20 Surface water and groundwater

20.1 Introduction

This section describes the existing flooding and drainage conditions within the catchment and provides detail on surface and groundwater resources from a quantity and quality perspective and recommends mitigation management measures.

Water resources, whether surface or sub-surface, are precious within the Northern Adelaide Plains, an area which places a high importance on quality and quantity of water. Much of the region relies on the horticultural value of the land and the availability of suitable water resources to enable use of that land. Therefore the effects of flooding and drainage on the land and any effects on the quality of water resources are important for the sustainability of the region, as well as the environment in general. Consultation identified concern about flooding and whether the project could lead to improvements relating to the region's stormwater management infrastructure.

20.2 Assessment methodology

Limited detailed investigations have been possible during the assessment process, and therefore much of the information contained within this section is based on previous investigations and desktop analyses. The assessment of surface water and groundwater resources in the area has been based on the following:

- a literature review of previous investigations and studies within the area
- compilation of existing water quality data obtained from local and State government bodies
- site inspections to determine existing drainage infrastructure
- consultation with local council employees and other individuals and groups familiar with the water resources of the region.

The general methodology for the assessment of impacts has been based on the procedures outlined in DTEI's *Protecting Waterways Manual* (Transport SA 2002).

20.3 Legislative and policy requirements

The management and protection of South Australia's water resources falls under the auspices of various Acts, policies and guidelines. Natural Resource Management boards are responsible for the development of water allocation plans for all prescribed water resources. The Adelaide and Mount Lofty Ranges Natural Resource Management Board is responsible for water resource management in the Northern Adelaide Plains.

20.3.1 State

Natural Resources Management Act 2004

The *Natural Resources Management Act 2004* (NRM Act) incorporates the provisions of the previous *Water Resources Act* 1997. It defines the legislative framework for managing South Australia's natural resources, including the planning and management of the water resources. Some activities within a watercourse require approval under the Act.

Environment Protection Act 1993

The *Environment Protection Act 1993* provides for the protection from pollution of air, land, water and ecosystem values and requires a 'duty of care' when undertaking potentially polluting activities. It provides a legislative framework for the licensing and regulation of polluting activities.

The Act protects water quality through regulating waste discharge to streams, rivers, coastal waters and groundwater. In addition, the Act requires periodic State of the Environment reporting on the state, pressures and response of our water resources, thus enabling continual review of management options to ensure optimised results.

Environment Protection (Water Quality) Policy

The main objective of the *Environment Protection (Water Quality) Policy* (EPWQP) under the Environment Protection Act is to:

> … achieve the sustainable management of waters, by protecting or enhancing water quality while allowing economic and social development.

The EPWQP was introduced in 2003 to bring South Australia into line with the national strategic push for sustainable use of water resources (the National Water Quality Management Strategy). The policy defines key environmental values and associated water quality targets for all surface water and groundwater resources. Industry and community obligations are defined with respect to preventing or minimising different water-polluting activities. Importantly, the policy makes it a statutory offence to pollute the State's waterways through activities such as allowing sediment from construction sites, bitumen cutting, wastewater, oil, grease and engine coolant from entering the stormwater system.

The EPWQP provides avenues of licensing and regulation, including the issuing of environmental protection orders, fines or prosecution.

The policy also makes the requirements in the *Stormwater Pollution Prevention Code of Practice for Local, State and Federal Government* (EPA 1998) mandatory.

Stormwater Pollution Prevention Code of Practice

The Stormwater Pollution Prevention Code of Practice provides government agencies with information on the strategies and management techniques available to reduce stormwater pollution at its source. The code also provides guidance on developing a Soil Erosion Drainage Management Plan (SEDMP).

20.4 Existing conditions

Flooding and drainage, groundwater and water quality conditions in the study area are described below.

20.4.1 Flooding and drainage conditions

The study area covers the catchments of two major watercourses; the Gawler River and the Smith Creek outfall. Of these, the Gawler River is a natural water watercourse while the Smith Creek outfall is a man-made drain to the west of Main North Road.

The Gawler River and the Little Para River to the south are both perched above the surrounding plains, in a natural drainage basin extending from the top of the Hills Face escarpment in the east to Gulf St Vincent in the west (BC Tonkin & Associates 1999). The basin is bounded to the north by the Gawler River and the south by the Little Para River. Prior to European settlement, floodwaters would have covered the plains in a shallow, slow moving sheet of water flowing generally in a south-westerly direction (BC Tonkin & Associates 1999). As a result of the flat grades, there would have been significant storage and reduction of flows with little, if any, run-off discharging to the gulf (BC Tonkin & Associates 1999).

