge breeding will be regularly maintained to reduce the risk of this occurring. Sites in the drainage system where water is being retained at sufficient time for mosquito breeding to occur will be treated with Larvacide bricks.

Flows through the constructed wetland will be maintained to ensure a stable water level and to continually flush the water. Optimal reported performance occurs for a retention time of 24 to 40 hours

(CSIRO, 1999). The proposed exchange period is less than four days based on a constant inflow of 5 litres/sec into the constructed wetland. This arrangement exceeds the preferred 24 to 40 hour period. Therefore, contingency measures designed to prevent algal growth and the proliferation of mosquitoes and midges (such as use of aeration units) may be needed. Details of the contingency measures can be found in the *Wetland Management Plan* for the constructed wetland (Coffey Environments, 2008h).

4.7 Facilities

Appropriately sized vermin proof rubbish bins will be provided in public open space areas to minimise the amount of litter across the site. These will be emptied on a weekly basis and preferably after the weekend. This will be the responsibility of the proponent during the management period. The location and design of the bins will be determined in consultation with the City of South Perth.

4.8 Education

Pamphlets will be provided to prospective buyers at the land sales office about waterwise gardening including information about the use of native plants in gardens and appropriate nutrient application techniques. Information may also be provided about declared weed species commonly found in gardens and their impact on the natural environment.

Information about the benefits of rainwater tanks and State Government rebates available will be promoted for use at the land sales office. Installation of rainwater tanks will help reduce the amount of stormwater generated from the roofs of housing and is in line with water conservation principles. Captured rainwater can be used for irrigation and in-house use (such as toilet flushing and clothes washing) to reduce reliance on potable water supplies. The use of rainwater tanks for this purpose in the Cygnia Cove Estate is particularly well supported due to the option of domestic bore installation being unavailable.

The creation of an artificial wetland habitat offers an opportunity to educate the public about wetland dynamics and the inter-relationship between fauna and their environment. Education and awareness can be achieved through a number of avenues such as the installation of interpretive signage and possible field visits for special interest groups. Signage will be installed in strategic locations advising the public of the importance of the wetland, Black Swan requirements and the importance of controlling incompatible activities (e.g. dog exercise, bird feeding) near key habitat areas. Signage will be designed in consultation with the City of South Perth and other relevant stakeholders.

The Water Corporation has a selection of written information that could be used and distributed through the land sales office during the land sales period. Pamphlets will be provided at the land sales office to provide information about:

- Waterwise gardening practices e.g. water conservation measures (e.g. mulching, irrigation methods etc), appropriate fertiliser use and management of weed species.
- In-house waterwise practices (e.g. rainwater harvesting, greywater reuse, water saving appliances and fixtures etc.

5 MONITORING PLAN

Monitoring the success of the management recommendations proposed in Table 4 is will be important to ensure that an adaptive management approach is taken. Monitoring and performance criteria will ensure that the objectives of the management plan are achieved while also being flexible to incorporating any changes or community values into the Management Plan.

5.1.1 Groundwater Monitoring

In addition to the baseline groundwater monitoring program, an on-going groundwater monitoring program will be implemented to assess the groundwater effects of remedial work and bulk earthworks and subdivision works. An additional six groundwater monitoring bores have been installed on-site (refer to Figure 5 for indicative locations) and monitored.

The duration of remedial works is expected to be approximately three months. At the completion of remedial works, it is proposed to undertake three-monthly groundwater monitoring for a period of six months (i.e. two rounds) to assess the impact of remedial works on groundwater. At this point, the need for further groundwater monitoring will be evaluated.

Due to the limited extent and duration of remedial earthworks, groundwater monitoring is not considered to be necessary during the remedial works.

As bulk earthworks and subdivision works will be undertaken in stages (where each stage may take one to two months) there will be a considerable period of groundwater monitoring for acid sulfate soil parameters, which will allow an assessment of groundwater quality with time.

- Daily field monitoring of water levels, pH and acidity; weekly/fortnightly laboratory analyses of metals, nutrients and inorganic parameters; and
- Three rounds of bi-monthly monitoring following completion of works.

Details of the monitoring to be carried out can be found in the *Baseline Groundwater Monitoring and Management Plan* (Coffey Environments, 2008b)

5.1.2 Acid Sulfate Soils and Dewatering Strategy

On-going groundwater monitoring will be required during and after ASS disturbance and dewatering at the site, as stipulated in the *Acid Sulfate Soils Management Plan* (Coffey Environments, 2008a). The frequency and analytical parameters required for the monitoring will vary based on field measurements of untreated dewatering effluent as specified in the *Acid Sulfate Soils Management Plan* (Coffey Environments, 2008a).

It is proposed to undertake the following water monitoring during dewatering operations:

- The Contractor will be responsible for continuously monitoring the dewatering discharge rate and volume.
- The Contractor will be responsible for monitoring and recording groundwater levels, pH and total acidity in the groundwater monitoring bores at the site daily. Trigger values for the groundwater levels will be set based on the proposed maximum depth of dewatering, plus 20cm.

- The Contractor will be responsible for daily monitoring and recording of the pH and total acidity of the dewatering effluent. If a dosing tank is used, the water will be sampled from the inlet pond supplying the tank, and the outlet of the tank. Trigger criteria will be used to determine the level of treatment required, or if more frequent field monitoring is required. This information should be provided to the Principal's Environmental Consultant on a weekly basis.
- For the duration of the dewatering program, the Principal's Environmental Consultant will be responsible for sampling and laboratory analysis of bores and dewatering effluent. The bores to be monitored may vary depending on which area of the site is undergoing earthworks and dewatering. The frequency and analytical parameters vary based on field measurements of untreated dewatering effluent. Limits of reporting should be selected to meet the most stringent assessment criteria (in this case, Fresh Waters).
- If the dewatering program runs for more than four weeks, the Principal's Environmental Consultant will be responsible for two-monthly sampling and laboratory analysis of the groundwater monitoring bores for a total period of six months after the cessation of the dewatering program for the analyte suite utilised during dewatering.

The results of the Contractor's water monitoring programs, along with actions taken to achieve water quality targets, will be reported to the Principal's Environmental Consultant at the end of each week. The Principal's Environmental Consultant will be responsible for providing advice to the Superintendent and/or Contractor regarding the water monitoring results.

The Principal's Environmental Consultant will be responsible for the more detailed groundwater quality monitoring program, reviewing all monitoring results and reporting to the DEC.

At the completion of the dewatering program, the Principal's Environmental Consultant will collect samples of the accumulated sediments at the base of each pond to determine the appropriate decommissioning requirements.

Appropriate decommissioning requirements may include treatment of accumulated sediments in accordance with the *Acid Sulfate Soils Management Plan* (Coffey Environments, 2008a).

5.1.3 Surface Water Monitoring

In accordance with discussions with the Swan River Trust, ***the proponent commits to maintaining pre-development water quality, ensuring that the quality of water discharging to Clontarf Bay is of no worse, or better quality when compared with pre-development conditions.***

Constructed Wetland and Drain

Ministerial Statement No. 692 requires that the water quality discharged into Clontarf Bay/Canning River be of no worse or better quality than pre-development conditions. Relative performance of the wetland with respect to its water quality treatment function can be adequately assessed by monitoring concentrations of selected parameters at inflows and outflows from the wetland. Quarterly monitoring of surface water discharged to Clontarf Bay will be undertaken pre-development and during the construction period to establish baseline water quality against which future sampling results can be compared. Surface samples will be collected from the northern side of the culvert upstream of the proposed wetland site in order to minimise potential tidal impacts on data.

To assess the performance of the wetland with respect to water quality, sampling downstream of the wetland (i.e. from the discharge zone) following construction on a quarterly basis during the two-year

maintenance period will allow comparison of upstream and downstream water quality. It is anticipated that the wetland will receive additional nutrient inputs through increased bird usage and decaying plant biomass.

Samples collected during the pre-development and post-development water quality monitoring program will be analysed for:

- Nutrients (Ammonia-N, NO_x-N, Total Kjeldahl Nitrogen, Total Nitrogen, and Total Phosphorus);
- Inorganic parameters (pH, conductivity, dissolved oxygen, total suspended solids (TSS) and acidity).

Significant exceedances (greater than 10% of pre-development surface water quality) in seasonal data on more than two occasions, and where values are greater than ANZECC/ARCANZ (2000) *Guidelines for Aquatic Ecosystems (for Fresh Waters including Lowland Rivers)* values (where available) will be further investigated with a view to establishing the cause of the exceedance with appropriate remedial works to be undertaken.

If water quality discharging from the constructed wetland is found to be significantly worse than the water quality of water entering the constructed wetland, then inflows could be diverted directly to the Canning River and by-pass the constructed wetland until the cause of the problem has been remedied. However, it should be noted that the design of the constructed wetland is such that there should be a full exchange of water within a four day period, and therefore unlikely to experience any significant water quality issues. It should be noted that this exchange period is based on a surface in-flow of 5 litres/sec. Under a 10 litres/sec scenario (which is more realistic), the exchange period would be less than two days.

In addition to quality, an assessment of flow rate at the upstream culvert and at the discharge point of the wetland at the time of water quality sampling will be undertaken quarterly to ensure that post-development flow-rate is comparable to pre-development conditions. The proponent has commissioned monthly flow rate monitoring. This monitoring commenced in April 2008 and will continue for a 12 month period. Flow rate monitoring results are provided in Section 2.4.1.

Results from the monitoring will be reported to the City of South Perth and the DoW on an annual basis. The report will outline criteria where pre-development or guideline values have been exceeded with details of remedial actions taken.

Detention Storage Areas

The proponent will implement a monitoring program to determine the effectiveness of the detention storage area in removing nutrients, sediments and gross pollutants from urban stormwater generated on the site. This will ensure maintenance procedures are adequate in maintaining the function of the detention storage areas, prior to the end to the two year post construction period.

The objectives of the monitoring program are to

1. Determine the effectiveness of the detention storage areas in improving the quality of urban stormwater runoff from the Cygnia Cove estate.
2. Ensure stormwater entering Clontarf Bay from the detention storage areas is of a suitable quality (no worse or better than pre-development water quality) for the analytes tested.

The monitoring will occur on a quarterly basis for a period of two years post-completion of earthworks. Samples will be collected from the discharge pipe flowing into the detention storage areas (where

possible) and from the outlet of the Detention Storage Area 1, and the culvert flowing to Clontarf Bay. It is not expected that Detention Storage Area 2 will overflow to the Canning River, therefore a surface sample is not proposed at the outflow.

Two pre-development surface water samples will be undertaken by the proponent in 2008/2009 (see Figure 5 for sampling locations), prior to the commencement of earthworks to establish baseline surface water quality.

With respect to post-development monitoring, if timing and climatic conditions permit, surface water sampling will be conducted just after significant rainfall events to try to capture samples of stormwater discharging into the detention storage areas.

5.1.4 Existing Wetland

The proponent will implement monitoring procedures to assess the success of management strategies addressing rehabilitation works, weed control activities and water quality during the two year management period as detailed in the *Wetland Management Plan* prepared by Coffey Environments (2008c) for the existing wetland. This will allow the identification of area requiring augmentation or remedial works to be identified early and appropriately planned. In addition, the monitoring will ensure that an adequate representation of species and plant diversity is achieved.

The water quality discharged from this wetland will be monitored as part of monitoring the performance of the constructed wetland.

5.1.5 Ecotoxicological Testing Program

The proposed residential subdivision has the potential to release contaminants into the Canning River. If the ground is disturbed there is potential to release heavy metals and total petroleum hydrocarbons, thus increasing the contaminant load in the Canning River at the wetland discharge point. Ministerial Statement 692 requires an Ecotoxicological testing plan to monitor benthic habitat at the wetland discharge point into Clontarf Bay be prepared prior to ground disturbing activity. Geotech Ecotoxicological Services have completed baseline studies.

A range of bioassays using different species from several different trophic levels are commonly used to assess environmental samples following the ANZECC/ARMCANZ (2000) Water Quality Guidelines. Several species are used as the sensitivities of different species varies e.g. one species may be very sensitive and another may be very tolerant.

A baseline study to assess the current state of the wetland discharge point has been performed using a unicellular algal growth test (Geotech Report ENV06-193) in August 2006 and a Microtox bacterial growth test (Geotech Report ECX07-2703) in March 2007.

Results for the microalgal growth inhibition assay showed that growth was enhanced in all concentrations of groundwater where some constituents of the samples were acting as nutrients. Therefore, the nutrients within the samples may be ameliorating or masking the effects of any toxicants present.

As the salinity of the Canning River varies from 10ppt (as measured in August 2006) to 41ppt (as measured in March 2007), the benthic communities at the discharge site would not remain static throughout the year. As the salinity changes, the organisms living in or on the benthos would move to a more suitable site. Therefore, performing tests on Canning River organisms is not considered feasible

due to the changing community structure and salinities. To overcome this problem Geotech proposes to perform a suite of bioassays using freshwater species indigenous to the wetland to characterise the toxicity of the discharge. Geotech also propose to assess the toxicity of the sediment using an indigenous amphipod (*Grandiderellia* sp.).

In order to fulfil the Ministerial Statement No. 692, Condition No. 7.4 a suite of five bioassays will be undertaken on the species listed above following initial ground disturbance and a rain event. This will determine if toxicity has changed due to an increase in contaminants leaching from the site to obtain a “worst case scenario”.

A routine monitoring program is then recommended which involves screening of the site on a regular basis using Microtox on a monthly or quarterly basis during construction and a three monthly basis after completion for a two year period. If any changes are detected then a full investigation (a full suite of toxicity tests) and management procedures are implemented.

The results from this monitoring can be used to trigger further testing or implementation of management procedures if results are significantly above those obtained from the baseline data assessment. Sediments are long-term integrators of contaminants and need only to be monitored annually. Therefore an annual bioassay will be undertaken during the construction phase of the Estate and results reported.

