10. Water quality

10.1 Introduction

Urban development substantially changes the dynamics of the quality (and quantity) of surface water run-off discharging into local waterways. In undeveloped natural environments, pervious areas can absorb surface run-off through transpiration and infiltration into the ground which helps to replenish the ground watertable. After urban development, the percentage of pervious areas to non-pervious areas within a catchment is significantly reduced and surface water run-off is usually collected by a drainage network and discharged into local waterways in a more concentrated manner.

Surface water run-off from non-pervious areas such as an asphalt road, can generally contain high loads of gross pollutants such as litter, nutrients (such as nitrogen and phosphorus) and sediment. All of these pollutants would have a significant negative impact on the quality of the receiving waterways. Therefore, when planning transportation infrastructure such as the South East Busway extension from Rochedale to Springwood, the quality of surface water run-off needs to be addressed during planning, construction and the life of the infrastructure to ensure that it does not have a negative impact on the quality of the receiving waterways.

10.2 Methodology

A desktop study has been undertaken to examine the likely impact of the quality of surface water run-off from the busway extension on the receiving waterways. It is considered that this level of information is appropriate for corridor preservation.

10.2.1 Previous investigations

Environmental Technical Report No. 44, Logan, Coomera and South Moreton Bay Regional Water Quality Management Study. Environmental Monitoring Program Annual Report 1999.

This investigation is relevant as it provides information relating to surface water run-off quality within the Logan estuary catchment. According to this study (by the Queensland Environmental Protection Agency in 1999), the Logan estuary is heavily impacted by surrounding land use. Poor water quality was common in the estuary and was seen to be caused by inputs from sewage treatment plants.

Ecosystem Health Monitoring Program

The South East Queensland Healthy Waterways Partnership was established in 2001 and is a special collaboration between government, industry, researchers and the community working together to improve catchment management and waterway health in the eastward draining rivers of south-east Queensland. This partnership is responsible for a monitoring program called the Ecosystem Health Monitoring Program, the results of which are published each year. These monitoring results have informed the water quality conditions of Slacks Creek and Logan River.

10.2.2 Additional investigations

This desktop analysis has sourced information from the South East Queensland Healthy Waterways Partnership and the Department of Environment and Resource Management to inform the health of existing waterways and identify relevant legislation. Other information has been sourced from Logan City Council, Queensland Urban Drainage Manual (Department of Natural Resources and Water 2007), and the Department of Transport and Main Roads.

10.3 Preliminary analysis

10.3.1 Existing situation

Slacks Creek and Logan River

Slacks Creek is a freshwater waterway while Logan River is an estuary. Both contribute to Logan River estuary catchment. The Ecosystem Health Monitoring Program has released a report card for Slacks Creek and Logan River for 2006 and 2007, which is summarised in Table 10-1 below. It can be seen that there are still significant improvements required to bring the health of these two waterways to a more acceptable level.

Table 10-1: Report card for Slacks Creek and Logan River

Waterway	2006	2007	Comments
Slacks Creek (Freshwater)	D+	D	Streams generally in poor condition Nutrient cycling and fish indicators continue to return lower scores than other indicators Lower scores for physical/chemical and aquatic macroinvertebrate indicators compared with last year
Logan River (Estuarine waters)	F	D-	Improved turbidity and dissolved oxygen levels in the middle and upper reaches compared with 2006 Lower freshwater inputs from the catchment resulting in higher salinity levels throughout the estuary compared with 2006 Some riparian habitat remains intact in the inter-tidal zone, but is heavily impacted above the highest tide mark throughout the estuary
D = Poor F = Fail			

Source: South East Queensland Healthy Waterways Partnership

The Environmental Technical Report No. 44 (Environmental Protection Agency 1999) states that in the mid-estuarine region of Logan River, poor water quality was common as indicated by low concentrations of dissolved oxygen and high concentrations of nutrients compared with Queensland water quality guidelines. The main cause was most likely inputs from sewage treatment plants. Algae were abundant in the upper estuary as it has been in previous years and should be monitored in future in order to determine if water quality is changing. Concentrations of nutrients at freshwater sites in Logan River were indicative of poor water quality.

Legislation

The Environmental Protection Agency (now Department of Environment and Resource Management) published a paper in 2007 entitled ‘Logan River, environmental values and water quality objectives, basin no. 145 (part) including all tributaries of the Logan River estuary’.

This document is made pursuant to the provisions of the Environmental Protection (Water) Policy 1997, which is subordinate legislation under the *Environmental Protection Act 1994* (Queensland). The Environmental Protection (Water) Policy 1997 provides a framework for:

- identifying environmental values for Queensland waters, and deciding the water quality objectives to protect or enhance those environmental values
- identifying environmental values and water quality objectives under Schedule 1 of the Environmental Protection (Water) Policy 1997.

This document contains environmental values and water quality objectives for waters in the catchment of Logan River estuary. Environmental values for water are defined as the qualities of water that make it suitable for supporting aquatic ecosystems and human water uses. These environmental values need to be protected from the effects of pollution, waste discharges and deposits to ensure healthy aquatic ecosystems and waterways that are safe for community use.

