# 16. Surface water and groundwater

## 16.1 Overview

Water resources, whether surface or sub-surface, are a vital resource and any effects on their quality are important for the sustainability of the area, as well as the environment in general. This section describes existing surface water, drainage and flooding conditions in the catchment and the quantity and quality of surface and groundwater resources.

## 16.2 Legislative and policy requirements

Regional stormwater drainage assets are managed by local government including all assets located in roadway or road reserve. Thus, the existing infrastructure along the corridor is under the care and control of the City of Port Adelaide Enfield Council (PAE). Other government bodies (below) have an interest in the drainage and water quality impacts of this project and they guide 'best-practice' with regard to state and local government objectives for the area of interest.

### 16.2.1 AMLR NRM Board

Under the *Natural Resources Management Act 2004*, the Adelaide and Mount Lofty Ranges Natural Resources Management (NRM) Board is involved in achieving proper stormwater management and flood mitigation procedures in the region. The Board's plan refers to, and seeks to support, local government and the Environment Protection Authority (EPA) to meet management of stormwater quality and flood mitigation objectives.

### 16.2.2 EPA

Under the Environment Protection (Water Quality) Policy 2003, clause 4(3) excludes application of the policy to public stormwater systems, specifically government or public authorities. This is interpreted to include the Department for Transport, Energy and Infrastructure (DTEI).

### 16.2.3 Development Plan

The PAE Development Plan Principles and Objectives, although not directly relevant to the South Road Superway Project, outline relevant Principles of Development Control (PDC) which can be interpreted for design standards considerations in this project. Development Plan return periods may not be fully representative of standards accepted by Council for trunk drainage infrastructure or for prevailing conditions.

PDC 14 seeks a 1 in 100 year flood protection, with further 0.3 m allowance for sea level rise.

Under PDC 131, development that affects stormwater management systems should seek to improve stormwater quality and minimise pollutant transfer to receiving waters. Stormwater management principles do not explicitly nominate a design standard but there is suggestion of 1 in 100 year flood protection to private properties.

Under Council-wide Objectives for Stormwater Management, Objective 112 seeks to minimise or eliminate water quality degradation. The protection of water quality is generally referred to in relation to development matters in the Council area.

## 16.3 Existing conditions

### 16.3.1 Flooding and drainage

#### Site description

As part of the project planning study, the impact and opportunities for three stormwater trunk conduits are being explored in the following catchments:

- South Road, North Arm West (NAW)
- Dunstan Road, North Arm West 5 (NAW5)
- Hindmarsh Enfield Prospect (HEP).

**Figure 16.1** shows the locations of the three catchments relative to the South Road Superway which is highlighted in red.

The current review is primarily concerned with the NAW stormwater drain as the nominated corridor.

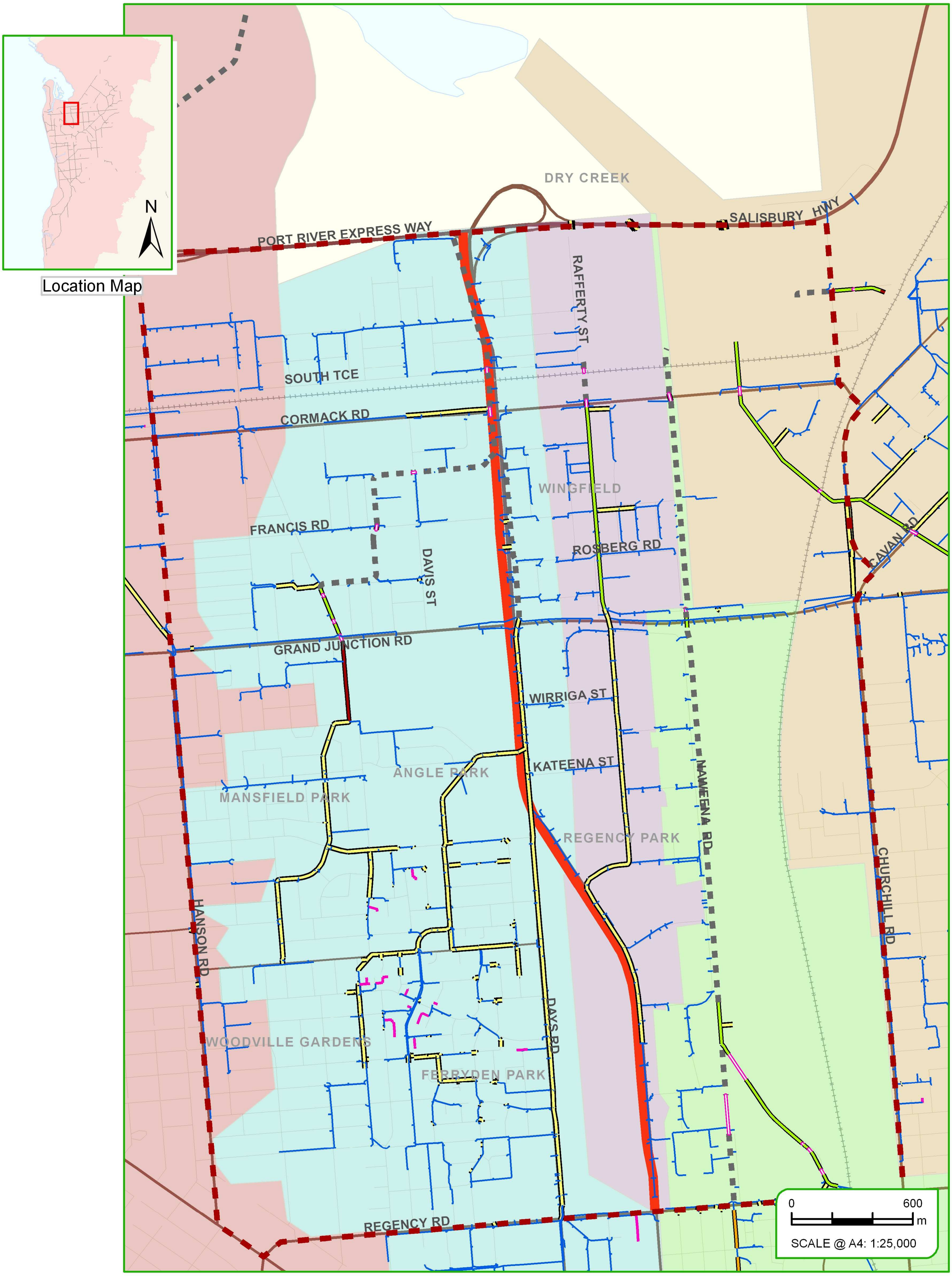
Stormwater in the NAW trunk is conveyed by a series of large box culverts and unlined open channels. It runs from Days Road, northbound along South Road up to the Port River Expressway. Between Grand Junction Road and the Port River Expressway, the conduit takes the form of an open unlined channel. Moving northwards, the open channel moves from the eastern reserve to the western reserve of South Road at the Senna Road junction. The Mansfield Park Drain also joins in at this point.