Table 4
Water Quality Monitoring Programs

Technical Area	Monitoring Analytes	Timing	Performance Criteria / Guideline	Contingency
Groundwater				
Remedial Work	Metals Nutrients	Physical Parameters Post works every 3months for 6 months	Aquatic Ecosystems (for Fresh Waters, including Lowland Rivers values where available) from ANZECC/ARMCANZ (2000) The need for further monitoring will be evaluated from initial results	DEC notified
Bulk earthworks and subdivision	pH Metals Nutrients Physical	Daily field Weekly	Aquatic Ecosystems (for Fresh Waters, including Lowland Rivers values where available) from ANZECC/ARMCANZ	DEC notified

Technical Area	Monitoring Analytes	Timing	Performance Criteria / Guideline	Contingency
	Parameters		(2000)	
Dewatering	Discharge rate and volume	Continuous	As specified in Dewatering Strategy	Weekly reporting to Principal's Environmental Consultant
	Levels pH Total acidity	Daily	Max depth of dewatering + 20cm Provided in ASSMP (Table 4)	
Retained Wetland Discharge	pH Nutrients Physical Parameters	Quarterly for two Years	Pre-Development Baseline Levels (i.e. no worse or better) Aquatic Ecosystems (for Fresh Waters, including Lowland Rivers values where available) from ANZECC/ARMCANZ (2000) Healthy Rivers Action Plan short and long term targets	Establish cause of exceedance and implement remedial works Annual report to DEC and DoW
	Flow Rate	Monthly sampling for 12 months pre-development	Pre-development flow rates	-
Constructed Wetland	Nutrients Physical Parameters Flow rate	Quarterly for two years	Pre-Development Baseline Levels and Flow Rate Aquatic Ecosystems (for Fresh Waters, including Lowland Rivers values where available) from ANZECC/ARMCANZ (2000) Healthy Rivers Action	Establish cause of exceedance and implement remedial works. If necessary water flow into wetland can be diverted to Canning River if outflow from constructed wetland is substantially worse than the

Technical Area	Monitoring Analytes	Timing	Performance Criteria / Guideline	Contingency
			Plan short and long term targets	water quality entering the wetland Annual report to DEC and DoW
Detention Basins	Nutrients Physical Parameters pH	Quarterly for two years	Aquatic Ecosystems (for Fresh Waters, including Lowland Rivers values where available) from ANZECC/ARMCANZ (2000) Healthy Rivers Action Plan short and long term targets	Establish cause of exceedance and implement remedial works Annual report to DoW
Ecotoxicological				
Worst Case	5 bioassays	After ground disturbance and after significant rainfall events	Significantly higher than baseline results	Full investigation and management procedures implemented
Routine	Microtox assays	Monthly during construction Every 3 rd month post construction for two years	-	

5.2 Implementation and Responsibilities

The developer will be responsible for the implementation of the management measures presented in this management plan, including the ongoing management, maintenance and monitoring to the satisfaction of the City of South Perth, Swan River Trust and the Bush Forever Office for a period of two years post construction.

From this period any remaining management, maintenance and monitoring activities will become the responsibility of the City of South Perth.

Table 5
Responsibility for Proposed Management

Strategy	Specification	Timing	Responsibility
Stormwater quality	Install and maintain Detention Storage Areas 1 and 2 to treat urban stormwater runoff.	Prior to construction	Developer
	Install sediment traps along drainage system prior to bulk earthworks.	Prior to construction	Developer
Drainage Maintenance	Removal of debris from drainage infrastructure.	On-going post construction	Developer for an initial two year period, thereafter the City of South Perth
	Street sweeping to reduce particulate build-up on road surface and gutters.	Monthly, during construction Quarterly; post construction	Developer for an initial two year period, thereafter the City of South Perth
	Maintenance of the stormwater network.	On-going post construction	Developer for an initial two year period, thereafter the City of South Perth

Strategy	Specification	Timing	Responsibility
	Mowing of grass in the grassed area and appropriate disposal of clippings.	On-going, monthly	Developer for an initial two year period, thereafter the City of South Perth
	Manual litter collections.	On-going during and after construction	Developer for an initial two year period, thereafter the City of South Perth
Public Open Space Facilities	Install interpretive signage highlighting the importance of wetland conservation and how residents can assist with protecting their local natural environment in two locations along the DUP.	Once	Developer
	Install vermin proof rubbish bins in small public open space area.	Once only, during construction	Developer
Public Education	Provide pamphlets on water wise gardens, fertiliser use and car washing facilities to prospective buyers.	During sales	Developer
General Maintenance and Monitoring	Litter and sediments to be removed from GPT, detention storage areas and wetlands.	Prior to winter After large storms Quarterly	Developer (unless identified otherwise) for initial two year period, thereafter the City of South Perth
	Undertake bi-monthly visual inspections of the wetland area and detention storage areas to identify emergent weeds that	Bi-monthly	Developer for initial two year period, thereafter City of South Perth

Strategy	Specification	Timing	Responsibility
	may require control.		
	Water Quality Monitoring as per separate monitoring programs refer to Table 4.	Quarterly	Developer for initial two year period
	Undertake bi-monthly visual inspections of the detention storage areas to ensure effective operation.	Bi-monthly	Developer for initial two year period
	Inspect the detention storage areas after large storm events to make sure no storm damage has occurred.	After large storms	Developer for initial two year period

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6 **DISCLAIMER**

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Figures

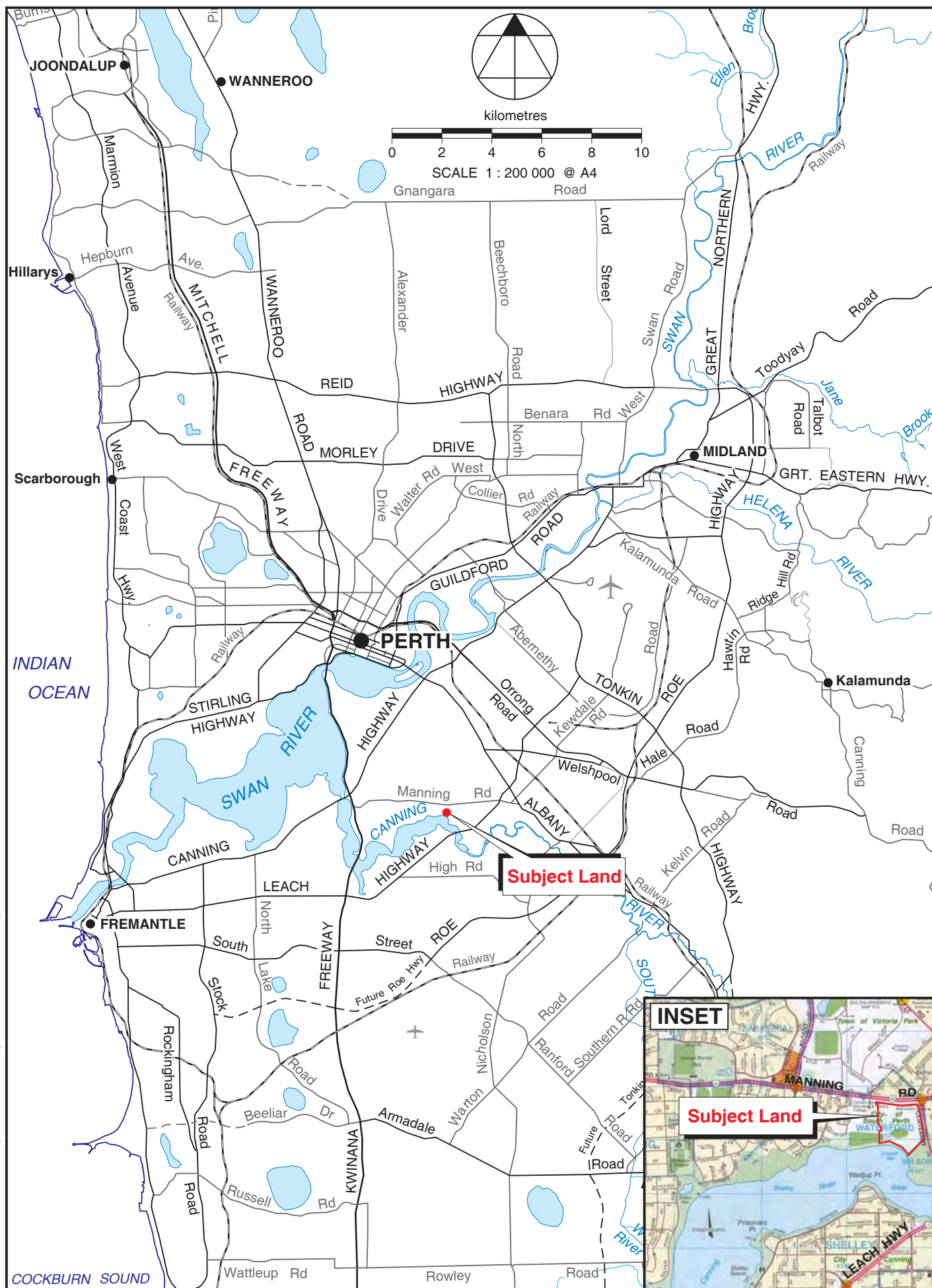
**Drainage, Nutrient, Irrigation and Water Quality Management Plan
Cygnia Cove Estate, Waterford**

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DRAINAGE, NUTRIENT, IRRIGATION & WATER QUALITY MANAGEMENT PLAN
CYGNIA COVE ESTATE, WATERFORD MINISTERIAL STATEMENT No. 692 &
PROPOSER COMMITMENTS
REGIONAL LOCATION
FIGURE 1

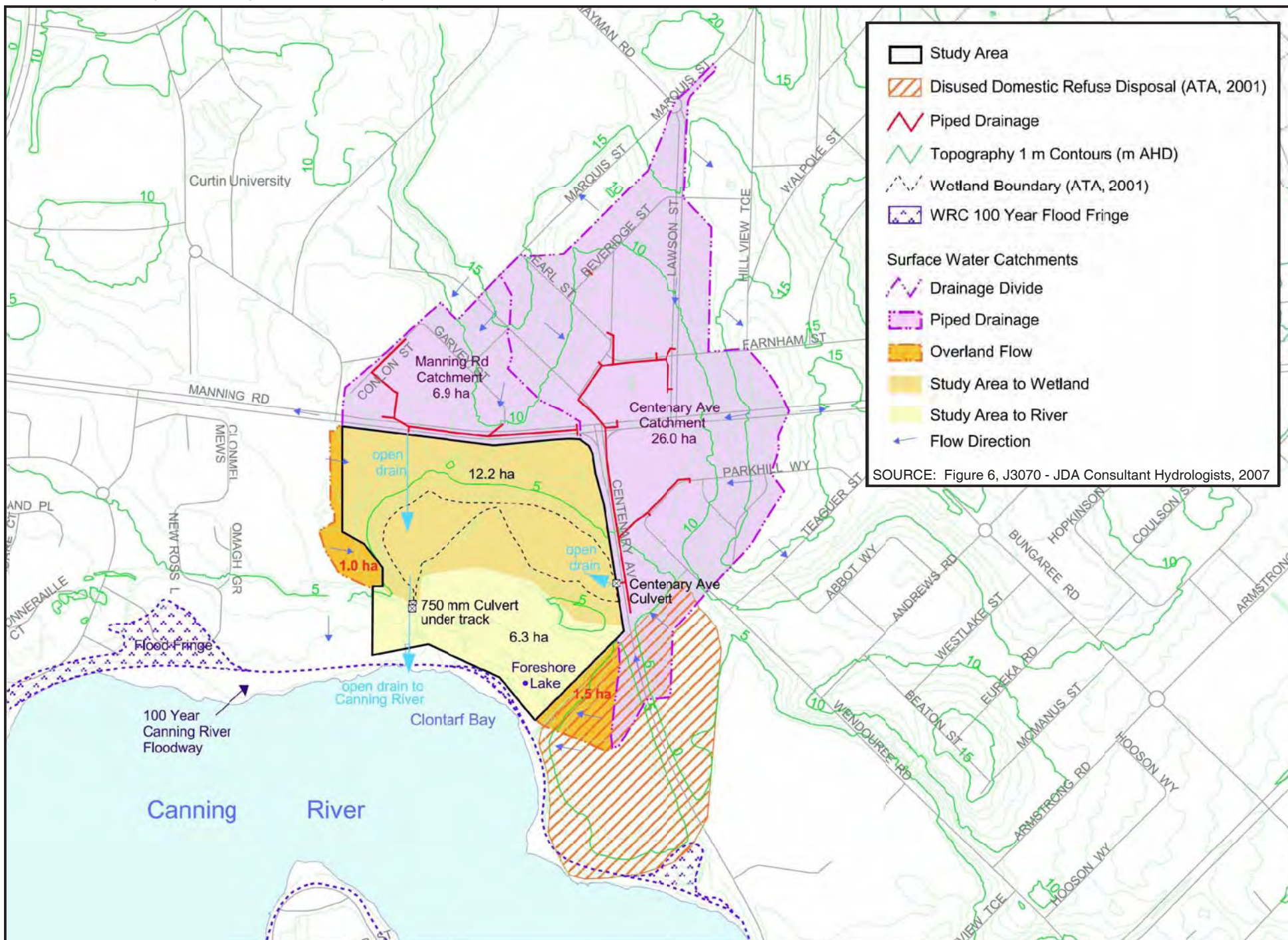


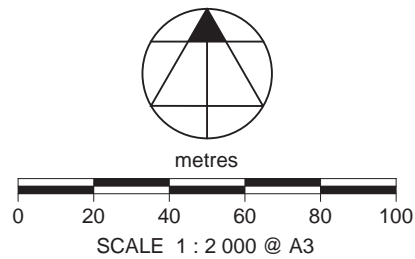


DRAINAGE, NUTRIENT, IRRIGATION & WATER QUALITY MANAGEMENT PLAN
CYGNIA COVE ESTATE, WATERFORD MINISTERIAL STATEMENT No. 692 &
PROPONENT COMMITMENTS