Water quality objectives are defined long-term goals for water quality management. They are numerical concentration levels or narrative statements of indicators established for receiving waters to support and protect the designated environmental values for those waters. They are based on scientific criteria or water quality guidelines but may be modified by other (e.g. social, cultural, economic) inputs. The environmental values for Slacks Creek and Logan River are summarised in Table 10-2 below.

Table 10-2: Environmental values for Slacks Creek and Logan River

Waterway	Environmental values
Slacks Creek	Aquatic ecosystem, secondary recreation, visual recreation and cultural and spiritual values
Logan River	Aquatic ecosystem, human consumer, primary recreation, secondary recreation, visual recreation and cultural and spiritual values, aquaculture, oystering and seagrass

Examples of water quality objectives that are used to achieve these designations include:

- total phosphorus concentration <20 micrograms per litre
- chlorophyll a concentration <1 micrograms per litre
- dissolved oxygen between 95% and 105% saturation
- family richness of macroinvertebrate > 12 families
- exotic individuals of fish < 5%.

10.3.2 Managing issues and opportunities

Surface water run-off

The alignment of the extension is within a brownfield catchment, of low to medium urban density. The additional non-pervious area generated by this development does not increase the overall impervious area of this catchment significantly. It is, however, likely to generate an increase of pollutants carried by surface water run-off which can threaten the quality of the receiving waters.

Surface water run-off from the busway extension will be collected by an augmented drainage network consisting of pipes and culverts (see Chapter 9), and discharged into Slacks Creek which feeds into Logan River.

Substantial amounts of sediment and pollutants can be generated from daily road use and scheduled repair operations. Table 10-3 below shows some of the constituents that can be present in surface water run-off and their primary sources. It demonstrates that there are numerous pathways for pollutant deposition on a road that can influence the water quality of surface water run-off.

Table 10-3: Constituents in surface water run-off and their primary sources

Constituent	Primary sources
Particulates	Pavement wear, vehicles, atmosphere
Nitrogen, phosphorus	Atmosphere, roadside fertiliser application
Lead	Tyre wear, vehicle exhaust
Zinc	Tyre wear, motor oil, grease
Iron	Auto body rust, steel highway structures, moving engine parts
Copper	Metal plating, brake-lining wear, moving engine parts, bearing and bushing wear, fungicides and insecticides
Cadmium	Tyre wear, roadside insecticide application
Chromium	Metal plating, moving engine parts, brake lining wear
Nickel	Diesel fuel and gasoline, lubricating oil, metal plating, brake-lining wear, asphalt paving
Manganese	Moving engine parts
Sulfate	Roadway beds, fuel, de-icing salts
Petroleum	Spills, leaks, or blow-by of motor lubricants, antifreeze and hydraulic fluids, asphalt surface leachate

The level of pollutants found on roads is variable and is determined by a number of factors including traffic volume, climate, surrounding land use, the design of the road, the presence of roadside vegetation, roadside application of pesticides and fertilisers, and the frequency of accidents and spills that can introduce hazardous chemicals. It is important to determine how these pollutants can be managed and prevented from being transported via surface water run-off into the downstream waterways.

Water-sensitive urban design

It is currently industry practice to consider water-sensitive urban design when planning, designing and constructing infrastructure such as roads. The water-sensitive urban design approach aims to promote the integration of surface water management at the outset of any proposed development to ensure the negative impacts on natural water cycles and ecosystems be minimised and or improved. The main principles of water-sensitive urban design for surface water and how they can be incorporated in the busway extension are set out in Table 10-4.

Table 10-4: Water-sensitive urban design for surface water

Water-sensitive urban design principles	Example of water-sensitive urban design approach
Protect existing natural features and ecological processes	▪ Disturbance to soils and landscape minimised by maintaining natural landforms. ▪ Waterways protected by providing a buffer of natural vegetation to urban development. ▪ Natural channel design and landscaping used to ensure that the drainage network mimics the natural ecosystem.
Maintain the natural hydrologic behaviour of catchments	▪ Limit the increase in stormwater run-off volume using natural drainage paths and infiltration basins.
Protect water quality of surface and ground waters	▪ Control sediment-laden run-off from disturbed areas during the construction phase of development. ▪ All stormwater run-off from hard surfaces is treated through infiltration, sedimentation, storage or biological treatment before leaving the site.
Integrate water into the landscape to enhance visual, social, cultural and ecological values.	▪ Water is celebrated as part of the landscape through rain gardens, sculpture and art. ▪ Minimise the use of hard engineered structures. ▪ Native vegetation is used in stormwater management and all landscaping to maximise habitat values.

Provision for incorporating a water-sensitive urban design approach during the design, construction and life of this infrastructure can be achieved. However, issues such as the limited area for developing treatment trains (see below), existing underground services and existing on ground infrastructure need to be addressed through treatment of surface water run-off that will need to be incorporated in subsequent planning and design phases.