A summary of the stormwater drain characteristics provided by DTEI is presented in **Table 16.1.** It is noted that this data has been sourced from the original stormwater design adopted for the NAW trunk drain. No survey has been undertaken to profile the existing drain to date, however digital terrain data obtained from PAE indicates that there is some variation to the drain profile as constructed.

**Table 16.1. Summary of design conduit type**

| Section | | Dimensions | |
|---|---|---|---|
| **From** | **To** | **Design data* (nominal)** | **Observed** |
| Days Road | Grand Junction Road | Box culvert, 2 or 3 of nom 2.6 m x 0.9 m | - |
| Grand Junction Road | Senna Road | Open trapezoidal channel,<br>depth varies 1.7–2.0 m, top width 17–25 m | 1.4 x 12.5 |
| Senna Road | South Terrace | Open trapezoidal channel,<br>depth varies 1.5–1.7 m, top width 30–15 m | 1.8 x 13 |
| South Terrace | Port River Expressway | Open trapezoidal channel,<br>depth 1.5 m, top width 15 m | 1.8 x 14 |

** Data provided by DTEI November 2006, interpreted from design documentation and unverified on site*




Study Area
South Road Superway
BC
BC Open Channel
Concrete Rectangular
Concrete Trapezoid
Earth Open Channel
PVC
RC
RIBLOC
Rock Channel
Dunstan Road (NAW5)
Hindmarsh Enfield Prospect (HEP)
North Arm East (NAE)
South Road (NAW)
Torrens Road Drainage Authority (TRDA)

**Catchment Areas**

**Figure 16.1**

**South Road, North Arm West Catchment**

## *Drainage conditions*

Following discussions to obtain anecdotal information on the drainage conditions of the NAW catchment, DTEI and PAE provided drainage design data for the Days Road and South Road trunk drain but the prevailing condition of the drain does not match the original design. The drain has been designed as a lined channel, to achieve a return period of 20 years.

The pre-existing intended design capacity for the open channel (north of Grand Junction Road), extracted from PAE records is shown in **Table 16.2.**

**Table 16.2. Original design flow capacity for NAW open channel (PAE/DTEI data) 2001**

| Segment | | Design ARI | Design capacity ($m^3/s$) |
|---|---|---|---|
| From | To | | |
| Grand Junction Road | Senna Road | 5 | 12.5 |
| Senna Road | South Terrace | 20 | 30.7 |
| South Terrace | Port River Expressway | 20 | 31.2 |

## *Current performance and capacity*

PAE indicated that, in its current unlined form, the channel achieves a 5-year return period. Given variance in the designed channel sections and the observed channel, the conveyance of existing channels was evaluated based on typical channel sections and assumed 300 mm freeboard to the design water level. Channel capacity was evaluated using digital terrain model data provided by PAE, with a generalised Manning's equation calculation for an unlined channel. The following design assumptions were applied:

- Corresponding Manning's n = 0.035
- 300 mm freeboard to adjacent roadway for both 20 year and 5 year.

Analysis of the data and site visits revealed that the open channel is not uniform; it has sporadic constrictions in width and pools in the channel. Thus the data in **Table 16.3** is an indicative estimate only; flows vary locally throughout the channel. The estimated capacity indicates that the existing channel capacity is significantly below the design capacity, especially north of South Terrace.

**Table 16.3. Estimated flow capacity of existing channel based on observed dimensions**

| Segment | | Estimated capacity ($m^3/s$) | Comparison with the design capacity |
|---|---|---|---|
| From | To | | |
| Grand Junction Road | Senna Road | 18 | >> design intent (12.5 $m^3/s$) |
| Senna Road | South Terrace | 26 | < design intent (30.7 $m^3/s$) |
| South Terrace | Port River Expressway | 20 | << design intent (31.2 $m^3/s$) |

Estimated existing flow capacity north of South Terrace is low in comparison with the capacity immediately upstream. Since 2001, works associated with the Port River Expressway (constructed 2005) have completed a full reconstruction of the segment of channel between South Terrace and the Port River Expressway. Channel capacity appears to have been reduced as a result of these works.