Development of the area has resulted in the construction of a man-made drainage network, which has altered the natural drainage pattern. A drainage network was constructed in the 1970s to provide protection to development from flooding and to dispose of stormwater run-off. As a result, the area is now divided into two major catchments, the Smith Creek outfall catchment and the Helps Road catchment.

The location of the Expressway route with respect to these catchments is shown in Figure 20.1.

Gawler River catchment

The Gawler River system is an ephemeral river system with two main tributaries, the North Para River and the South Para River (Figure 20.2). The Gawler River itself is only 30 km in length, meandering from the township of Gawler in a westerly direction to Gulf St Vincent (NABCWMB 2000). The plains over which the Gawler River flows are dominated by horticulture, agriculture and rural residential living.

The Gawler River becomes perched (i.e. not connected to a shallow water table) as it traverses the Northern Adelaide Plains, with its capacity reducing from 450 m^3/s near Gawler to 70 m^3/s near Virginia, and to only 10 m^3/s closer to the coast. Current estimated peak flood flows at Gawler range from 190 m^3/s for the 10 year ARI event to 420 m^3/s for the 100 year ARI event.

This large discrepancy between flood flows and channel capacity results in frequent, extensive flooding of the plains.

Major flooding of the Northern Adelaide Plains from the Gawler River has occurred in 15 years of the last 150 years, or on average once every 10 years (GRFMA 2003). In recent history, multiple floods occurred between September and December 1992, with the largest estimated at a 1 in 40 year ARI event. More recently, flooding in November 2005, estimated at less than a 1 in 20 year ARI event, flooded several properties in Gawler and caused extensive flooding in the Virginia area due to a failure of one of the Gawler River flood levees at Virginia.

In response to the frequent and extensive flooding of the lower Gawler River flood plains, the Gawler River Flood Mitigation Scheme was developed specifically to address flooding issues in the catchment through the construction of physical works. These works are supplemented by the existing flood warning and planning measures.

The combined effect of these works will substantially reduce the current estimated peak 1 in 100 year ARI flow at Gawler and provide increased flood protection to downstream properties by reducing the frequency of breakout flows from the river.

A portion of the flood mitigation works is due for completion in 2007, with the remainder to be completed in 2008–2009. It is anticipated that flood mitigation works will be completed prior to the commencement of construction on the proposed Expressway across the Gawler River flood plain.

Smith Creek

The headwaters of the Smith Creek outfall catchment lie on the Hills Face escarpment to the east of Main North Road. While there are a number of natural watercourses in this area, these generally become ill-defined to the west of Main North Road due to the flat grades of the plains.

Smith Creek and the man-made extension to Smith Creek (referred to herein as 'Smith Creek outfall') form the major stormwater outfalls to the area. The creek is maintained in a natural condition within a drainage reserve to Uley Road (just upstream of Main North Road); downstream of this point, the watercourse is man-made. Some distance downstream of Main North Road, Smith Creek enters the Stebonheath Flow Control Park (FCP), which, among other uses, provides detention for the estimated 100 year ARI flow.

The drain downstream of Stebonheath FCP, which is the drain over which the proposed Northern Expressway passes, was constructed in the mid-1970s. It was excavated with 1V:1H side slopes, and 30 years later has eroded to near vertical sides and is in a poor hydraulic and visual condition.

Significant development upstream of Stebonheath FCP will ultimately affect flows downstream. The City of Playford has advised that the estimated peak 100 year ARI discharge from the Stebonheath FCP, taking into account this upstream development, will be 61 m^3/s.

The outfall channel between the Stebonheath FCP and Heaslip Road does not have sufficient capacity to convey the estimated 100 year ARI flow, even with the flood mitigation capacity of the FCP. A previous study of the catchment recommended that batters needed laying back to 1V:4H to increase its capacity to the estimated 100 year ARI flow.

Local minor catchments

The proposed Expressway alignment crosses several local minor drains, predominantly within the City of Playford council area. These minor drainage systems, although often ill-defined, will be allowed for in the design of the proposed Northern Expressway. Many of these existing drainage systems currently experience minor flooding and drainage problems.

20.4.2 Groundwater conditions

The proposed Expressway route passes through the area of groundwater management known as the Northern Adelaide Plains Prescribed Wells Area. The area contains relatively fertile soils underlain by a series of water-bearing beds of sand, gravels and limestone aquifers which have been heavily utilised by irrigators in the horticultural sectors of Virginia, Waterloo Corner and Angle Vale since the 1950s.