WETLANDS

FIGURE 3





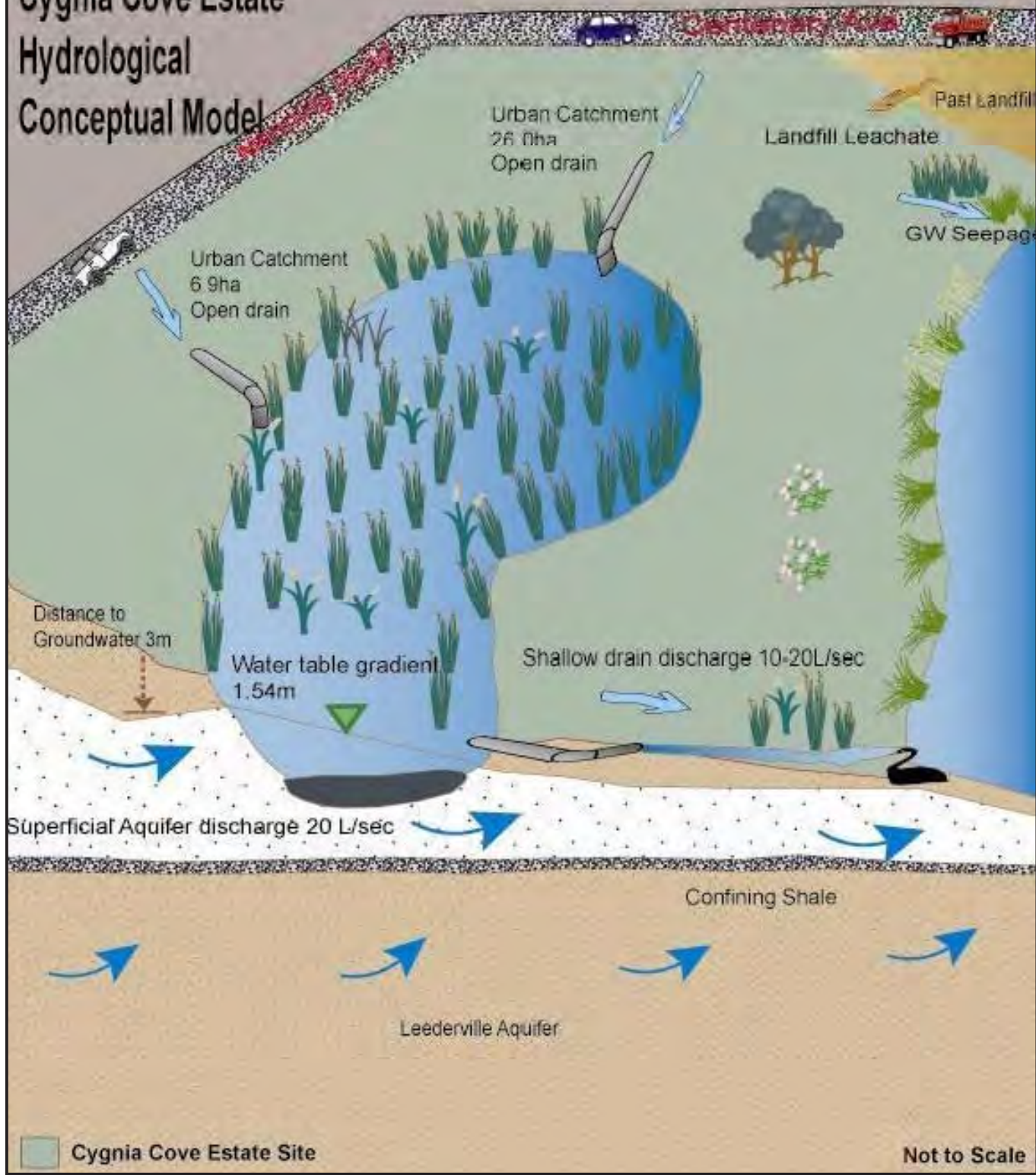
- LEGEND**
- Development Footprint Boundary
 - AAMGL (JDA, June 2003)
 - Proposed Detention Storage Area
 - Existing Groundwater Monitoring Bore Location
 - Proposed Groundwater Monitoring Bore Location
 - Proposed Groundwater Abstraction Bore Location
 - △ Pre-development Surface Water Monitoring Point
 - ★ Post-development Surface Water Monitoring Point

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CYGNIA COVE ESTATE, WATERFORD MINISTERIAL STATEMENT No. 692 &
PROPONENT COMMITMENTS

MONITORING LOCATIONS
FIGURE 5

Cygnia Cove Estate Hydrological Conceptual Model



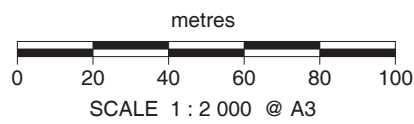


DRAINAGE, NUTRIENT, IRRIGATION & WATER QUALITY MANAGEMENT PLAN
CYGNIA COVE ESTATE, WATERFORD MINISTERIAL STATEMENT No. 692 &
PROPONENT COMMITMENTS

REMEDIATION AREAS

FIGURE 7





LEGEND

- Cadastral Boundary
- 2.44 AAMGL
- Drainage Catchment Boundary
- - - Proposed Drainage Catchment Boundary
- Drain
- - - Proposed Drain
- (SEP CH 108.7) Side Entry Pit
- (GGP CH 60.2) Grated Gully Pit
- (CGP CH 14.2) Circular Grated Pit
- (BUP F) Bubble Up Pit
- (GPT CH 208.6) Gross Pollutant Trap

SOURCE: Tabec Civil Engineers, October 2007

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CYGNIA COVE ESTATE, WATERFORD MINISTERIAL STATEMENT No. 692 &
PROPONENT COMMITMENTS

DRAINAGE SYSTEM - MINOR
FIGURE 9

PLANTING ZONE LEGEND

EXISTING WETLAND

- EW1 Bushucker Garden
- EW2 Dry Revegetation
- EW3 Lower Embankment Re-vegetation/ submerged

CONSTRUCTED WETLAND

- CW1 Dry Revegetation
- CW2 Upper Embankment Revegetation
- CW3 Lower Embankment Infill
- CW4 Lower Embankment Revegetation/ Submerged

FORESHORE RESERVE

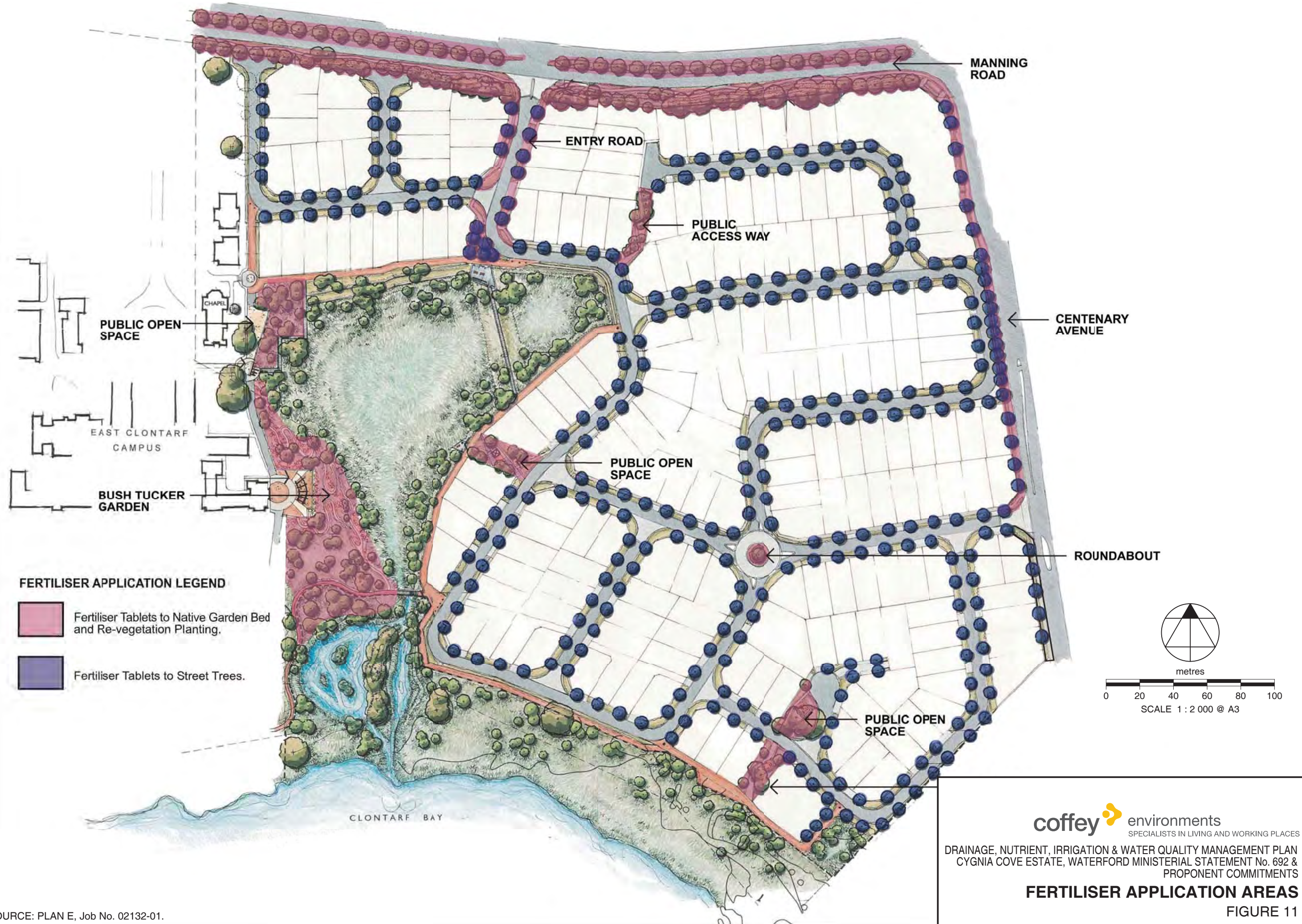
- FSR1 Foreshore Infill
- FSR2 Woodland Vegetation
- FSR3 Samphire Revegetation
- FSR4 Stream Revegetation

STREETSCAPE

- SS1 Median Strip Planting
- SS2 Verge Planting



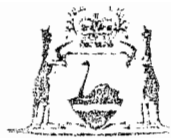
SOURCE: PLAN E, Job No. 02132-01, October 2007 Rev E



Appendix A

Ministerial Statement No. 692

**Drainage, Nutrient, Irrigation and Water Quality Management Plan
Cygnia Cove Estate, Waterford**



GOVERNMENT OF WESTERN AUSTRALIA

MINISTER FOR THE ENVIRONMENT; SCIENCE

Statement No.

000692

**STATEMENT THAT A PROPOSAL MAY BE IMPLEMENTED
(PURSUANT TO THE PROVISIONS OF THE
ENVIRONMENTAL PROTECTION ACT 1986)**

**EAST CLONTARF RESIDENTIAL DEVELOPMENT
WATERFORD, CITY OF SOUTH PERTH**

Proposal: The residential development of the East Clontarf site, Waterford, as documented in schedule 1 of this statement.

Proponent: Trustees for The Christian Brothers in Western Australia Inc

Proponent Address: c/- Richard Noble and Associates, PO Box 7071 Cloisters' Square, PERTH WA 6850.

Assessment Number: 1467

Report of the Environmental Protection Authority: Bulletin 1156

The proposal referred to above may be implemented by the proponent subject to the following conditions and procedures:

1 Implementation

- 1-1 The proponent shall implement the proposal as documented in schedule 1 of this statement subject to the conditions and procedures of this statement.

2 Proponent Commitments

- 2-1 The proponent shall implement the environmental management commitments documented in schedule 2 of this statement.

Published on

11 OCT 2005

3 Proponent Nomination and Contact Details

- 3-1 The proponent for the time being nominated by the Minister for the Environment under section 38(6) or (7) of the *Environmental Protection Act 1986* is responsible for the implementation of the proposal until such time as the Minister for the Environment has exercised the Minister's power under section 38(7) of the Act to revoke the nomination of that proponent and nominate another person as the proponent for the proposal.
- 3-2 If the proponent wishes to relinquish the nomination, the proponent shall apply for the transfer of proponent and provide a letter with a copy of this statement endorsed by the proposed replacement proponent that the proposal will be carried out in accordance with this statement. Contact details and appropriate documentation on the capability of the proposed replacement proponent to carry out the proposal shall also be provided.
- 3-3 The nominated proponent shall notify the Department of Environment of any change of contact name and address within 60 days of such change.

4 Commencement and Time Limit of Approval

- 4-1 The proponent shall substantially commence the proposal within five years of the date of this statement or the approval granted in this statement shall lapse and be void.

Note: The Minister for the Environment will determine any dispute as to whether the proposal has been substantially commenced.

- 4-2 The proponent shall make application for any extension of approval for the substantial commencement of the proposal beyond five years from the date of this statement to the Minister for the Environment, prior to the expiration of the five-year period referred to in condition 4-1.

The application shall demonstrate that:

- 1. the environmental factors of the proposal have not changed significantly;
- 2. new, significant, environmental issues have not arisen; and
- 3. all relevant government authorities have been consulted.

Note: The Minister for the Environment may consider the grant of an extension of the time limit of approval not exceeding five years for the substantial commencement of the proposal.

5 Compliance Audit and Performance Review

- 5-1 The proponent shall prepare an audit program and submit compliance reports to the Department of Environment which address:

1. the status of implementation of the proposal as defined in schedule 1 of this statement;
2. evidence of compliance with the conditions and commitments; and
3. the performance of the environmental management plans and programs.

Note: Under sections 48(1) and 47(2) of the *Environmental Protection Act 1986*, the Chief Executive Officer of the Department of Environment is empowered to monitor the compliance of the proponent with the statement and should directly receive the compliance documentation, including environmental management plans, related to the conditions, procedures and commitments contained in this statement.

6 Wetland

- 6-1 Within 12 months following subdivision/development approval, the proponent shall substantially commence construction of an approximately 1.9-hectare wetland shown in Figure 1 of schedule 1 as Public Open Space, to the requirements of the Minister for the Environment on advice of the Environmental Protection Authority.

This wetland shall include the following:

1. Black Swan breeding habitat;
 2. revegetation with local indigenous species;
 3. landform recontouring;
 4. establishment and maintenance of wetland connection to Clontarf Bay and the Canning River;
 5. weed control measures;
 6. water quality and quantity monitoring; and
 7. contingency measures to maintain or improve water quality of water flowing into Clontarf Bay and the Canning River.
- 6-2 Prior to commencement of construction of the wetland required by condition 6-1, the proponent shall prepare a Wetland Management Plan which includes identification of species to be used in revegetation works on site, to the requirements of the Minister for the Environment on advice of the Environmental Protection Authority.
- 6-3 The proponent shall implement the Wetland Management Plan required by condition 6-2.
- 6-4 The proponent shall make the Wetland Management Plan required by condition 6-2 publicly available.

7 Water Quality

- 7-1 Prior to ground-disturbing activity, the proponent shall prepare a Drainage, Nutrient, Irrigation and Water Quality Management Plan to the requirements of the Minister for the Environment on advice of the Environmental Protection Authority.