The original design sought construction of lined channels but discussions with Council indicate that the current unlined channels provide significant contribution to water quality treatment ahead of discharge into the Barker Inlet Wetlands.

## *Flooding*

During 1993, PAE issued a brief to design the Barker Inlet Wetlands to act as a downstream ponding area to store stormwater that cannot be discharged directly to the sea because of tide levels and the impacts of stormwater discharge. A review of the Barker Inlet Wetland Management Plan indicated that the drainage sought to achieve a 100 year average recurrence interval (ARI). At present, the extent of flooding issues in the NAW catchment has not been quantified. Council plans detailed flood mapping in future years.

### Mansfield Park drain (lateral), North Arm west catchment

Senna Road crossing marks the confluence of flows from the South Road drain and the Mansfield Park Drain. The Mansfield Park drain collects a catchment area to the west of South Road, a catchment area of approximately 270 ha.

Based on design flow information of the South Road drain, it is anticipated that this drain services the local catchment to a return period of 5 years, analogous to the channel segment from Grand Junction Road to Senna Road. Based on the catchment characteristics and larger portion of industrial land, the equivalent impervious area for both catchments is comparable. Thus a design standard equivalent to South Road (upstream of Senna Road) has been adopted for the purposes of drainage requirements to accommodate local roadway augmentation. A 5-year flow of 12.5 $m^3/s$ is applied.

### Dunstan Road, North Arm west 5 catchment

The NAW5 catchment is small, covering an area of 233 ha and is located between the NAW and HEP catchments. The drain takes form as an open channel from Grand Junction Road to Cormack Road. At Cormack Road, the drain discharges into Barker Inlet Wetlands. The channel is, on average, 20 m wide and 1.8 m deep (allowing 0.4 m between the waterline and neighbouring properties).

Current information received from PAE does not include design flows of the Dunstan Road drain. This will be investigated at a later stage. Analysis of the channel indicates an estimated prevailing capacity of 20.9 $m^3/s$, for a fully unlined channel at an average grade of 0.09%.

### Hindmarsh Enfield Prospect catchment

The HEP catchment is 1311 ha and located east of the NAW and NAW5 catchments. A significant proportion of the catchment, upstream of Regency Road, is residential; downstream the catchment includes the rail yards, and is predominantly industrial. The following areas of the existing drain will be affected by local road modifications:

- an open channel north of Sunnybrae Farm (to Naweena Road), approximately 480 m length in the form of an extension of Gallipoli Grove South
- Naweena–Gallipoli link intersection at Grand Junction Road, local modification of open channel to form a signalised intersection
- Naweena–Gallipoli link crossing to Rosberg Road.

The designed hydraulic capacity and size of the channel for sections of the drain affected (**Table 16.4**) is based on information received from DTEI (PAE records).

**Table 16.4. Hydraulic capacity and channel size**

| Location | Original council designed data | | | Prevailing conditions | |
|---|---|---|---|---|---|
| | | Conduit | Flow | Conduit | Flow |
| Gallipoli Grove South | 5y | Concrete lined open channel, base width 9 m, 1:1 batter slopes to depth 2.8 m | 18.41 $m^3/s$ | Open earth channel, base width 10 m, 1:3 batter slopes to depth 2 m | 35.3 $m^3/s$ |
| Grand Junction Road–Gallipoli Grove Intersection | 20y | Open earth channel, base width 18m, 1:3 batter slopes to depth 3 m | 53.00 $m^3/s$ | Open earth channel, base width 28 m, 1:1 batter slopes to depth 2 m | 77.3 $m^3/s$ |
| Gallipoli Grove North–Rosberg Road | 20y | Open earth channel, base width 18 m, 1:3 batter slopes to depth 3 m | 53.37 $m^3/s$ | Open earth channel, base width 28 m, 1:1 batter slopes to depth 2 m | 77.3 $m^3/s$ |

Although the designed dimensions are not consistent with the prevailing conditions, existing information indicates that the conduit capacity satisfies the original intended design flows.

Any modification to the above three segments of open drain, through widening of the local roads adjacent the open channels, should be undertaken in a manner that will not reduce the hydraulic capacity of the channels below the original council designed data.

### 16.3.2 Wetlands

NAW catchment currently discharges into Barker Inlet Wetlands, immediately north of the Port River Expressway. The wetlands are managed by PAE and were originally constructed for both local flood alleviation and stormwater quality improvement.

Whilst stormwater affected by the project discharges into Barker Inlet Wetlands, the physical form of the wetlands north of the Port River Expressway are unlikely to be affected by the current project. The unlined drainage channel of NAW catchment provides a noted contribution to improvement of water quality in the wetlands.

HEP catchment stormwater quality is identified by PAE as the highest of all four catchments feeding Barker Inlet Wetlands.

### 16.3.3 Groundwater

The following groundwater conditions for the site have been identified in a desktop review (DTEI 2008):

- Groundwater in the region is considered to be relatively shallow, typically ranging 2–6 metres below ground surface (mbgs), in the sandy clay aquifer of the Pooraka Formation. It is noted that north of Grand Junction Road the depth to groundwater is quite shallow, observed to be less than 2 mbgs at the northern end of the corridor near the Barker Inlet Wetland system.
- South of Grand Junction Road, groundwater is considered to be found at the base of deposited fill material typically <10 mbgs.
- The regional groundwater flow direction is believed to be generally northwesterly towards the coastal wetlands which are the closest surface waterbody to the study area. However, the aquifer is located in generally discontinuous sand lenses resulting in local variability in the groundwater flow direction.