Groundwater in the area consists of a series of shallow Quaternary aquifers, beneath which lie the two relatively deep Tertiary aquifers (limestone and sediment-based) from which the majority of the region's groundwater is harvested (NABCWMB 1998). The shallow aquifers, consisting of sand and gravel layers within alluvial silt and clay, are variable in depth and quality. The shallowest lie at a depth of between 3 and 10 m, although groundwater was not intercepted during any of the investigations undertaken for this study. The upper Tertiary aquifer (T1 aquifer) generally occurs at a depth of around 60 to 100 m.

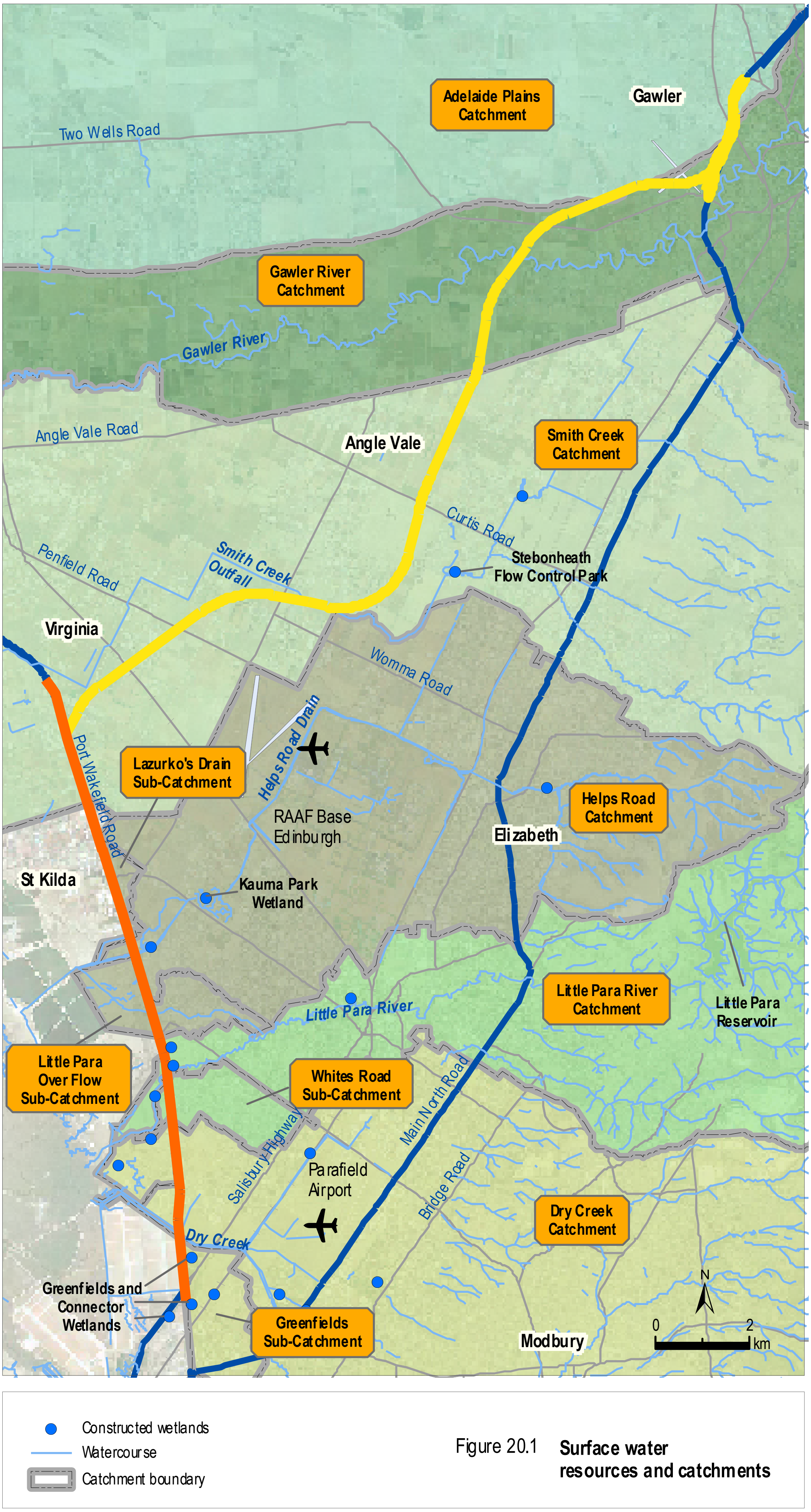

Figure 20.1 **Surface water resources and catchments**

Gawler River – view from Wingate Road looking west

Gawler River corridor and Wingate Road looking north

Figure 20.2 **Gawler River**

The Tertiary aquifers (T1 and T2) are confined, which limits potential contamination pathways to leaky wells and pollutants introduced through established wells (EPA 2006). Over-extraction of the Tertiary aquifers of the plains has led to the creation of pronounced cones of depression centred on Waterloo Corner and Virginia. These are of concern as they encourage vertical leakage and horizontal inflow of more saline groundwater from overlying Quaternary aquifers, thus reducing water quality. With the potential for ingress of water from shallow aquifers, this also creates a risk of contamination by other means.