This Plan shall address the following environmental quality objectives as described in *Riverplan – An Environmental Management Framework for the Swan and Canning Rivers (August 2004)* to protect, restore and maintain:

1. ecosystem health;
 2. biological diversity;
 3. natural landscape;
 4. recreation; and
 5. water supply.
- 7-2 The proponent shall implement the Drainage, Nutrient, Irrigation and Water Quality Management Plan required by condition 7-1.
- 7-3 The proponent shall make the Drainage, Nutrient, Irrigation and Water Quality Management Plan required by condition 7-1 publicly available.
- 7-4 Prior to ground-disturbing activity, the proponent shall prepare an Ecotoxological Testing Plan to monitor the benthic habitat at the wetland discharge point into Clontarf Bay, to the requirements of the Minister for the Environment on advice of the Environmental Protection Authority.
- 7-5 The proponent shall implement the Ecotoxological Testing Plan required by condition 7-4.
- 7-6 The proponent shall make the Ecotoxological Testing Plan required by condition 7-4 publicly available.

8 Site Contamination

- 8-1 Prior to ground-disturbing activity, the proponent shall prepare a Site (Soil and Groundwater) Contamination Investigation, Remediation and Validation Plan to the requirements of the Minister for the Environment on advice of the Environmental Protection Authority with the concurrence of the Department of Health.

This Plan shall be prepared in general accordance with the Department of Environment *Contaminated Sites Management Series of Guidelines*, and shall include:

1. an Acid Sulfate Soil Management Plan; and
 2. an Asbestos Management Plan.
- 8-2 The proponent shall implement the Site (Soil and Groundwater) Contamination Investigation, Remediation and Validation Plan required by condition 8-1.
- 8-3 The proponent shall make the Site (Soil and Groundwater) Contamination Investigation, Remediation and Validation Plan required by condition 8-1 publicly available.

Procedures

- 1 Where a condition states “to the requirements of the Minister for the Environment on advice of the Environmental Protection Authority”, the Environmental Protection Authority will provide that advice to the Department of Environment for the preparation of written notice to the proponent.
- 2 The Environmental Protection Authority may seek advice from other agencies or organisations, as required, in order to provide its advice to the Department of Environment.
- 3 Where a condition lists advisory bodies, it is expected that the proponent will obtain the advice of those listed as part of its compliance reporting to the Department of Environment.

Notes

- 1 The Minister for the Environment will determine any dispute between the proponent and the Environmental Protection Authority or the Department of Environment over the fulfilment of the requirements of the conditions.

Dr Judy Edwards MLA
MINISTER FOR THE ENVIRONMENT; SCIENCE

11 OCT 2005

The Proposal (Assessment No. 1467)

The proposal is for:

- the residential development of the 18-hectare East Clontarf site bounded by Manning Road, Centenary Avenue, the Clontarf Aboriginal Campus and the Canning River, creating up to 200 lots, as shown in Figure 1;
- the filling and draining of approximately 2.1 hectares of Resource Enhancement wetland identified in the *Environmental Protection (Swan Coastal Plain Lakes) Policy 1992* and the *Draft Environmental Protection (Swan Coastal Plain Wetlands) Policy 2004*;
- the creation of an approximately 1.9-hectare wetland and associated upland vegetation adjacent to the existing wetland and Canning River;
- increasing the river foreshore area by approximately 8350 square metres;
- investigation into soil and groundwater contamination, and remediation as required;
- installation of two additional monitoring bores to perform additional ground and surface water monitoring; and
- provision of road frontage along both the wetland and the river foreshore, but not including the western section of Public Open Space which is to be a revegetated dryland buffer.

Table 1 – Key Proposal Characteristics

Element	Description
Proposal	Creation of up to 200 residential allotments
Area of disturbance	Approximately 16 hectares
Major components – <ul style="list-style-type: none"> • Wetland modification • Dewatering • Disturbance to site hydrology • Remediation of site contamination • Additional foreshore reserve • Potential acid sulfate disturbance • Created wetland • Noise and dust creation 	<p>Draining and filling of approximately 2.1 hectares of Resource Enhancement wetland as depicted on schedule 1.</p> <p>Creation of not less than 1.9 hectares (approximately) of wetland.</p> <p>Provision of 8350 square metres of additional foreshore reserve.</p> <p>Hydrological maintenance – water quality and quantity.</p> <p>Remediation of on-site contamination.</p>

Figure (attached).

Figure 1 - Residential Development Plan

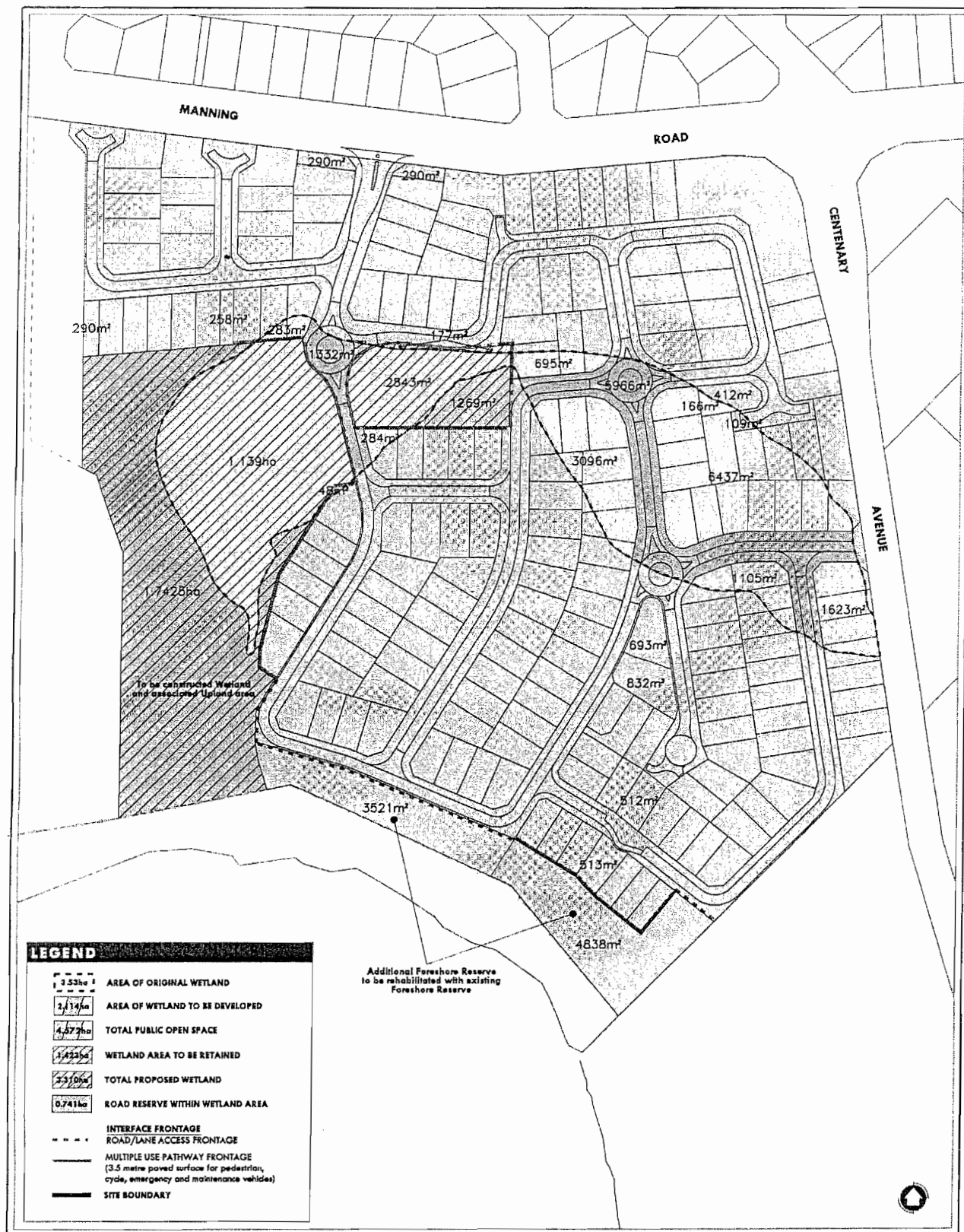


Figure 1 - Residential Development Plan

Note: The area for residential development is within the "site boundary", but excludes "Public Open Space", the "Wetland Area", and the "Area of Proposed Rehabilitated Wetland" indicated above.

Schedule 2

Proponent's Environmental Management Commitments

(September 2005)

**East Clontarf Residential Development
Waterford, City of South Perth**

(Assessment No. 1467)

Trustees for
The Christian Brothers in Western Australia Inc

Proponent's Environmental Management Commitments – September 2005

EAST CLONTARF RESIDENTIAL DEVELOPMENT, WATERFORD (Assessment No. 1467)

Note: The term “commitment” as used in this schedule includes the entire row of the table and its six separate parts as follows:

- a commitment number;
- a commitment topic;
- the objective of the commitment;
- the ‘action’ to be undertaken by the proponent;
- the timing requirements of the commitment; and
- the body/agency to provide technical advice to the Department of Environment.

No.	Topic	Objective	Action	Timing	Advice
1.	Construction Management	<p>To protect the remnant wetland vegetation identified for protection within <i>Bush Forever</i> adjoining the development from potential impacts associated with construction.</p> <p>To minimise (direct and indirect) impacts associated with the construction of the residential development and surrounds on fauna, surface and groundwater quality and quantity and local residents.</p>	<p>Prepare and implement a Construction Environmental Management Plan (CEMP) to the satisfaction of the DoE and the Cities of South Perth and Canning, which addresses:</p> <ol style="list-style-type: none"> 1. Dewatering Program; 2. Detailed Remediation Assessment of Contaminated Soils; 3. Acid Sulfate Soils Management Plan; 4. Construction Noise Management Procedures; and 5. Construction Dust Management Procedures. 	<p>Prepared and approved prior to construction.</p> <p>Implemented during construction.</p> <p>Audits to be completed during construction works and post-construction.</p>	<p>City of South Perth</p> <p>City of Canning</p>

No.	Topic	Objective	Action	Timing	Advice
2.	Foreshore Management	<p>To protect the conservation values identified for protection within the development adjacent to the Canning River foreshore.</p> <p>To mitigate proposed clearing within the development and enhance linkages and habitat value.</p>	<p>Prepare and implement a detailed Foreshore Management Plan to the satisfaction of the DPI, the SRT and the City of South Perth, which will include:</p> <ol style="list-style-type: none"> 1. Comprehensive weed eradication program; 2. Revegetating and restoring foreshore POS adjoining conservation areas with appropriate indigenous flora of the Canning River; 3. Increase the area contained within POS adjoining Bush Forever Site No. 333; 4. Creation of habitat and wildlife corridors; 5. Controlling vehicle and pedestrian access; 6. Construction of a dog-proof fence along the existing Foreshore Reserve, if considered appropriate; 7. Provision of public facilities; 8. Soil and plant source material hygiene; 9. Fire management including provision of fire hydrants; 10. Provision of educational and interpretative materials within the area to raise awareness of JAMBA/CAMBA species which frequent the area; 11. Encouraging community involvement and awareness by promoting control of pets (eg cats and dogs); 12. Water conservation principles; 13. Monitoring re-establishment or native and exotic plant species for a period of not less than 2 years followed by review; 14. Monitoring criteria to determine the success of the revegetation and weed eradication program; 15. Progress and compliance reporting; and 16. Timing and implementation schedule. 	<p>Preparation prior to construction.</p> <p>Implementation to be as determined in schedule within the Foreshore Management Plan.</p>	<p>CALM SRT City of South Perth</p>
3.	Wetland Management	To minimise impacts on wetlands and to offset any wetland impacts to ensure no net loss of function or value.	<p>Prepare and implement a Wetland Management Plan to the satisfaction of the DoE and the City of South Perth which will include:</p> <ol style="list-style-type: none"> 1. Identification of existing wetland area to be retained; 2. Avoiding direct and minimising indirect impacts on the wetland; 3. Ensuring no net loss of wetland values and functions; 4. Rehabilitation techniques to be employed; 	<p>Preparation prior to construction.</p> <p>Implementation to be as determined in schedule within the Wetland Management Plan.</p>	City of South Perth

No.	Topic	Objective	Action	Timing	Advice
			<ol style="list-style-type: none"> 5. Selection of appropriate local wetland and dryland species to maintain and enhance existing habitats; 6. Mitigation strategies for loss of any vegetation will be investigated, including both on-site and off-site options; 7. Creation of a new wetland area to be located adjacent to the existing wetland and the river foreshore suitable for Black Swan breeding habitat; 8. adopt existing mosquito and midge management protocols currently utilised by the City of South Perth; 9. Monitoring criteria to determine the success of the plan; 10. Progress and compliance reporting; and 11. Timing and implementation schedule. 		
4.	Groundwater Management	<p>To ensure that emissions do not adversely affect environmental values or the health, welfare and amenity of people and land uses by meeting statutory requirements and acceptable standards.</p> <p>To determine the potential impacts of dewatering during the construction phase on the vegetation within the wetland areas, Canning River and groundwater quality.</p>	<p>(1) Prepare and implement a Groundwater Management Plan as a component of the CEMP to the satisfaction of the DoE, SRT and Water Corporation which will include:</p> <ol style="list-style-type: none"> 1. Determining the nature and extent of groundwater contamination; 2. Installation of 2 additional monitoring bores; 3. Quarterly sampling of both additional and existing monitoring bores for a 12-month period; 4. Groundwater flow characteristics; and 5. Groundwater contamination plume management. <p>(2) Develop a Dewatering Program as a component of the CEMP to the satisfaction of the DoE.</p>	<p>Preparation of Groundwater Management Plan and Dewatering Program prior to construction.</p> <p>Implementation as per Plan/Program.</p> <p>Construction works to be timed and staged to minimise the volume of dewatering required.</p>	SRT Water Corporation