A search of the Department for Water, Land and Biodiversity Conservation Obswell Database yielded results for 157 groundwater wells located within 0.5 km of the project site. Groundwater depth in the vicinity of the project area is 6.8–16.9 mbgs. The 66 wells that provided data for salinity levels indicate a typical range of 3,500–27,703 mg/L total dissolved solids or 6,220–33,894 µS/cm electrical connectivity in the upper aquifer.

## 16.4 Drainage design

### 16.4.1 Design standards

Drainage for the project has been evaluated in the current assessment. The minimum level of service for the South Road Superway Project should achieve the existing drainage capacity, subject to ownership, design constraints and land availability.

The design of the minor drainage network (laterals) has not been assessed at this stage and is expected to be designed to a return period of 5 years.

Major surface flows must be considered and the effects of major flows predicted. If the consequences are significant then the design standard of the system should be increased accordingly, after agreement with Council(s) and the Project Manager.

### 16.4.2 Methodology

**DRAINS modelling**

**DRAINS is a stormwater drainage system design and analysis program.**

#### *Background*

A preliminary underground stormwater network assessment has been undertaken with a rationalised DRAINS model, developed based on local subcatchments in the North Arm West catchment area. The catchment upstream of the South Road open channel at Grand Junction was modelled based on drainage infrastructure GIS data. Resolution of the DRAINS model was limited to major lateral drains at Days Road and Angle Road, and the trunk drain nominated as the box culverts along South Road drain from Days Road to Grand Junction Road.

#### *Assumptions*

The following assumptions were applied in the model:

- water level at Grand Junction Road channel is RL 3.3 m (nom), equivalent to the top of the box culvert and providing 300 mm freeboard to the roadway
- the system is downstream constrained and inlet pits do not limit inflows to the system
- unless other information has been provided, pipe dimensions and descriptions are based on GIS data provided by PAE
- catchment impervious areas estimated based on generalised residential and industrial proportions ascertained from aerial imagery.

#### *Modelling*

The DRAINS model was verified by calculations with the rational method of analysis for the 20-year and 5-year events.

Modelling was undertaken to identify peak 20-year flows and peak 5-year flows in the existing system.

Design of the box culverts between Days Road and Grand Junction Road was based on:

- the existing box culvert sizes
- maintaining the existing cross-section where the culverts provide lesser conveyance.

**Open channel design**

### *Background*

All existing channels are unlined, acting as filter strips or drainage swales and facilitate some treatment of stormwater. The intent of the design is to capitalise on water quality treatment where possible while managing constraints of the roadway footprint. Accordingly, three channel types were considered:

- unlined trapezoidal channel
- lined trapezoidal channel
- composite channel.

### *Assumptions*

Assumptions applied to channel sizing are:

- roughness of channel surfaces
  - n = 0.013 for concrete lining
  - n = 0.035 for unlined channels with dense vegetation and aquatic plants
- banks at 1:3 batters for safety
- channels are of uniform type, with no internal obstructions (i.e. piers).

### *Methodology*

Design of open channel sections was based on Manning's Equation, optimising the width of channel based on a nominated design flow.

Each channel is characterised by its design flow and channel surface type. For all unlined and lined channels, the design depth is limited to no more than the existing channel depth. For the composite channel, the overall channel depth has been allowed to increase up to 0.4 m below the existing channel invert, providing some freeboard to the perched groundwater level (see **Figure 16.2**).

The unlined channel takes a trapezoidal form, lined with dense vegetation and aquatic plants (Cross-section 1). The lined channel takes a trapezoidal form, lined with concrete to a trowel finish (Cross-section 2). The composite channel has both unlined and lined segments: the unlined segment in the lower portion of channel, treats low flows up to a 3-month ARI; for events above the 3-month ARI, flows fill the channel, lined with concrete to improve conveyance of major storm flows.