Groundwater quality is monitored throughout the region by the EPA and the Department of Water, Land and Biodiversity Conservation (DWLBC). Groundwater quality with respect to dissolved metals, nutrients and pesticides is generally within guideline limits set by the *Environment Protection (Water Quality) Policy 2003* and the ANZECC *Guidelines for Fresh and Marine Waters 2000* for all environmental values. Iron concentrations often exceed guidelines for irrigation and drinking water. Salinity of the groundwater is currently considered fair, although this is highly variable and at risk of increasing due to continued over-extraction.

20.4.3 Surface water quality

Investigations of surface water quality have focused on the determination of existing conditions through review of water quality data, where available. Surface water quality is monitored across the Northern Adelaide Plains by community, local, South Australian and Australian Government-run programs.

The EPA and DWLBC run ongoing surface water monitoring programs with State funding. The EPA program measures various water quality indicators (e.g. phosphorus, nitrogen and salinity), macro-invertebrates, and/or seagrass cover depending on the location. The DWLBC runs a separate yet symbiotic program tracking stream flow volumes and rates, which in conjunction with local climate data, provides some explanation of seasonal and storm-induced fluctuations in water quality. Surface water quality data is available for both major streams within the study area, and where there are other tributaries of interest, local government and community often supplement this information through volunteer-based or locally funded monitoring programs such as the Waterwatch program. Monitoring frequency varies, from continuous data loggers recording stream flow to quarterly or bi-annual water chemistry assessments.

Macro-invertebrate diversity and basic stream attributes have been recorded by the AUS RIVer Assessment System (AUSRIVAS) program, an initiative which provides a rapid assessment methodology of the biological health of Australian rivers.

The surface watercourses along the proposed Northern Expressway route are of variable quality. The Gawler River was classified poor for total nitrogen, total phosphorus and soluble phosphorus in 2006, but still maintained a good healthy diversity of macro-invertebrates. Smith Creek, on the other hand, was well within range for total nitrogen and total phosphorus, but had reduced dissolved oxygen at the inlet to the Stebonheath Flow Control Park and had a higher turbidity. High nutrient and sediment mobilisation are characteristic of a landscape dominated by horticultural and agricultural practices.

20.5 Effects of project upon existing conditions

20.5.1 General considerations

The proposed Expressway route will intersect two major waterways, the Gawler River and Smith Creek outfall.

Roadway construction and associated vehicle use can affect water quality and aquatic ecosystems in a variety of ways. Potential effects can be characterised in three main areas (Transport SA 2002):

- hydrological – altering the volume, timing and direction of surface and subsurface flows
- physical – altering landforms, altering creek lines, altering ambient water temperature
- pollution – during construction and operation phases from vehicles, machinery and materials.

The Northern Expressway has the potential to affect water resources during two distinct phases; construction and operation. Construction effects may result from earthworks, vegetation loss and resultant sedimentation, while the operation phase effects may result from road run-off, transport and maintenance issues (e.g. spills, leaks and associated pollution).

This section considers the possible effects on the quantity and quality of local waters during construction and operation of the road.

20.5.2 Flooding and drainage

Gawler River

Effects on peak flood levels and inundation periods

The construction of significant flood mitigation works on the Gawler River system upstream of the proposed route, as part of the Gawler River Flood Mitigation Scheme, will reduce the extent of flooding outside the main river channel during the estimated 100 year ARI peak flow event. The most significant of these works, a stormwater detention dam on the North Para River, is anticipated to be completed in 2007, with the remainder due for completion in 2008–2009.

The Expressway will cross the Gawler River on a bridge which will span the full width of the main river channel. Additional culvert openings either side of the main river channel will allow the passage of infrequent flood flows under the Expressway in larger events. This being the case, there are not likely to be any effects on peak flood levels across the existing flood plain. Detailed modelling will be used to confirm this during the detailed design phase.

Effects on the time during which flood-prone land is inundated during Gawler River flood events would also be negligible due to the negligible effect of the project on the general flooding behaviour of the river system.