No.	Topic	Objective	Action	Timing	Advice
5.	Drainage, Nutrient, Irrigation and Water Quality Management	<p>To maintain acceptable water quality within the wetland and the Canning River in keeping with the Riverplan framework of management and best practice in urban stormwater management.</p> <p>To ensure that no road surface run-off directly enters the wetland.</p> <p>To ensure that there is provision for contaminant spillage entrapment.</p>	<p>Prepare and implement a Drainage, Nutrient, Irrigation and Water Quality Management Plan (DNIWQMP) to the satisfaction of the DoE, the SRT and the City of South Perth, which will include:</p> <ol style="list-style-type: none"> 1. Design and construction of the detention/infiltration basin; 2. Periodic monitoring of the infiltration basin (post-construction) to ensure continued function and maintenance as required; 3. Quarterly sampling of surface water body for a 12-month period; 4. Maximising infiltration of uncontaminated stormwater at sources to recharge the groundwater system; 5. Water conservation principles; 6. Nutrient control; 7. Prescribed fertilizer applications for areas of POS; 8. Determination of flushing requirements, associated impacts and management options; 9. Treating contaminated stormwater via gross pollutant and sediment traps; 10. Directing treated stormwater into the Canning River along the south-eastern corner boundary of the site (as per DoE advice); 11. Monitoring criteria to determine the success of the plan; 12. Develop and implement contingency measures to be implemented in the event that monitoring criteria are exceeded; 13. Progress and compliance reporting; and 14. Timing and implementation schedule. 	<p>Preparation prior to construction.</p> <p>Implementation to be as determined within the DNIWQM Plan.</p>	<p>SRT City of South Perth</p>
6.	Site Contamination Assessments	<p>To determine nature and extent of any soil or groundwater contamination present within the site which may pose a risk to human health or the environment.</p>	<p>(1) Prepare and implement a Site Remediation (Contaminated Soils) Management Plan as a component of the CEMP to the satisfaction of the DoE.</p> <p>(2) Areas of soil identified as contaminated in excess of EIL or HIL criteria will be excavated (if directed by DoE) and the base and walls of the excavations validated in accordance with relevant DoE Guidelines for the Remediation of Contaminated Land.</p>	<p>Preparation and implementation prior to site works in areas identified in the DSI as potentially contaminated.</p>	<p>DoH Worksafe City of South Perth City of Canning</p>

No.	Topic	Objective	Action	Timing	Advice
			<p>(3) The excavated soil will then be assessed to determine the appropriate management option. A final decision on the management of excavated contaminated soils will be made once analytical results are available for excavated soil.</p> <p>(4) An alternative that may be considered is to screen the material to remove geotechnically unsuitable materials and then re-use the material as fill in appropriate areas on the site, such as POS.</p> <p>(5) A remediation assessment report will be submitted to DoE on conclusion of remediation works which provides detailed information on:</p> <ol style="list-style-type: none"> 1. The remediation strategy implemented; 2. The results of validation and stockpile sampling; and 3. Details of the management of all contaminated material. <p>(6) Where areas have been identified as potentially affected by asbestos cement sheeting, prepare a specific Health and Safety Plan.</p> <p>This plan will be prepared as an appendix to the overall Site Remediation Management Plan.</p>	Before works commence	
7.	Water Conservation Principles	To conserve water.	<p>Water conservation measures will be applied within the development. These include:</p> <ol style="list-style-type: none"> 1. Promoting the use of plant species which have low water and fertiliser requirements; 2. Utilising local native plant varieties in landscaping; 3. Promoting landscape treatments sympathetic to climatic conditions and prevailing site conditions – soil types, topography, environment, wetlands etc.; 4. Utilising "cluster or clump" plantings to provide useable shade areas and better use of reticulated water in preference to single item or symmetrical planting regimes; 5. Irrigating POS areas at appropriate times so as to reduce evaporative loss and minimise transpiration losses; and 6. Ensuring that the irrigation regime applied to areas of POS is responsive to prevailing weather conditions. 	To be considered within preparation of the Foreshore Management Plan, Groundwater Management Plan and the DNIWQMP (Commitments 3 and 9).	SRT City of South Perth

No.	Topic	Objective	Action	Timing	Advice
8.	Noise	To protect the amenity of nearby residents from noise impacts resulting from activities associated with the proposal by ensuring that the noise levels meet statutory requirements and acceptable standards.	<p>Noise Management Procedures will be prepared for the site as part of the overall CEMP (see commitment 1).</p> <p>Measures to minimise noise levels received by proposed residences within the development from existing roadways will include:</p> <ol style="list-style-type: none"> 1. Construction of noise barriers between the roadway and residential lots; 2. Specifying appropriate setbacks of proposed residences from existing roadways; and 3. Specification of construction methods and materials (in keeping with “quiet house design” principles). 	<p>Prepared and approved prior to construction. Implemented during construction.</p> <p>Audits completed during construction works and post-construction.</p>	City of South Perth City of Canning
9.	Dust	To protect the surrounding land users such that dust and particulate emissions will not adversely impact on their welfare and amenity or cause health problems in accordance with the EPA’s Guidance Statement No. 18: Prevention of Air Quality Impacts from Land Development Sites.	<p>(1) Dust generated during construction will be minimised by the application of EPA guidelines and best practice in dust suppression.</p> <p>(2) Dust Management Procedures will be prepared for the site as part of the overall CEMP (see commitment 1).</p> <p>Measures to minimise dust levels will include:</p> <ol style="list-style-type: none"> 1. Watering of exposed surfaces; 2. Minimising working surfaces at any one time; and 3. Progressive rehabilitation of disturbed areas. 	<p>Prepared and approved prior to construction. Implemented during construction.</p> <p>Audits to be completed during construction works and post-construction.</p>	City of South Perth City of Canning
10.	Acid Sulfate Soil (ASS)	To plan and manage development that may potentially impact on ASS to avoid adverse effects on the natural and built environment and human activities and health.	<p>Prepare and implement an Acid Sulfate Soil Management Plan as a component of the CEMP (see commitment 1) to the satisfaction of the DoE, which will include:</p> <ol style="list-style-type: none"> 1. The area of PASS soils to be disturbed by excavation or dewatering will be minimised as far as possible; 2. Where ASS must be disturbed: <ul style="list-style-type: none"> • Earthworks will be completed as quickly as possible to minimise the time that the walls and base of excavations are exposed to the atmosphere; 	<p>Prepared prior to commencement of any earthworks or dewatering in areas identified as having potential for Acid Sulfate Soils.</p> <p>To be implemented during construction.</p>	SRT

No.	Topic	Objective	Action	Timing	Advice
			<ul style="list-style-type: none"> • Un-neutralised ASS/PASS will be stored for only limited periods on on-site bunded hardstand areas constructed from alkaline materials; • The quality of groundwater and dewatering effluents will be monitored regularly to ensure early detection of any alteration in water chemistry; and • if necessary, dewatering effluent will be treated to ensure that appropriate water quality is maintained; and <p>3. Where excavated soils must be directed for off-site disposal, they will be directed to a site approved for acceptance and/or treatment of ASS by the DoE.</p>		
11.	Archaeological Investigations	To fulfil the requirements stipulated on the Section 18 clearance of the <i>Aboriginal Heritage Act 1972</i> .	<p>(1) Apply for clearance under Section 18 of the <i>Aboriginal Heritage Act 1972</i> to remove both previously recorded sites and any new sites that emerge as a result of earthmoving procedures located within the site which will be impacted by the development.</p> <p>(2) Also undertake further archaeological investigations if required as part of the Section 18 clearance. Such investigations may include:</p> <ol style="list-style-type: none"> 1. Surface recording, mapping and collection of archaeological material; 2. Archaeological excavation and/or sub-surface evaluation; 3. Recovery of samples for radiometric dating; and 4. Analysis of recovered material. 	Site Heritage Protocol will be prepared prior to commencement of construction and implemented during construction, with any statutory processes followed as per the requirements of the <i>Aboriginal Heritage Act 1972</i> .	DIA

Abbreviations:

ASS - Acid sulfate soils
 CAMBA – China-Australia Migratory Birds Agreement
 CALM - Department of Conservation and Land Management
 DIA - Department of Indigenous Affairs
 DoE - Department of Environment
 DoH - Department of Health

Assessment No. 1467

Abbreviations continued:

DPI – Department for Planning & Infrastructure
DSI – Detailed site investigation
EIL – Ecological Investigation Levels
HIL – Health Investigation Levels
JAMBA - Japan-Australia Migratory Birds Agreement
PASS – Potential acid sulfate soils
POS – Public Open Space
SRT - Swan River Trust

Appendix B

Groundwater Monitoring Results

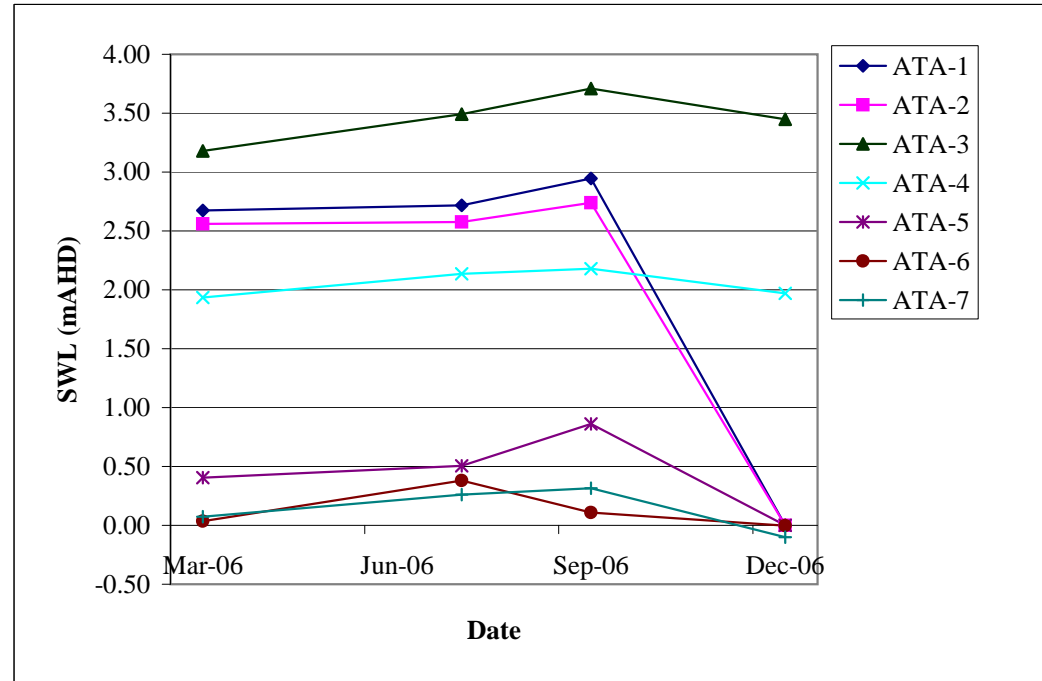
**Drainage, Nutrient, Irrigation and Water Quality Management Plan
Cygnia Cove Estate, Waterford**