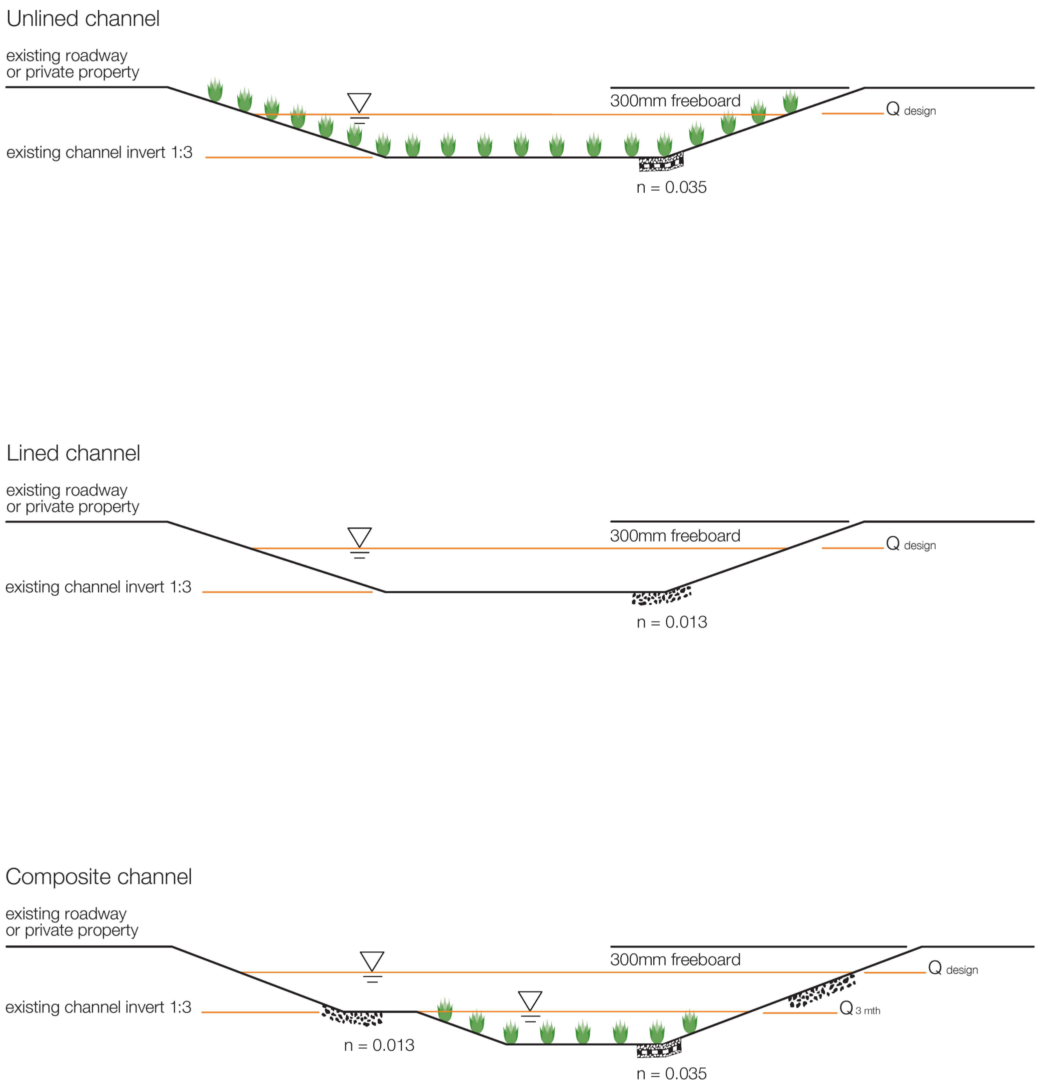



**Figure 16.2. Channel forms**

## Box culvert design

Box culverts have been designed according to the Australian Concrete Pipe Association, Hydraulics of Precast Concrete Conduits manual, Procedure 3.3, where an outlet control condition is assumed. The culverts are also assumed to be flowing full for the purposes of design. Accordingly, Figure 3.6 of the manual was adopted for culvert sizing.

Where the designed box culvert size and configuration was smaller than the existing box culverts in the equivalent section of roadway, the existing box culvert configuration has been adopted.

## Design hierarchy

By order of preference, the following cross-sections have been selected subject to footprint and overhead infrastructure constraints, optimising water quality and conveyance.

- unlined trapezoidal channel
- composite channel
- lined channel
- box culvert.

### 16.4.3 Peak flow assessment

**DRAINS and rational method**

Based on the preliminary DRAINS model and rational method calculations, the following design flows were identified, and have been used to size all drainage conduits and channels accordingly. **Table 16.5** and **Table 16.6** detail the design flows adopted for a 5-year return period and 20-year return period respectively.

**Table 16.5. 5-year ARI catchment peak flows**

| Roadway segment | $Q_5$ Flow ($m^3/s$) |
|---|---|
| Days Road to Grand Junction Road | 8 |
| Grand Junction Road to Senna Road | 12 |
| Senna Road to Port River Expressway | 21 |

**Table 16.6. 20-year ARI catchment peak flows**

| Roadway segment | $Q_{20}$ Flow ($m^3/s$) |
|---|---|
| Days Road to Grand Junction Road | 12 |
| Grand Junction Road to Senna Road | 18 |
| Senna Road to Port River Expressway | 30 |

The 3-month design flows were estimated by logarithmically extrapolating the design flows determined using the AR&R84 procedure for Australian Rainfall and Runoff (**Table 16.7**).

**Table 16.7. 3-month ARI design flows**

| Roadway segment | $Q_{3\ month}$ Flow ($m^3/s$) |
|---|---|
| Grand Junction Road to Senna Road | 2 |
| Senna Road to Port River Expressway | 3.5 |

**Design flows**

The design approach applied adopts the higher flow of:

- estimated flows
- original design flows.

The prevailing channel capacity is variable and, based on estimated flows, the actual design standard (i.e. 5 or 20 years) is not consistent with the original design intent. Thus, prevailing capacities have been regarded for the purpose of selecting design flows (but not strictly applied under the above design approach).

**Table 16.8** and **Table 16.9** summarise 5-year and 20-year designs.

**Table 16.8. 5-year ARI design flows**

| Roadway segment | $Q_5$ Flow ($m^3/s$) |
|---|---|
| Days Road to Grand Junction Road | 8 |
| Grand Junction Road to Senna Road | 12 |

| Roadway segment | $Q_5$ Flow ($m^3/s$) |
|---|---|
| Senna Road to Port River Expressway | 21 |

**Table 16.9. 20-year ARI design flows**

| Roadway segment | $Q_{20}$ Flow ($m^3/s$) |
|---|---|
| Days Road to Grand Junction Road | 12 |
| Grand Junction Road to Senna Road | 18 |
| Senna Road to Port River Expressway | 31.5 |

### 16.4.4 Stormwater network

**Drainage for 5-year stormwater event**

The design is able to provide a number of unlined channel sections, with the greatest constraints exhibited where ramps are provided to link the local road network and elevated roadway. The current trunk stormwater drainage system design consists of lined, unlined and composite channels in addition to sections of box culverts.