Effects on floodwater distribution and velocity

There are not likely to be any significant effects on the distribution or velocity of floodwaters within the Gawler River system as the river will be spanned by a bridge, and flood plain culverts will be provided to allow the passage of any flood plain flows for the estimated 100 year ARI peak flow event at the road crossing location.

Smith Creek outfall

The project includes the realignment of a section of the Smith Creek outfall. The realigned section will be designed to cater for the estimated 100 year ARI peak flow downstream of Stebonheath Road. A series of culvert crossings associated with the Heaslip Road interchange will be designed to ensure minimal impacts on water levels upstream in the estimated 100 year ARI peak flow event.

The effects of the proposal on local flood levels within Smith Creek will be examined in detail during the design phase.

Effects on peak flood levels and inundation periods

While the effects are yet to be quantified in detail, the design of the Smith Creek realignment, and culvert crossings will be such that there are minimal effects on flood levels upstream. Additional culvert openings either side of the channel will allow the passage of infrequent flood flows under the Expressway in larger events.

There is not anticipated to be any significant change to the time during which flood-prone land is inundated due to the negligible effect the project is expected to have on flooding behaviour in general.

Effects on floodwater distribution and velocity

There are not expected to be any significant effects on the distribution of floodwaters in the Smith Creek catchment. There may be localised increases in velocities at new culvert crossing locations, but these will be managed with dissipaters and erosion control structures where necessary.

General flooding and drainage effects

Given the flat nature of the plains over which the alignment traverses, even minimal modification to topography has the potential to cause the localised pooling of stormwater in undesirable locations. Waterlogged soils are more susceptible to damage by construction vehicles, and would require treatment.

The construction of the proposed road embankment will intercept a number of minor drainage systems and interrupt the general migration of surface water, which flows in a south-westerly direction across the plains. This will require the incorporation of waterway openings to maintain the natural overland flow path during events which exceed the design capacity of the formal drainage system.

The channelling of excess surface water flows through such openings has the secondary effect of increasing local velocities, and the potential for scouring and erosion. While this is a potential issue, it is one which will be readily managed through the use of appropriate design and erosion protection measures.

Local stormwater flows generated from the new carriageway itself will be managed through the stormwater drainage system. Again, effects which will be appropriately managed will include additional stormwater flows, concentrated stormwater discharges and an increased potential for erosion at discharge locations.

20.5.3 Groundwater

Effects due to general road construction

Potential effects on groundwater resulting from general road construction are considered to be negligible, due to the depth of groundwater and lack of excavation at significant depth. No changes to groundwater levels are expected. All other risks will be minimised by ensuring site practices follow the requirements of the Construction Environmental Management Plan (CEMP).

Potential for contamination

Road run-off can contain pollutants resulting from normal use of the road, as well as from leaks, spills, and accidents. Pollutants can include hydrocarbons (petrol, diesel, oils), metals, nutrients and other compounds. The risks of contamination via these sources are considered low due to the depth of groundwater beneath the plains; nevertheless, these risks will need to be managed during both the construction and operational phases, in conjunction with the management of surface water quality.

Particularly sensitive areas will include the Gawler River, its flood plain and any other areas of regionally high groundwater or existing wells.

20.5.4 Surface water quality

The potential effects both during construction and during the operational phase on surface water quality are summarised below.

Effects during construction

The highest potential risk to surface water quality in the Gawler River and Smith Creek outfall drain would be during the construction phase and would be related to the following:

- export of sediment and associated pollutants such as heavy metals and nutrients via wind and water erosion
- heavy metals, toxic organics and surfactants used by machinery and other vehicles in the road-building process itself.

While the majority of effects are likely to be confined to the construction zone immediately adjacent to the watercourses, there is also the potential for some effects outside the immediate watercourse area due to the movement of construction vehicles.

Bituminous materials used to surface roads emit a range of volatile organic compounds, the characteristics of which will vary depending on the solvents and surfacing materials selected for each job. A different range of chemicals is used to pre-treat the gravel surface prior to coating with bitumen. Pollution risk is highest during the transport, storage and application of materials, and will be greater in the event of an on-site accident.

In addition to fuel combustion by-products, construction and other general vehicles will provide a range of potential pollutants including leaked fuels, battery acid, car-care products, coolants and lubricants, tyre, clutch and brake lining parts, larger pieces of metal, glass and plastic, and bulk materials spilled from open trays (e.g. soils, chemicals). Oils and grease typically adsorb (i.e. gather on a surface in a condensed layer) to suspended solids and may persist in sediment deposits for prolonged periods, affecting bottom-dwelling organisms. If present as a surface film, the hydrocarbons can disrupt the transfer of oxygen into the water body.