Appendix B
Groundwater Monitoring Results

		OC/OP Pesticides (µg/l)				BTEX (mg/l)				TPH (mg/l)				PAH (µg/L)	Heavy Metals (mg/L)										Inorganics & Nutrients (mg/L unless otherwise stated)																				
		Dieldrin	DDE	Total OCs	Total OPs	Benzene	Toluene	Ethylbenzene	Xylenes	C ₆₋₉	C ₁₀₋₁₄	C ₁₅₋₂₈	C ₂₉₋₃₆	Polycyclic Aromatic Hydrocarbons	Aluminium (pH>6.5)	Arsenic	Barium	Cadmium	Chromium	Copper	Iron	Manganese	Mercury	Nickel	Lead	Selenium	Zinc	pH (no units)	Conductivity (mS/cm)	Total Suspended Solids	Total Acidity (mgCaCO ₃ /l)	Alkalinity (mgCaCO ₃ /l)	Carbonate (mgCaCO ₃ /l)	Hydroxide (mgCaCO ₃ /l)	Hardness	Chloride	Sulphate	Ammonia-N	NO _x -N	Total Kjeldahl Nitrogen	Total Nitrogen	Total Phosphorus			
Drinking Water ¹		0.0003	0.02	NV	NV	0.001	0.8	0.3	0.6	0.5*	0.5*	1.0*	NV	NV	0.2*	0.007	0.7	0.002	0.05	2	0.3*	0.5	0.001	0.02	0.01	0.01	0.01	3*	6.5-8.5*	NV	500	NV	NV	NV	NV	200*	250*	250	0.5	50	NV	NV	NV		
Aquatic Ecosystems ²		NV	NV	NV	NV	NV	NV	NV	NV	NV	NV	NV	NV	NV	0.055	0.013	NV	0.0002	0.001	0.0014	NV	NV	0.00006	0.01	0.0034	0.005	0.008	6.5-8.0	0.12-0.3	NV	NV	NV	NV	NV	NV	0.08	0.15	NV	1.2	0.065					
Sample ID	Date	SAMPLE ANALYTICAL RESULTS																																											
MW1	Mar-06	<0.001	<0.001	<0.019	<0.095	<0.001	<0.001	<0.001	<0.003	<0.02	<0.02	<0.04	<0.04	<2.5	0.70	<0.001	<0.05	<0.0001	0.019	0.001	0.37	0.34	<0.0001	0.010	0.004	0.001	0.025	5.7	0.43	<5	88	30	<5	<5	-	96	57	<0.2	0.35	1.0	1.0	0.07			
MW1 (Filtered)		-	-	-	-	-	-	-	-	-	-	-	-	-	0.40	0.001	<0.05	<0.0001	0.001	0.001	0.50	0.33	<0.0001	0.009	<0.001	0.002	0.016	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-			
MW1 Unfiltered	Jul-06	<0.001	<0.001	<0.019	<0.095	<0.001	<0.001	<0.001	<0.003	<0.02	<0.02	<0.04	<0.04	<2.5	0.73	<0.001	<0.1	<0.0002	0.001	<0.001	0.99	0.06	<0.0001	<0.01	0.002	<0.001	0.027	6.0	0.48	28	80	25	<5	<5	-	110	23	0.2	0.03	0.7	0.7	0.19			
MW1	Sep-06	<0.001	<0.001	<0.019	<0.095	<0.001	<0.001	<0.001	<0.003	<0.02	<0.02	0.37	<0.04	<2.5	0.70	0.001	<0.5	0.0001	0.001	0.002	1.90	0.15	<0.0001	0.003	0.001	0.001	0.006	6.1	0.43	33	65	47	<5	<5	56	95	10	<0.2	<0.01	1.7	1.7	0.14			
MW1	Dec-06	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-			
MW2	Mar-06	<0.001	<0.001	<0.019	<0.095	<0.001	<0.001	<0.001	<0.003	<0.02	<0.02	<0.04	<0.04	<2.5	<0.1	<0.001	<0.05	<0.0001	0.001	0.001	0.02	0.01	<0.0001	0.005	<0.001	0.001	0.017	6.2	0.51	<5	45	25	<5	<5	-	85	38	<0.2	9.00	0.9	0.9	0.03			
MW2 (Filtered)		-	-	-	-	-	-	-	-	-	-	-	-	-	<0.1	<0.001	<0.05	<0.0001	0.001	0.001	0.02	<0.01	<0.0001	0.005	<0.001	0.001	0.018	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-			
MW2 Unfiltered	Jul-06	<0.001	<0.001	<0.019	<0.095	<0.001	<0.001	<0.001	<0.003	<0.02	<0.02	<0.04	<0.04	<2.5	0.08	<0.001	<0.01	<0.0002	<0.001	<0.001	<0.01	<0.01	<0.0001	<0.01	<0.001	<0.001	0.007	6.3	0.54	<5	31	20	<5	<5	-	92	27	0.2	2.10	1.1	1.1	0.06			
MW2	Sep-06	<0.001	<0.001	<0.019	<0.095	<0.001	<0.001	<0.001	<0.003	<0.02	<0.02	<0.04	<0.04	<2.5	0.20	<0.001	<0.5	0.0001	<0.001	0.001	0.03	<0.01	<0.0001	0.001	<0.001	0.001	0.010	6.2	0.52	<5	21	22	<5	<5	73	94	34	<0.2	12.00	1.2	13.0	0.07			
MW2	Dec-06	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
MW3	Mar-06	<0.001	0.020	0.038	<0.095	<0.001	<0.001	<0.001	<0.003	<0.02	<0.02	<0.04	<0.04	<2.5	0.70	0.003	<0.1	<0.0002	0.002	0.016	0.45	<0.01	<0.0001	0.060	0.001	0.001	0.086	7.0	0.48	14	<5	42	<5	<5	-	120	39	<0.2	0.39	0.6	1.0	0.72			
MW3 (Filtered)		-	-	-	-	-	-	-	-	-	-	-	-	-	<0.1	0.002	<0.1	<0.0002	0.001	0.016	0.08	<0.01	<0.0001	0.040	<0.001	0.002	0.084	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
MW3 Unfiltered	Jul-06	<0.001	<0.001	<0.019	<0.095	<0.001	<0.001	<0.001	<0.003	<0.02	<0.02	<0.04	<0.04	<2.5	0.09	0.026	<0.1	<0.0002	<0.001	0.002	0.09	<0.01	<0.0001	<0.01	<0.001	<0.001	0.076	6.4	0.59	<5	56	37	<5	<5	-	110	54	0.4	1.10	1.0	1.0	1.50			
MW3	Sep-06	<0.001	<0.001	<0.019	<0.095	<0.001	<0.001	<0.001	<0.003	<0.02	<0.02	<0.04	<0.04	<2.5	<0.1	<0.001	<0.5	0.0001	<0.001	0.001	0.07	<0.01	<0.0001	<0.001	<0.001	0.001	<0.005	6.2	0.44	6	40	37	<5	<5	78	84	44	<0.2	3.60	0.7	4.3	0.19			
MW3	Dec-06	<0.001	<0.001	<0.019	<0.095	-	-	-	-	<0.02	<0.02	<0.04	<0.04	-	0.10	<0.001	<0.1	<0.0001	<0.001	0.002	0.15	<0.01	0.0002	0.001	<0.001	0.001	0.005	5.9	0.42	14	-	-	-	64	80	23	<0.2	-	-	2.0	0.33				
MW4	Mar-06	0.001	0.001	0.019	<0.095	<0.001	<0.001	<0.001	<0.003	<0.02	<0.02	<0.04	<0.04	<2.5	2.80	0.002	0.30	<0.0002	0.001	0.001	22	0.58	<0.0001	0.080	<0.001	0.003	0.049	6.0	0.69	980	<5	630	<5	<5	-	220	49	1.1	0.29	1.9	2.2	0.23			
MW4 (Filtered)		-	-	-	-	-	-	-	-	-	-	-	-	-	<0.1	0.001	<0.1	<0.0002	<0.001	0.001	<0.01	0.44	<0.0001	0.050	<0.001	0.003	0.050	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
MW4 Unfiltered	Jul-06	<0.001	<0.001	<0.019	<0.095	<0.001	<0.001	<0.001	<0.003	<0.02	<0.02	<0.04	<0.04	<2.5	0.02	0.001	<0.1	<0.0002	<0.001	<0.001	9.5	0.34	<0.0001	<0.01	<0.001	<0.001	0.028	6.5	0.84	25	170	96	<5	<5	-	170	30	1.6	0.03	1.6	1.0	0.15			
MW4	Sep-06	<0.001	<0.001	<0.019	<0.095	<0.001	<0.001	<0.001	<0.003	<0.02	<0.02	<0.04	<0.04	<2.5	0.20	<0.001	<0.5	0.0001	<0.001	<0.001	9.3	0.35	<0.0001	0.004	<0.001	<0.001	0.015	5.9	0.70	64	170	61	<5	<5	74	170	32	1.0	<0.01	2.2	2.2	0.05			
MW4	Dec-06	<0.001	<0.001	<0.019	<0.095	-	-	-	-	<0.02	<0.02	<0.04	<0.04	-	<0.1	0.001	<0.1	<0.0001	0.001	0.001	34	0.3	<0.0002	0.002	<0.001	0.001	0.019	5.9	0.76	54	-	-	-	81	180	27	<0.2	-	-	1.4	0.01				
MW5	Mar-06	<0.001	0.001	0.019	<0.095	<0.001	<0.001	<0.001	<0.003	<0.02	<0.02	<0.04	<0.04	<2.5	2.00	0.003	0.20	<0.0002	0.001	0.001	21	0.15	<0.0001	0.030	<0.001	0.002	0.006	6.8	1.30	380	<5	63	<5	<5	-	220	39	19.0	0.10	1.7	1.8	0.20			
MW5 (Filtered)		-	-	-	-	-	-	-	-	-	-	-	-	-	<0.1	0.001	<0.1	<0.0002	0.001	0.002	0.01	0.01	<0.0001	0.020	<0.001	0.003	0.005	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
MW5 Unfiltered	Jul-06	<0.001	<0.001	<0.019	<0.095	<0.001	<0.001	<0.001	<0.003	<0.02	<0.02	<0.04	<0.04	<2.5	0.02	0.003	0.20	&																											

Appendix B Groundwater Monitoring Results

Bore ID	TOC mAHD	Date	SWL mbTOC	SWL mAHD
ATA-1	6.86	28/03/2006	4.19	2.67
	6.86	17/07/2006	4.14	2.72
	6.86	26/09/2006	3.91	2.95
	6.86	19/12/2006	-	-
ATA-2	9.55	28/03/2006	6.99	2.56
	9.55	17/07/2006	6.97	2.58
	9.55	26/09/2006	6.81	2.74
	9.55	19/12/2006	dry	-
ATA-3	7.91	13/03/2006	4.73	3.18
	7.91	17/07/2006	4.42	3.49
	7.91	26/09/2006	4.20	3.71
	7.91	19/12/2006	4.46	3.45
ATA-4	3.08	13/03/2006	1.15	1.94
	3.08	17/07/2006	0.95	2.14
	3.08	26/09/2006	0.90	2.18
	3.08	19/12/2006	1.11	1.97
ATA-5	2.1	13/03/2006	1.70	0.40
	2.1	17/07/2006	1.59	0.51
	2.1	26/09/2006	1.24	0.86
	2.1	19/12/2006	-	-
ATA-6	0.53	13/03/2006	0.50	0.04
	0.53	17/07/2006	0.15	0.38
	0.53	26/09/2006	0.42	0.11
	0.53	19/12/2006	0.53	0.00
ATA-7	1.21	13/03/2006	1.14	0.07
	1.21	17/07/2006	0.95	0.26
	1.21	26/09/2006	0.89	0.32
	1.21	19/12/2006	1.31	-0.10



Appendix C
Bore Abstraction Licence
Drainage, Nutrient, Irrigation and Water Quality Management Plan
Cygnia Cove Estate, Waterford



RECEIVED

15 APR 2008

Our ref: RF2885
Enquiries: Jessica Chapman
Phone: 6250 8000

Trustee for the Christian Brothers in WA Incorporated
C/- Richard Noble & Company
PO Box 8210
SUBIACO EAST WA 6008
Attention: Alex Gregg – Managing Director

Dear Mr. Gregg,

Re: Application for a Licence to Take Water under Section 5C of the Rights in Water and Irrigation Act 1914 & an Application for a 26D Licence to Construct / Alter Well/s

Property Location: : Lot 83 On Plan 2461 - Volume/Folio 2048/181 - Lot 83 Manning Rd Waterford; Lot 829 On Diagram 88770 - Volume/Folio 2048/180 - Lot 829 Manning Rd Waterford; Lot 9001 On Plan 44883 - Volume/Folio 2598/42 - Lot 9001 Waterford

The Department of Water acknowledges receipt of your application, dated 8 November 2007 for a Licence to Take Water and to construct a well for the above locations.

The Department undertakes to grant you a Licence to allow you to take water from one new non-artesian bore for the proposed irrigation of 1.95ha of Lawns and Gardens (under Schedule 1 Clause 9 (2) of the above Act), subject to the following information being provided to the Commission by 11 July 2008:

- All relevant approvals required under written law to carry out the activities to which the licence relates.

Please be aware that the groundwater licence when issued will contain conditions including, but not limited to, the following:

1. Water may not be taken for irrigation through sprinkler systems between 9 am and 6 pm after licence issue date except for watering newly planted areas for a period of up to 28 days from planting or for testing the sprinkler system.
2. That the licensee shall have the irrigation project completed by the licence expiry date. An inspection of the property will be undertaken at this time. Please be aware that in accordance with the *Statewide Policy No 11; Management of Unused Licensed Water Entitlements*, failure to complete the development within this

licence period may result in allocations being amended to reflect actual water usage at the time.

3. That the maximum annual draw from the approved groundwater source shall not exceed 14,625kL

This letter of undertaking is valid until **11 July 2008**. Before this date, you must supply the information requested. Please keep the Department informed of any problems that may prevent you from complying.

Please note that it is an offence of the *Rights in Water and Irrigation Act 1914* to take water without a valid licence.

I must emphasise that the licence will be subject to regular review in accordance with groundwater availability and our water allocation guidelines, as applicable from time to time.

Your licence to construct a well is also enclosed.

Within one month of completing the wells, you are required to submit a **Form L – Particulars of Completed Borehole** for each well drilled, to the Water and Rivers Commission Office in Victoria Park. A penalty of \$150 applies for failure to submit this Form.

If the water from this well is being improperly used, is being wasted or is having a harmful effect, the Commission may direct the closing of this well. For further information, please read the enclosed pamphlet *What are my obligations as a licence holder?*

It should be noted that although one of the objectives for water resources management is to secure a reliable source of groundwater for all licensed users, it cannot be assumed that any approved allocation will be maintained in perpetuity.

If you have any queries relating to the above matter, please contact Jessica Chapman on 6250 8000.

Yours faithfully



Paul Gherghetta
Natural Resource Management Officer
Swan Avon Region

11 / 4 / 08
...../...../.....

**LICENCE TO CONSTRUCT OR ALTER WELL**

Granted by the Department under section 26D of the Rights in Water and Irrigation Act 1914

Licensee(s)	Trustee for the Christian Brothers in WA Incorporated	
Description of Water Resource	Perth Perth - Superficial	
Location of Well(s)	Lot 9001 On Plan 44883 - Volume/Folio 2598/42 - Lot 9001 Waterford	
Authorised Activities	Activity	Location of Activity
	Construct 1 non-artesian well(s).	Lot 9001 On Plan 44883 - Volume/Folio 2598/42 - Lot 9001 Waterford
Duration of Licence	From 11 April 2008 to 11 October 2008	

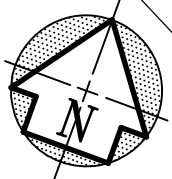
This Licence is subject to the following terms, conditions and restrictions:

- 1 The well must be constructed by a driller having a current class 1 water well drillers certificate issued by the Western Australian branch of the Australian Drilling Industry Association or other certification approved by the Department of Water as equivalent.
- 2 That the depth of the bore/s shall be limited to the superficial aquifer.
- 3 That should the bore/s be abandoned it/they shall be sealed off to the satisfaction of the Department of Water.
- 4 The licensee is required to provide to the Department of Water a completed 'Particulars of Completed Bore Hole Form' on completion of the approved drilling programme.

End of terms, conditions and restrictions

Appendix D
Stormwater Drainage – Standard Details
Drainage, Nutrient, Irrigation and Water Quality Management Plan
Cygnia Cove Estate, Waterford

Appendix E
Drainage System - Major
Drainage, Nutrient, Irrigation and Water Quality Management Plan
Cygnia Cove Estate, Waterford



GROSS CONTRIBUTING
AREA = 3.5 Ha TO
PROPOSED STORAGE
BASIN 1.

GROSS CONTRIBUTING
AREA = 7.4 Ha TO
PROPOSED STORAGE
BASIN 1.

GROSS CONTRIBUTING
AREA = 2.51 Ha TO
PROPOSED STORAGE
BASIN 1.

BASIN 1.

ACTUAL STORAGE
VOLUME = 1595 m³.
TWL = RL 2.30.

TOTAL GROSS CONTRIBUTING
AREA = 16.58 Ha TO
PROPOSED STORAGE
BASIN 1.

LEGEND

Ag=0.071 ha CATCHMENT AREA GROSS IN HECTARES TO PIT.
An=0.068 ha CATCHMENT AREA NETT IN HECTARES TO PIT.
GL=6.85 GUTTER LEVEL.
%-2.26 GRADE OF ROAD AT PIT.