### 16.4.5 Conclusions: mitigating drainage impact

Duplication of the existing drainage system is difficult to achieve under the spatial restrictions of the project. The design does not reduce the hydraulic capacity of the channel, and where box culverts replace existing channel, the capacity for the drain to receive overland flow is no longer available. Therefore the design has minimised the use of box culvert as much as possible.

Adopting a long section of box culverts downstream of Grand Junction Road, on an extremely flat grade, presents risks such as serviceability and siltation. This option was therefore discounted.

It is acknowledged that an area needs to be allowed for PAE to augment the drain in the future to the ultimate design capacity, with consideration of constraints such as piers/columns, maintenance track, bicycle track, services, clearance requirements. It is expected that further refinement of the drains, in combination with detailed evaluation of the opportunity to locate the channel under pier structures, will enable additional unlined or composite channel segments.

### 16.4.6 Other drainage considerations

Alternative options for management of drainage issues has been provided for the trunk drain of the North Arm West catchment. Final design of the South Road upgrade will affect the drainage solutions selected. Changes to the NAW trunk main affect three other drainage lines (see **Figure 16.3**):

- Mansfield Park drain (sub-catchment to the South Road drain, connecting to the trunk at Senna Road)
- North Arm West 5, Dunstan Road drain
- Hindmarsh Enfield Prospect, Naweena Road drain.


Drain Locations

Figure 16.3

### Mansfield Park drain

The new Davis Street connection over the Mansfield Park drain will require a new drainage link. It is anticipated that this would take form as a box culvert, facilitating a 20-year ARI standard. This design standard would be provided to ensure that future upgrades to the channel would not be precluded by the box culvert.

Accordingly, the dimensions of the box culverts crossing South Road at Senna Road are adopted as an upper limit estimate of the size required. Thus three 3.2 m x 1 m box culverts are recommended in this section.

### Dunstan Road drain: Rafferty Street extension

The roadway design proposes to extend and formalise the Rafferty Street roadway between South Terrace and Cormack Road, affecting a 125 m length of the Dunstan Road channel. This segment of channel is unlined and is slightly wider than that immediately downstream, with a top width of approximately 23 m. Flow through this segment of channel is constrained by the narrower downstream channel and box culvert sections.

Construction of a retaining wall has been proposed for this segment of channel. Based on preliminary layout plans, the channel width could be maintained at approximately 20 m. The local surface treatment for the retaining wall will need to be investigated but it is anticipated that the hydraulic capacity of the Dunstan Road drain could be maintained by provision of a 20 m wide unlined open channel.

The proposed road widening will cause the removal of a small strip of vegetation from the unlined drain which is expected to have negligible effect on overall water treatment functionality.

### Naweena Road drain

## *North of Sunnybrae Farm*

The drain to the north of Sunnybrae Farm will be affected by local augmentation of the road network, resulting in approximately 480 m of open channel taking form as a box culvert. This could be achieved by extending the existing culverts passing underneath the Sunnybrae Farm property. Approximately 80 m north of the existing culverts is the confluence of the main drain with the Prospect culverts, which will also require extension in their current form until the drainage line is resolved into an unlined open channel.

Dimensions of the existing culverts require on-site confirmation; existing design drawings indicate that up to 4 x 1950 mm diameter pipes run underneath Sunnybrae Farm, with a further 2 x 1800 mm diameter pipes forming the Prospect conduit outfall.

## *Naweena Road*

The following recommendation applies to both the Naweena Road–Grand Junction Road intersection and the Rosberg Road connection.

The local narrowing of the open channel to the north of Grand Junction Road, for approximately 100 m, should be accommodated by local channel lining and extension of the existing box culvert segments as appropriate. Based on original design drawings, 3 x 3000 mm x 1800 mm box culverts are provided for this crossing.

At the Rosberg Road crossing, a box culvert segment duplicating the Grand Junction Road crossing, 3 x 3000 mm x 1800 mm should be provided.

## 16.5 Water quality

### 16.5.1 Design standards

For purposes of modelling, a minimum return period of 3 months was applied for the biological treatment of stormwater in channels, where achievable. The 3-month period was based on a typical design threshold applied for constructed stormwater treatment wetlands.

### 16.5.2 Model for Urban Stormwater Improvement and Conceptualisation

Due to the need to increase lined channel segments and box culverts, it is expected that the stormwater arriving at the Port River Expressway will be of lesser quality than existing conditions without alternative treatments. Accordingly, water quality assessments were undertaken on the existing situation in order to ascertain the loss of water quality that could result from the project.

The Model for Urban Stormwater Improvement and Conceptualisation (MUSIC) models stormwater flows through the catchment and the progressive change in water quality as a result of various treatment techniques. This includes drainage swales (akin to the existing unlined open channels) and wetland systems. The model uses typical urban pollutant loading and pollutant removal parameters.

### 16.5.3 Existing conditions

Existing water treatment uses unlined open channels, or drainage swales, in three primary segments located between Grand Junction Road and Senna Road, Senna Road and South Road, and South Road and the Port River Expressway (**Figure 16.4**).