Effects during operation

During normal operation, the proposed Expressway has the potential to affect the water quality of the Gawler River, Smith Creek and downstream receiving waters by introducing additional pollutants associated with the use of the road. These pollutants are normally associated with roads such as the Expressway and include:

- stormwater related pollutants
  - suspended solids from the road surface, embankments and open channel drains
  - pollutants, for example, heavy metals (such as zinc, cadmium, and to a lesser extent, lead) attached to sediment particles washed off the road surface
  - oil, grease and other hydrocarbon products
  - gross litter
  - organic material (grass clippings, leaves, etc.)
- accidental spillage of contaminants such as petrol, oil or other toxic compounds as a result of a collision or some other incident.

These pollutants have the potential to affect the environment in the following ways:

- suspended sediments reduce the clarity of water, thereby reducing light penetration, and causing siltation of downstream drainage systems and waterways
- heavy metals are toxic to aquatic organisms
- excess nutrients can encourage eutrophication of and algal growth within surface waters, particularly in slow flowing systems common across the Adelaide plains
- oils and grease are unsightly and can smother organisms in extreme cases
- accidental spills of hydrocarbons or chemicals can cause severe ecosystem damage and have the potential to leach into the shallow groundwater system, particularly within the Gawler River
- litter is unsightly, can create bad odours and can damage fragile ecosystems
- organic material can reduce dissolved oxygen levels when it breaks down and can create bad odours and discolouration of the water.

Accidental spills

The Northern Expressway will act as a heavy vehicle transport route, which will enable the high-speed passage of trucks carrying a variety of hazardous substances. The high safety standard adopted in the road design will reduce the risk of collision or accident; however, due to the large traffic volumes expected, the risk of accidental spillage of hazardous materials will remain.

The management of these issues is addressed in the following section.

20.6 Environmental management

20.6.1 Principles adopted to minimise effects

The management of flooding and drainage effects, surface water quality and groundwater resources are, in this case, integrally linked. Through appropriate and sensitive management of stormwater within the study area, water quality effects will be minimised both from a surface water and groundwater perspective. At the same time, the necessary drainage relief will be provided. Potential surface water management measures will be considered in the design phase and incorporated into the project's civil design and landscape works.

The principle of water-sensitive urban design is about managing the urban water cycle in a more sustainable way. Water-sensitive urban design (WSUD) has multiple environmental benefits including improving the urban landscape, reducing pollutant export, retarding stormwater flows and in some cases reducing irrigation requirements (Melbourne Water 2005). By including water-sensitive urban design elements into the drainage and landscaping design of the proposed Expressway, multiple objectives will be fulfilled including the provision of attractive landscaping along the corridor, providing necessary drainage elements, and addressing water quality effects.

From a water quality perspective, it will be important to treat stormwater run-off where drainage is directed to natural waterways, urban drainage systems, flood plains or environmentally significant areas. In addition, areas considered at a high risk in terms of spill potential should be considered for spill containment.

20.6.2 Measures to minimise effects during planning and design

Flooding and drainage

The minor drainage system for the new road will be designed for a 20 year ARI capacity, while new crossings of the Gawler River and Smith Creek outfall will be designed to a 100 year ARI capacity with minimal effect on upstream flooding conditions.

The existing natural surface water flow across the plains, including minor drainage systems, will be maintained through waterway openings in the embankment at necessary locations. Scour protection downstream of culverts will be included in the design to reduce erosion and sediment transport.

The Gawler River will be spanned by a bridge designed to provide 0.3 m freeboard from the bottom of the bridge deck to the estimated 100 year ARI flood level within the main river channel, post-implementation of the Gawler River flood mitigation works.

The realignment of the Smith Creek outfall will be designed for the estimated 100 year ARI flow and with all culverts designed for minimal head loss in the 100 year ARI event, will therefore have negligible effects on upstream flood levels. The channel cross-section will be designed with flatter batter slopes than the existing channel (maximum 1V:4H), thereby reducing future erosion potential.

Detention basins

Detention basins will be placed along the Expressway route at strategic locations to assist in the drainage function by limiting downstream flows, and the size of downstream infrastructure, and ensuring any existing drainage problems are not exacerbated.

All stormwater design will be undertaken in accordance with recommended principles in *Australian Rainfall and Runoff: A Guide to Flood Estimation* (Pilgrim [ed.] 1987) and consistent with DTEI standards.