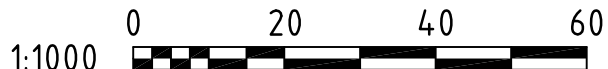
CLONTARF CAMPUS

EXISTING WETLAND

FORESHORE RESERVE

CENTENARY PARK

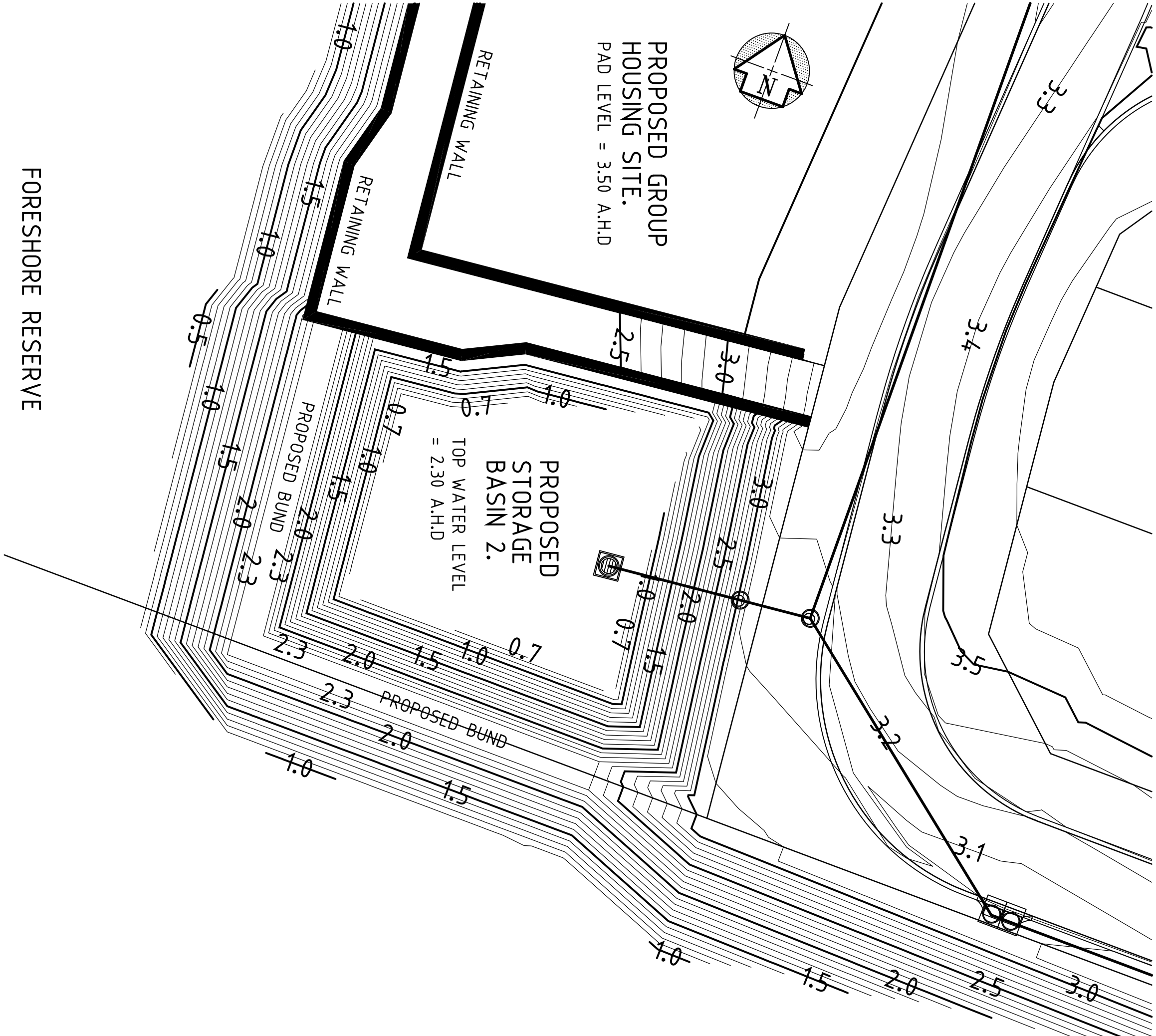
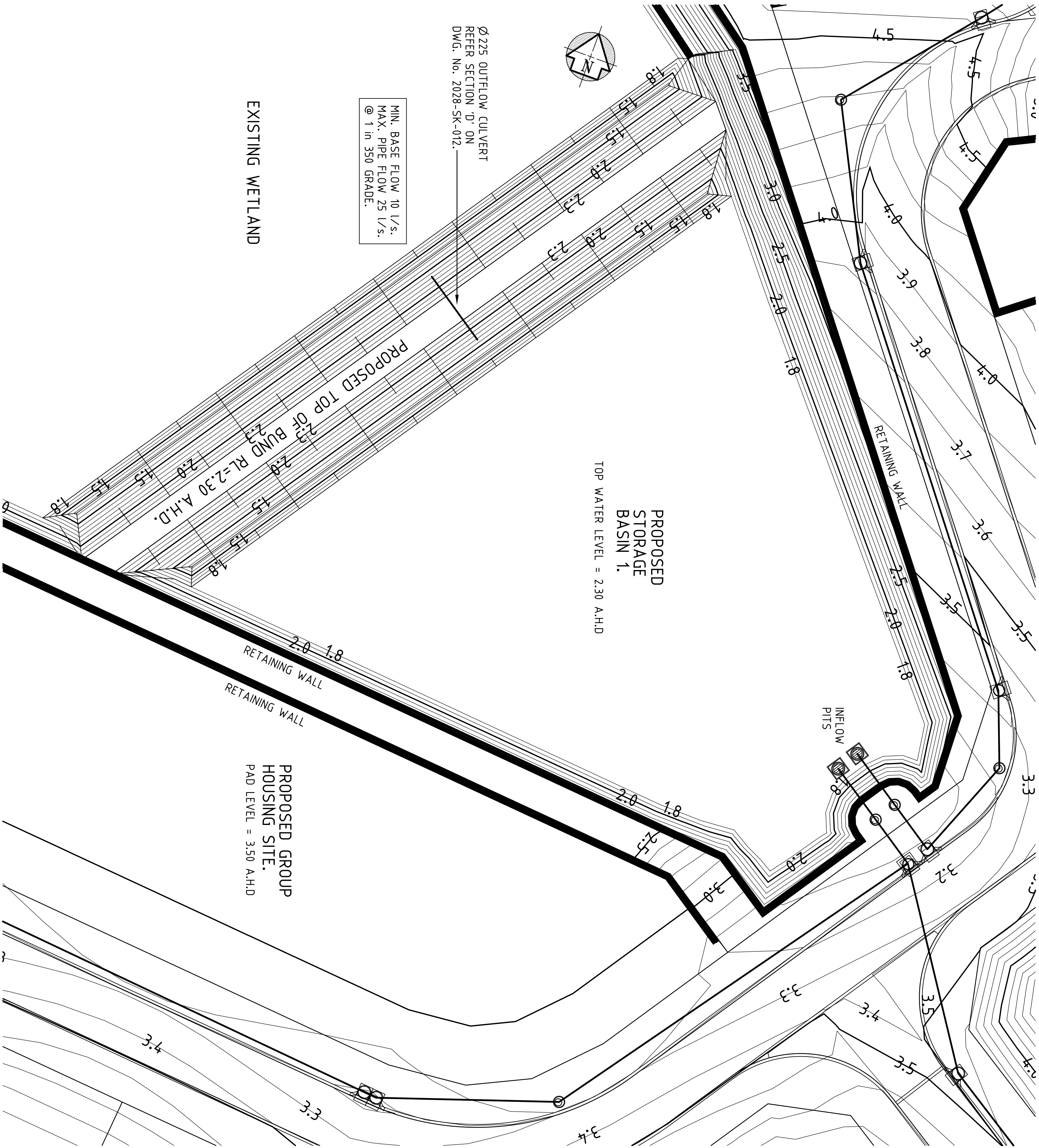
CAD No. 2028SK015
WAPC No. 121124



A1

										CLIENT		PROJECT	
										RICHARD NOBLE & COMPANY		CYGNA COVE ESTATE, WATERFORD	
												TITLE	
												GENERAL STORMWATER DRAINAGE	
												CATCHMENT PLAN	
												DRAWING NUMBER	
												2028-SK-015	
												ISSUE	
												A	

Appendix F
Detention Storage Areas
Drainage, Nutrient, Irrigation and Water Quality Management Plan
Cygnia Cove Estate, Waterford

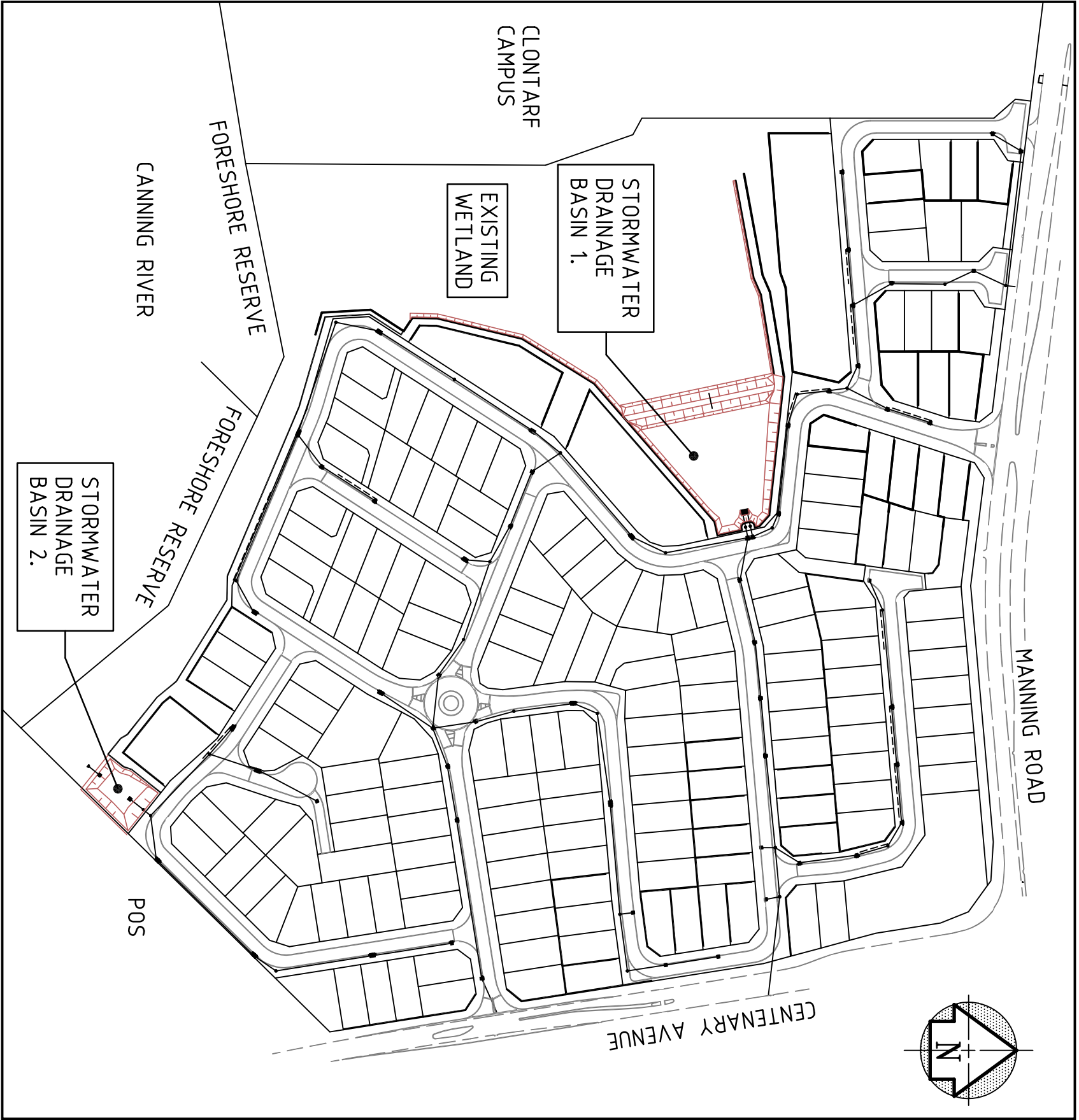


STORMWATER DRAINAGE STORAGE BASIN 1.
SCALE 1:250

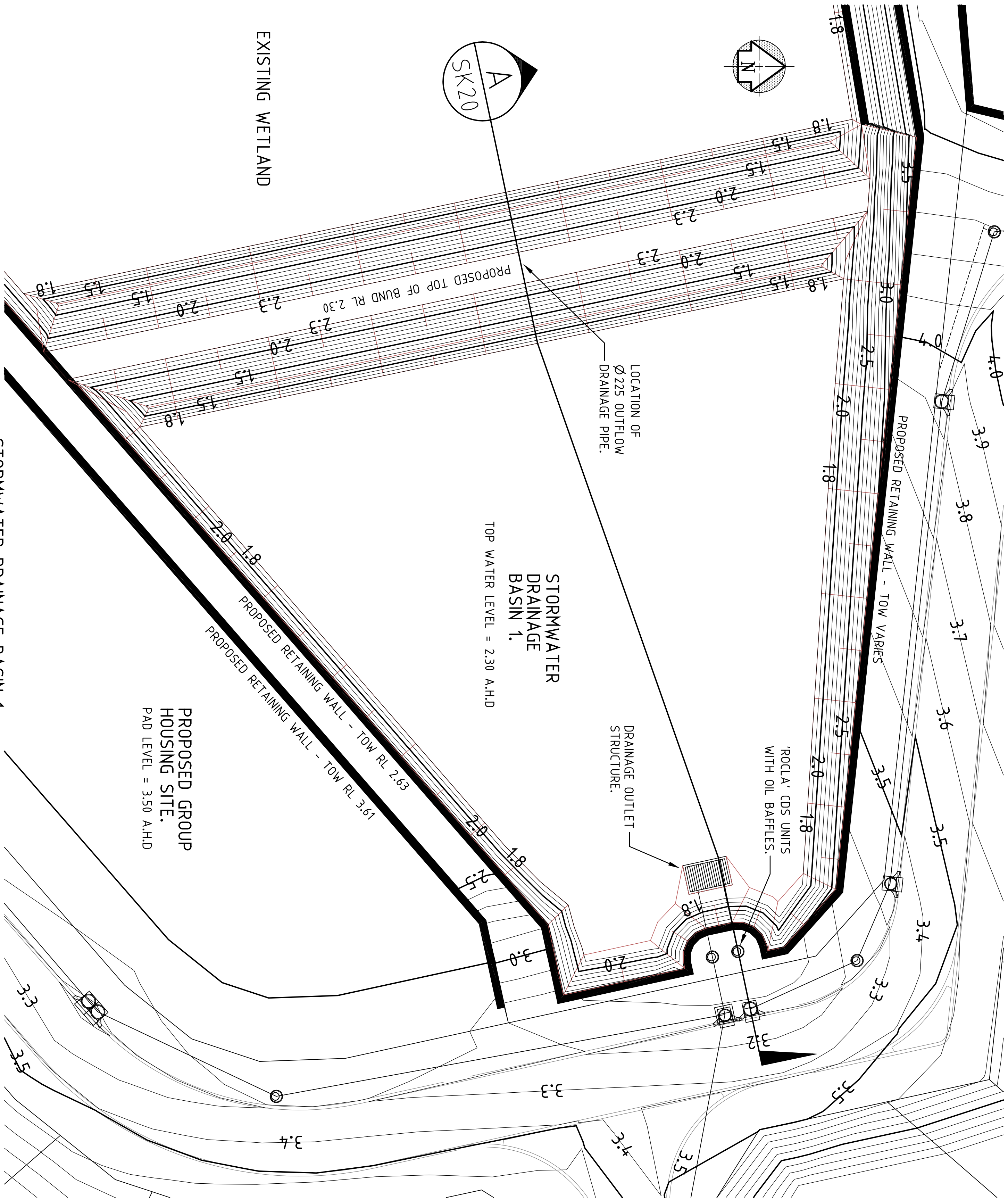
STORMWATER DRAINAGE STORAGE BASIN 2.
SCALE 1:250