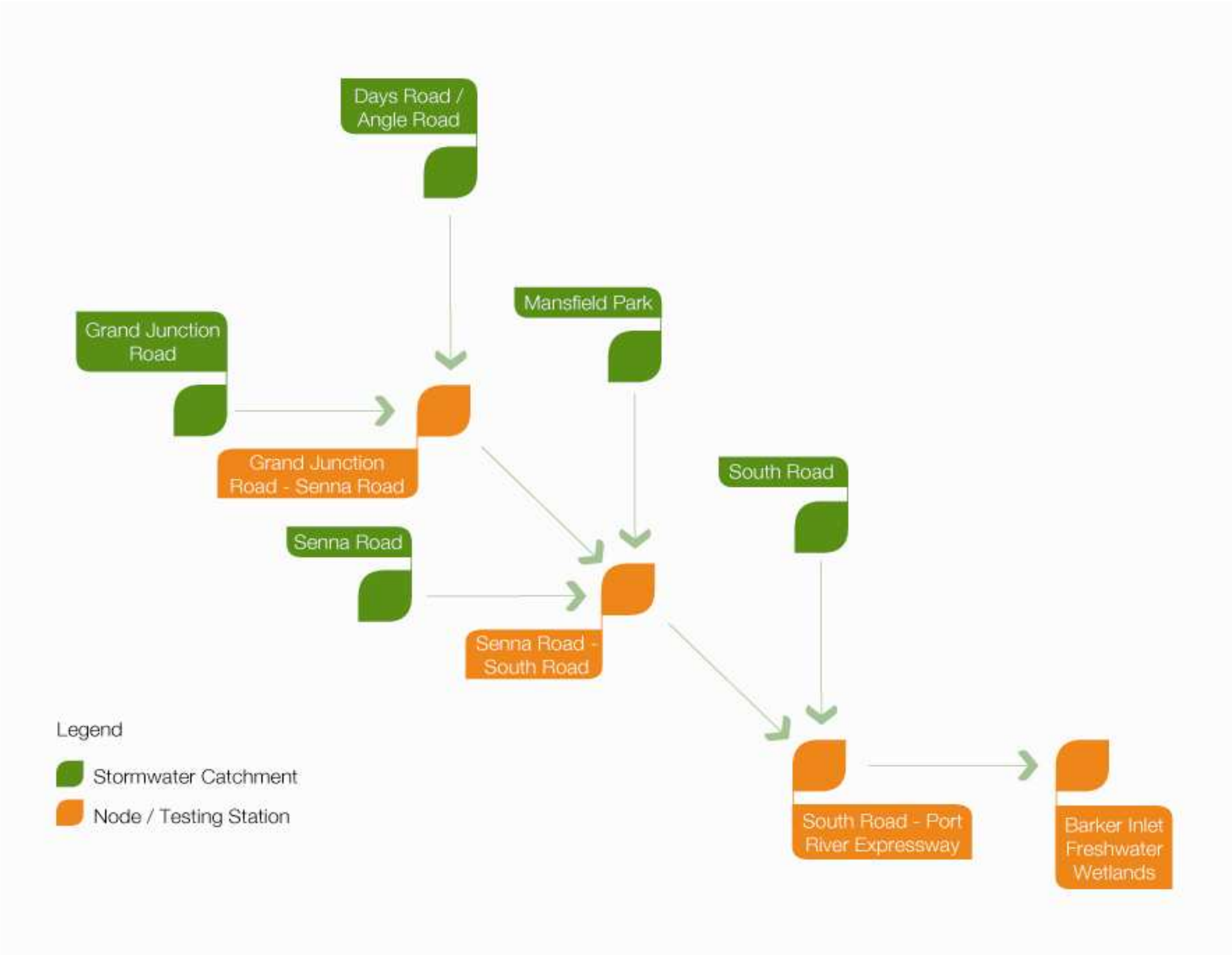



**Figure 16.4 MUSIC model of the existing treatment train**

Pollutants are significantly reduced by treatment through the drainage swales prior to discharge into Barker Inlet Wetlands (**Table 16.10**).

**Table16.10. Average annual improvement in water quality at Port River Expressway**

| Pollutant | % Pollutant reduction at Port River Expressway |
|---|---|
| Total suspended solids (kg/yr) | *78%* |
| Total phosphorus (kg/yr) | *55%* |
| Total nitrogen (kg/yr) | *21%* |
| Gross pollutants (kg/yr) | *100%* |

### 16.5.4 Water quality improvement measures

The proposed reduction in unlined drainage swales along the length of South Road require additional treatment, for example by wetlands, drainage swales or ponds, to achieve an equivalent water quality discharge upstream of Barker Inlet Wetlands.

A number of locations in the project corridor were identified as potential treatment locations.

**Southwestern corner of Port River Expressway and South Road: ephemeral wetland**

In this location, a nominally 0.2 ha planted basin is targeted to treat minor flows passing through the NAW catchment before discharge into Barker Inlet Wetlands. Major flows would bypass the planted the planted basin and enter directly into Barker Inlet Wetlands. A detention time of notionally 6 hours has been allowed for this wetland, and major flows would need to be diverted around the wetland.

**Southeastern corner of Port River Expressway and South Road: ephemeral wetland**

In this location, a nominally 0.3 ha planted basin, downstream of the southwestern basin, is targeted to treat minor flows passing through the NAW catchment before discharge into Barker Inlet Wetlands. Low flows of the South Road drain should feed the basin through an equalising pipe under the South Road embankment. A detention time of notionally 6 hours has been allowed for this wetland.