Water quality

Further evaluation of the effect on water quality within receiving environments will be undertaken during the planning and design phase, and will involve conducting a water quality risk assessment to gauge the likelihood and consequence of changes in water quality in specific areas. This will be undertaken in line with DTEI's *Protecting Waterways Manual* (Transport SA 2002). Specific areas identified during the risk assessment process will be managed through the implementation of the management principles introduced throughout this section. Monitoring requirements during construction will also be determined through the risk assessment.

Key to the management of potential water quality effects will be the management of suspended sediment transported by stormwater. A Soil Erosion and Drainage Management Plan (SEDMP) will be developed prior to the commencement of construction. While soil erosion and the generation of sediment during construction cannot be entirely prevented, sound project planning and appropriate design of control measures will reduce the effect on water quality both on site and off site.

The SEDMP will be prepared in accordance with EPA guidelines, such as those contained in the *Stormwater Pollution Prevention Code of Practice for Local, State and Federal Government* (EPA 1998).

The design of sediment control facilities will be undertaken during the planning and design phase which will ensure the allocation of sufficient space for sediment traps and other structures to satisfy pre-determined suspended solid and turbidity targets both during the construction phase and during the operational phase. Other stormwater management facilities and spill containment devices, discussed in more detail in Section 20.4.4, will also be designed during the planning and design phase.

20.6.3 Measures to minimise effects during construction

Flooding and drainage

Key to managing flooding and drainage issues during construction will be the maintenance of an adequate standard of drainage for the duration of construction works.

The existing drainage capacity of the Gawler River, Smith Creek outfall and all local minor drainage systems will be maintained during construction, with care taken to ensure natural flow paths are not blocked by the placement of temporary structures, such as dams, bunds or stockpiles.

Surface water quality

Erosion and sediment control

Erosion and sediment control will be managed in a variety of ways during construction, including:

- sedimentation basins and minor sediment traps
- hay bales and sandbags
- sediment fences
- catch drains.

A sedimentation basin is a dam designed to intercept run-off and hold it for a sufficient period to allow suspended sediment to settle before release. These basins reduce the release of sediments into creeks and receiving waters, and minimise damage to downstream ecosystems. They also reduce potential siltation of stormwater pipes, culverts and swales. Hay bales, sandbags and sediment fences act as a physical filter of the stormwater and are useful around headwalls and in swale drains.

Measures may be required to limit sediment tracking from the construction site onto adjacent roads, particularly in the near vicinity of townships (e.g. Gawler) and in close proximity to sensitive areas and watercourses. Treatments such as shaker ranks, wash-down bays or street sweeping will be used as required in accordance with appropriate guidelines

The Soil Erosion and Drainage Management Plan (SEDMP) prepared during the design phase will be incorporated into the Construction Environmental Management Plan (CEMP) and implemented during construction. Erosion and sediment controls would also be designed during the detailed design phase. Many of the water quality control devices required during construction will form part of the final surface water quality treatment process.

Management of toxic substances

Pollution of ground and surface waters with toxic organics, oils, surfactants and heavy metals will be managed by following basic site management principles including the limited use of herbicides and pesticides (selecting a low toxicity compound suitable for aquatic environments); isolation of vehicle maintenance and refuelling to designated areas away from drainage lines, shallow aquifers and other sensitive features; and the appropriate storage of all hazardous liquids and solids.

A rapid response plan developed for spills and accidents will ensure minimal pollution risk away from centralised storage and maintenance sites.

Groundwater

With recharge of Northern Adelaide Plains aquifers occurring primarily in the Mount Lofty Ranges, groundwater resources will be most vulnerable to contamination where shallow aquifers or natural recharge and/or leakage points exist such as in and adjacent to the Gawler River. Key to limiting potential effects will be the containment and treatment of all site water and the diversion of natural surface flows away from the construction site. Where containment/treatment structures cannot be sited away from sensitive areas, alternative off-site locations or the use of impervious linings and isolation valves will be considered.

The greatest threat to groundwater quality is likely to be posed by spills and accidents, where there is the potential for large quantities of liquids to seep into subsurface systems once spilt on an unsealed surface. Spill containment and isolation structures should be installed in high risk locations, adjacent to central storage and servicing locations, and coupled with site risk management and induction for all construction workers. The implementation of a spill plan will be important for a faster response to limit potential effects.