				This plan shall not be used for construction unless issued as rev 0 and signed as approved.			
				COPYRIGHT The concepts and information contained in this document are the copyright of TABEC Pty. Ltd. Use or copying of the information without the written permission of TABEC Pty. Ltd. constitutes an infringement of copyright.			
				CLIENT RICHARD NOBLE & COMPANY			
				DESIGNED NJW			
				CHECKED CCB			
				APPROVED DATE			
				PROJECT CYGNIA COVE ESTATE, WATERFORD			
				TITLE STORMWATER DRAINAGE STORAGE BASINS			
				DRAWING NUMBER 2028-SK-014			
				ISSUE C			
C	13-6-08	NJW	CCB	DRAINAGE DATA ADDED. ISSUED FOR INFORMATION.			
B	1-12-07	NJW	CCB	BASIN 2 AMENDED. RE-ISSUED FOR INFORMATION.			
A	2-12-07	NJW	CCB	ISSUED FOR INFORMATION.			
No.	DATE	DRAWN	APPROVED	AMENDMENT			

CAD No. 2028SK014
WAPC No. 121124



GENERAL LAYOUT PLAN
SCALE 1:2500

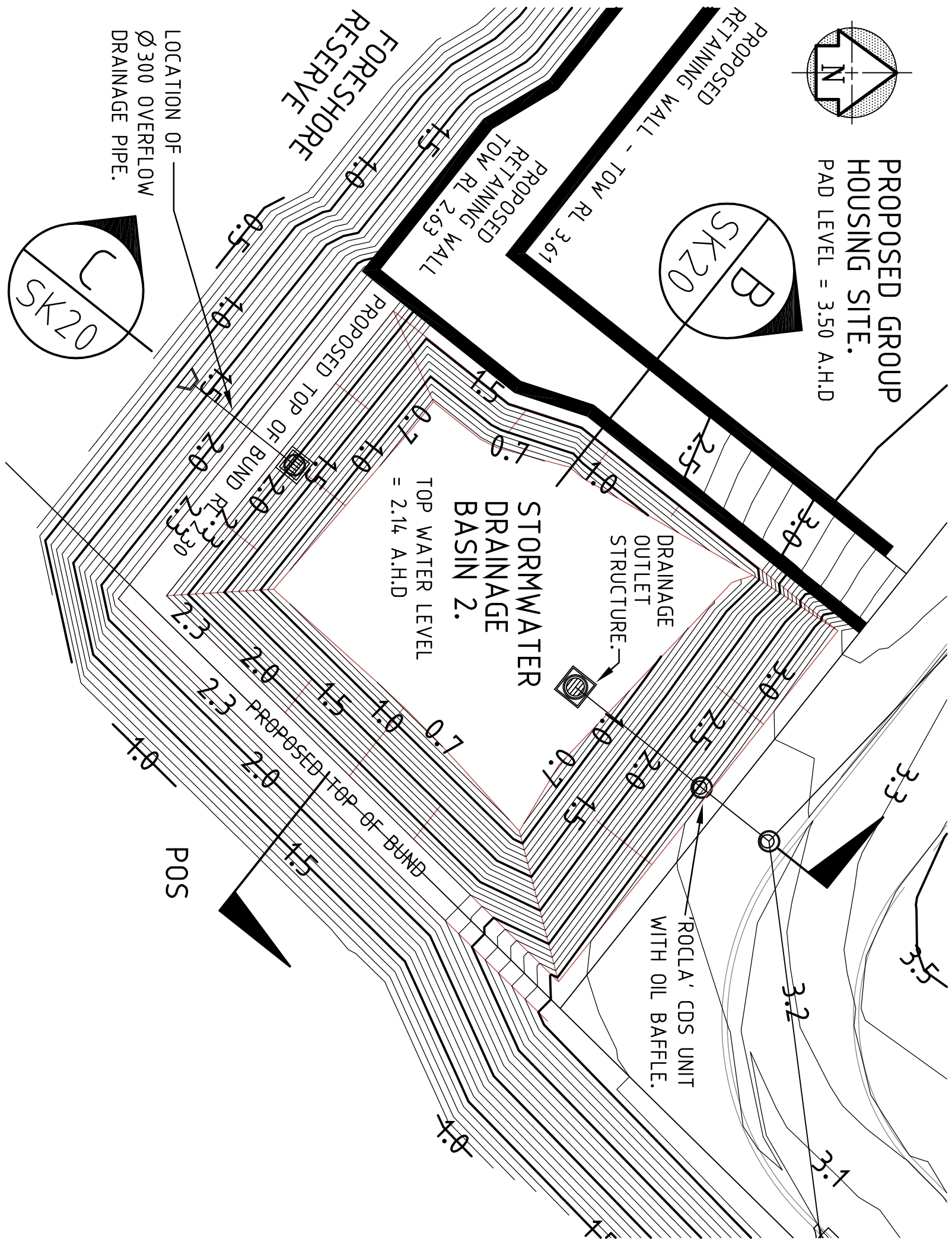


STORMWATER DRAINAGE BASIN 1.
SCALE 1:250

STORMWATER DRAINAGE BASIN 1.					EXISTING WETLAND			RESIDENCE TOTAL TIME IN BASIN & WETLAND (HOURS)	
AVERAGE TOP OF WATER RL	BASEIN PIPE OUT- FLOW (L/S)	BASEIN STORAGE (M3)	TIME IN BASIN (HOURS)	AVERAGE DEPTH OF WATER (M)	WETLAND PIPE OUT- FLOW (L/S)	WETLAND STORAGE (M3)	TIME IN WETLAND (HOURS)		
1.85	12	214	5	0.05	29	622	6	11	
1.90	20	357	5.1	0.10	29	1250	12	17.1	
1.95	26	504	5.4	0.15	29	1882	18	23.4	
2.00	29	652	6.2	0.20	29	2519	24	30.2	
2.05	29	803	7.7						
2.10	29	957	9.2						
2.15	29	1112	10.7						
2.20	29	1270	12.2						
2.25	29	1431	13.7						
2.30	29	1595	15.3						

NOTE :
ASSUMED BASE OF BASIN AND WETLAND IS RL 1.80 A.H.D.

STORMWATER DRAINAGE BASIN 2.				
NOTE : 1 IN 100 YEAR STORMWATER DRAINAGE IS FULLY CONTAINED AT APPROXIMATE RL 2.14. ANY EXCESS TO OVERFLOW VIA A Ø 300 PIPE TO THE FORESHORE RESERVE.				

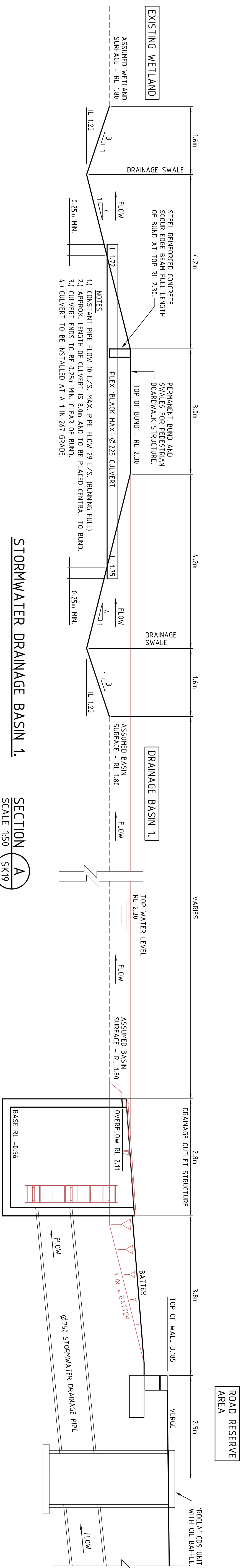


STORMWATER DRAINAGE BASIN 2.
SCALE 1:250

NOTE :
THIS DRAWING TO READ IN CONJUNCTION WITH DWG. No. 2028-SK-020.

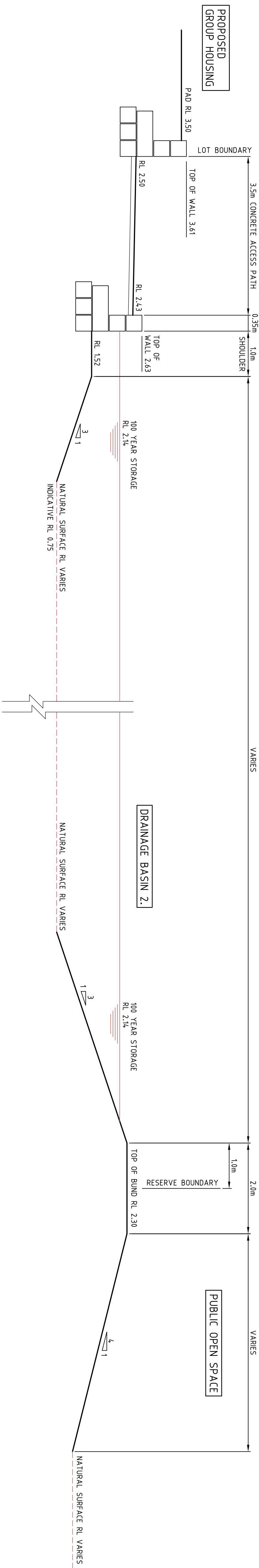
CAD No. 2028SK019
WAPC No. 121124

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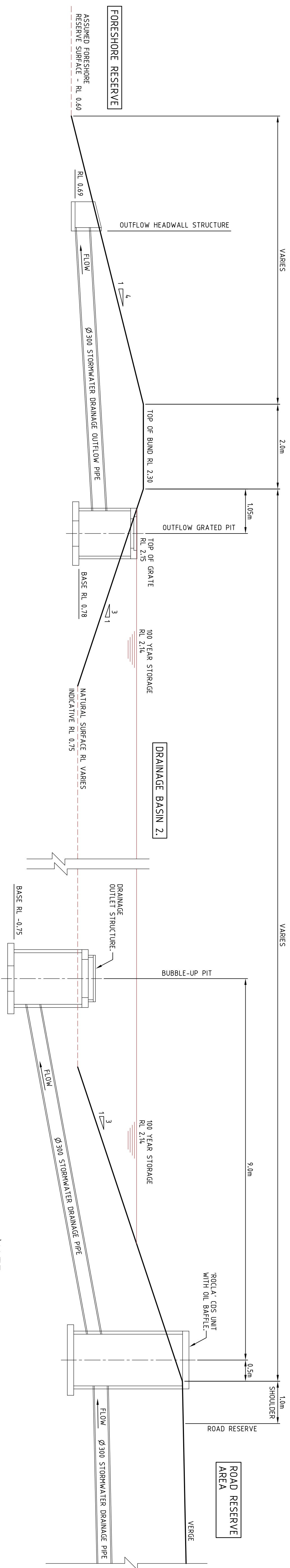
STORMWATER DRAINAGE BASIN 1.

SECTION A
SCALE 1:50 SK19



STORMWATER DRAINAGE BASIN 2.

SECTION B
SCALE 1:50 SK19



STORMWATER DRAINAGE BASIN 2.

SECTION C
SCALE 1:50
SK19

NOTE:
THIS DRAWING TO READ IN CONJUNCTION WITH DWG. No. 2028-SK-019

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<p>DRAWN NJW</p> <p>CHECKED CCB</p> <p>DATE</p>										<p>TABEC</p> <p>Civil Engineering Consultants</p> <p>TABEC Pty Ltd ACN 090 785 874 14 WILSON STREET NORTH WILSON Telephone 9225 4100, Fax 9225 4198 Email info@tabec.com.au</p>									
<p>PROJECT CYGNA COVE, WATERFORD</p>										<p>TITLE STORMWATER DRAINAGE BASINS 1 & 2</p> <p>GENERAL SECTIONS</p>									
<p>DRAWING NUMBER 2028-SK-020</p>										<p>ISSUE A</p>									

Appendix G
Proposed Plant Species for Vegetation of
the Detention Storage Area
Drainage, Nutrient, Irrigation and Water Quality Management Plan
Cygnia Cove Estate, Waterford

02132-01 – CYGNIA COVE
DETENTION BASIN – REED, SEDGE and TREE SPECIES

Rushes and Sedges
<i>Baumea articulata</i>
<i>Baumea juncea</i>
<i>Baumea rubiginosa</i>
<i>Baumea vaginalis</i>
<i>Carex appressa</i>
<i>Carex fascicularis</i>
<i>Eleocharis acuta</i>
<i>Eleocharis spacelata</i>
<i>Isolepis nodosa</i>
<i>Juncus kraussii</i>
<i>Lepidosperma longitudinale</i>
<i>Leptocarpus diffusus</i>
<i>Meeboldina scariosa</i>
<i>Schoenoplectus validus</i>

Herbs
<i>Lobelia alata</i>
<i>Samolus repens</i>

Tree
<i>Banksia littoralis</i>
<i>Eucalyptus rudis</i>
<i>Melaleuca raphiophylla</i>