**Basins under the Superway: ephemeral wetlands**

Depending on the evolution of the overall design, large vacant areas will become available under the elevated roadway, which has the potential to be formed into a series of ponds.

The proposed elevated roadway opens up land area, not available in the existing road reserve, under the suspended structures. These areas can provide additional conveyance capacity and also enhance other elements such as water quality, aesthetic and biodiversity. The new ponds will mainly be ephemeral wetlands which not only remove contaminants from flow but also promote biodiversity and aesthetic enhancement through appropriate landscaping and urban designs. The extent of implementation is restricted by the ability of vegetation to grow in shade, safety and other competing land uses such as footpaths and tracks.

It is estimated based on the current road footprint, that a minimum basin area of 0.4 ha would be achievable taking into account a 3-metre clearance from adjacent service roads, 33% batter slopes and utility services.

### 16.5.5 Other water quality improvement measures

Additional water quality improvement opportunities should not be restricted to the project corridor. Underdeveloped public lands abutting the corridor should also be considered and could be developed into attractive wetlands that introduce biodiversity and habitat to the area.

### 16.5.6 Ultimate water quality

Ultimate water quality will be determined by the final road, drainage and wetlands design, and will target a comparable water quality to the current conditions.

### 16.5.7 Design scenarios

**Intent**

In consultation with the PAE, it was identified that any changes to the drainage should not compromise the water quality achieved by the existing drainage swales and wetlands (see water quality improvement opportunities and their potential locations in Section 16.5.4).

## 16.6 Groundwater

### 16.6.1 Effects of project on existing groundwater conditions

Potential effects on groundwater in the vicinity of the project footprint are primarily groundwater quality deterioration through contamination of soil or direct contamination of groundwater during excavation. Groundwater levels could also be lowered and flow paths altered with particular regard to the development of wetlands.

The potential effects of the construction and operation of the expressway on groundwater will be further investigated in detailed studies including a Phase II contaminated land investigation as well as a geotechnical investigation.

### 16.6.2 Mitigation measures to minimise effects

Mitigation and monitoring measures to reduce the likelihood and consequence of potential impacts to the groundwater located in the study area will be developed and incorporated into the project construction environmental management plan (CEMP) and operational environmental management plan (OEMP). Mitigation and monitoring measures may include:

- baseline monitoring of the current groundwater quality and level in the project footprint
- routine monitoring of the groundwater quality and level during project construction to identify if the water quality or level is influenced
- if groundwater quality or level is identified as declining then management measures should be developed to reduce or ameliorate this impact
- implementation of measures to reduce the likelihood or consequence of soil and surface water contamination which could indirectly contaminate the groundwater (see Section 21).

### 16.6.3 Conclusion

Potential impacts to current groundwater conditions include indirect contamination of groundwater through contamination of soil or surface water or direct contamination of groundwater during excavation activities and/or development of the proposed wetlands. Any influence on the regional groundwater conditions can be observed through a baseline and construction phase monitoring program.

The potential for these effects will be investigated further in detailed studies. Potential impacts will be minimised and managed through the implementation of mitigation measures incorporated in the CEMP and OEMP.

## 16.7 Summary and recommendations

The desktop assessment of design opportunities to mitigate the impact of the construction works on existing drainage infrastructure has addressed two key parameters:

- hydraulic capacity of the main drainage line
- water quality of stormwater discharged to Barker Inlet Wetlands north of Port River Expressway.

The original trunk drain capacity was designed to a return period of 5 years (Days Road to Grand Junction Road) and 20 years (Grand Junction Road to Port River Expressway) respectively but prevailing condition indicates a capacity of about 5 years, with an even lower standard between South Terrace and Port River Expressway. A 5-year design standard has been adopted for the planning design to establish a base for progressing other design elements; however, it should not be mandatorily adopted in the final design. This is due to the PAE ownership of the drain infrastructure and allowance or consideration for them to implement their original design standard to the drain.

It is recommended that the drain be designed in accordance with the following guidelines:

- Drain shall be open channel as much as possible.
- Open channel should be designed for current flows but configured such that it can be upgraded (by Council) to ultimate (20-year PAE flows) even if that means channel lining of some form, without further land acquisition. If this is not possible without further land acquisition, consider acquiring the necessary land now.
- Where an open channel is not possible, longitudinal culverts should be provided to the current flows but with space available for further longitudinal culverts to be added (by Council) for the ultimate flows.
- Where space is not available, either acquire additional land now, to allow longitudinal culverts to be added in the future, or provide culverts for the ultimate flows.

- Where the drain crosses from one side to the other of the road (e.g. at Senna Road), crossover culverts should be provided for ultimate PAE flows, either by augmentation or replacement of existing culverts, depending on the particular constraints at each site.

Due to spatial project constraints, the water quality of nominated designs for the project decreases in comparison to the existing conditions. The relative impact of the design has been determined with a water quality model, and opportunities to achieve a standard meeting or exceeding current conditions have been identified. Construction of wetlands upstream of the Port River Expressway is identified as an option to suitably mitigate water quality impacts.

Geotechnical and groundwater investigations, and detailed survey, have not been undertaken and are required to further develop and confirm the concept detailed above. Flood modelling has not been undertaken by PAE, and may also be required in revisions to this drainage design to evaluate the effect of any potential new obstructions to overland flow paths.