20.6.4 Measures to minimise effects during operation

Flooding, drainage and water quality

Road drainage

The conceptual design of infrastructure for the management and treatment of stormwater generated from the Northern Expressway will ensure that all run-off is managed and receives appropriate treatment before release. Treatment will vary depending on the individual sites and results of the risk assessment, but will comprise the following:

Swales and buffer strips: these are vegetated surface features that drain water evenly off impermeable areas. Vegetated swales are long shallow channels used to convey stormwater in lieu of pipes and aid in the removal of coarse and medium sediment in the stormwater. Buffer strips are gently sloping, vegetated areas over which the run-off passes before reaching its discharge point. Aside from the physical filtering provided, swales also act to temporarily store and infiltrate run-off.

The batters of the road embankment when revegetated will form a buffer strip prior to run-off reaching the swale drains, which will form the main drainage system for the new road.

Sedimentation basins and constructed wetlands: Sedimentation basins are specifically used to remove coarse to medium sediments by settling, while constructed wetlands are more complex ecosystems which treat stormwater via a range of physical, chemical and biological processes.

Sedimentation basins and constructed wetlands will be used to treat stormwater run-off prior to discharge to the Gawler River and Smith Creek. Some of the sediment ponds used during construction for sediment control will be modified and utilised for this purpose.

Stormwater detention basins: The primary purpose of detention basins is the attenuation of stormwater flows to limit downstream flooding problems. Due to their detention capacity, they also often perform a sedimentation function as well.

Detention basins will be sited along the Expressway route at strategic locations where problems in local receiving drainage networks are anticipated. Some landscape treatment will be undertaken to provide some visual amenity and additional water treatment capacity.

Ongoing maintenance

It will be important to ensure that drainage features are periodically monitored and maintained. This would include cleaning and mowing of swales and buffer strips, desilting of sedimentation facilities and replacement of damaged erosion protection.

Accidental spill containment

The Northern Expressway will act as a heavy vehicle transport route, which will enable the high-speed passage of trucks carrying a variety of hazardous substances. The high safety standard adopted in the road design will reduce the risk of collision or accident; however, due to the large traffic volumes expected, the risk of accidental spillage of hazardous materials will remain.

Stormwater drainage swales along the road corridor will be designed to allow the use of temporary bunding, and containment of run-off to mitigate potential effects of accidental spills. Likewise, stormwater detention basins and constructed wetlands will be constructed so that areas can be shut off in case of a spill. In areas at high risk of groundwater contamination, the use of impermeable liners within basins will be considered.

A quick response to spills will be facilitated by a spill response plan (i.e. modified from the construction stage) identifying isolation points, vulnerabilities and an efficient chain of events to enable clean-up.

Groundwater

Groundwater across the Northern Adelaide Plains is monitored extensively to satisfy prescription requirements under State legislation. A regular appraisal of these results will enable the early identification of effects, but with an exhaustive planning and design phase, these are expected to be minimal. Additional targeted monitoring of groundwater quality would, however, be required if stormwater is considered for aquifer storage and recovery (ASR) injection.

20.7 Conclusion

The Northern Expressway has the potential to cause effects during construction and operation including physical changes to drainage infrastructure, changes in hydrological characteristics, and additional pollution loads in local drainage systems and receiving waters. Primary effects will be associated with the construction of a new road embankment which intercepts the natural flow of water across the plains, and the creation of a new impervious surface which generates additional stormwater flows and additional stormwater pollution.

Effects during the construction phase will be predominantly associated with erosion and sedimentation, and nuisance drainage problems. These effects will be managed through the implementation of a Soil Erosion and Drainage Management Plan during the construction phase which will form part of the Construction Environmental Management Plan. This will address stormwater management during construction and document the erosion control measures such as hay bales and silt fences to be utilised during construction.

Longer term effects associated with day-to-day operation of the Northern Expressway will be related to the disruption to natural flows across the plains, additional stormwater generated from the road surface and any associated pollutants caused by use of the road.

Natural stormwater flow paths will be maintained as much as possible through the provision of culvert openings through the embankment which will allow surface waters from upstream catchments to continue flowing in its current path. The Gawler River crossing will consist of a bridge spanning the full width of the river channel, while the Smith Creek crossing(s) will be designed to minimise any upstream hydraulic effects during the 100 year ARI event.

The extremely flat topography of the area means that drainage across the plains is already challenging, with existing drains often not able to cope with current stormwater flows. Drainage infrastructure within the Expressway corridor will consist of a combination of swales, pits and pipes, and detention basins to ensure any local drainage problems are not exacerbated. Stormwater treatment devices and spill containment measures will be provided prior to the discharge of any flows to the Gawler River and Smith Creek. The sizes and locations of structures and treatments will be determined during the detailed design phase of the project.