Treatment train concept

A stormwater treatment train typically consists of a series of devices through which run-off flows prior to its discharge to receiving waterways and/or drainage channels. The best choice of suitable devices varies depending on the nature of the development, the surrounding environment, and availability of land for treatment devices such as wetlands or bio-retention filtration devices. Treatment measures that could be considered for the busway extension are as follows:

- propriety inline interception devices (such as Humeceptor, Ecosol unit or Rockla Downstream defender) for removal of litter, hydrocarbons, and medium to coarse sediment
- bio-retention filter areas for removal of nutrients (e.g. nitrogen and phosphorous)
- the provision of grass buffer strips and/or roadside swales may be considered however these may be undesirable due to maintenance requirements and the need to minimise the width of the corridor
- unlined vegetated open channels. These may allow improved infiltration rates to groundwater stores and have the capability to remove part of the sediment and nutrient loading of the run-off.

It is noted that most treatment train elements require periodic maintenance if their effectiveness is to be retained throughout their design life.

Recommended treatment train elements

Inline interceptors

These devices are usually precast, compact, and installed in the ground so that they are not intrusive aesthetically. There are three types — the two main types provide treatment for gross pollutants and the other to provide sediment and oil separation. The capability to trap oils as well as sediments and gross pollutants is considered to be preferable as this would provide some mechanism for oil spill capture. These units are usually located at regular intervals along the drainage network or immediately before the piped system's outlet.

At this time it is envisaged that the underground drainlines along the busway corridor would be fitted with an inline interceptor before discharging to further treatment devices.

Bio-retention filter areas

Achieving water quality objectives for nutrient levels for the busway corridor stormwater discharge without the use of bio-retention filters is highly unlikely.

Bio-retention filters are suitable for the removal of fine sediment and nutrients from run-off. They utilise a combination of vegetation nutrient uptake and granular filter beds (approximately up to 1 metre in depth) to filter low (or "first flush") flows which are commonly responsible for a large proportion of pollutant loads to downstream waterways. The filter bed has an underdrain which conveys treated run-off to downstream drainage infrastructure, that is, pipes or open drains. When flows reach a rate in excess of filter capacity they bypass the filter and are discharged to downstream waterways untreated.

There are a number of areas along the corridor that may be suitable for the implementation of bio-retention filters. These are shown on drawing no's 2112646A-TRA-0073 and 2112646A-TRA-0074 (see Volume 2 of the Concept Design Study).

Grassed buffer strips and roadside swales

Roadside buffers are typically used as pre-treatment measure with their main function being the removal of sediment. It is considered at this stage that the nature of the corridor and the recommended provision of inline interceptors would preclude using such measures.

Open drainage channel

Another method of pollutant treatment can be provided by utilising the longitudinal sections of open-channel drains along the eastern side of the busway extension. These are shown indicatively on drawing no's 2112646A-TRA-0073 and 2112646A-TRA-0074 (see Volume 2 of the Concept Design Study) between approximate chainages 3000 m and 3300 m. These channels could be vegetated to provide a mechanism for sediment and limited nutrient removal.

Desktop evaluation of possible sites for bio-retention treatment areas

An assessment has been made to identify areas suitable for treatment and to determine a preliminary sizing for such measures. Due to the corridor constraints, south of chainage 3400 m there is little chance of providing bio-retention filter areas with the exception of a narrow strip of land beneath the elevated busway between chainages 3750 m to 4350 m and within the existing detention basin at the Springwood bus station. The suitability of the detention basin site should be further investigated to determine if an outlet to the filter media underdrain would be obtainable with the existing drainage pipes in the vicinity.

Areas which may be suitable are briefly discussed as follows:

- sag at the eastern side of chainage 2580 m (adjacent to Anna Marie Street)
- land on the eastern side of the busway corridor from chainages 3000 m to 3200 m approximately
- narrow strip of land beneath the busway elevated structure between chainages 3740 m and 4350 m (this may not be suitable for a vegetated bio-retention filter area due to shading)
- existing detention basins at the Springwood bus station.

Preliminary design calculations to provide an indicative areal requirement for bio-retention filtration areas were carried out and are shown in Table 10-4. The Healthy Waterways Technical Design Guidelines for South East Queensland (June, 2006) have been referred to and a treatment area equating to 2.0% – 2.5% of contributing catchment area appears to be optimal for the reduction of nutrients in run-off.

Table 10-5: Preliminary sizing of bio-retention treatment areas

Discharge location (approx chainage)	Approximate busway corridor catchment area (hectares)	Longitudinal extent of catchment (chainage)	Area required for bio-retention filter (based on 2.5% of catchment area) (m^2)
2570 m	1.1	2200 m – 2620 m	260
3100 m	2.4	2620 m – 3590 m	610
4500 m #	1.2	3590 m – 4600 m	300

Options for locations for treatment of this catchment are at the existing detention basin and/or beneath the elevated busway structure

10.4 Future investigations

Given the already well documented poor quality of receiving waterways it would not be environmentally responsible to carry out the busway extension without providing stormwater quality treatment measures.

During subsequent planning and design phases of the busway extension, it is important to keep abreast of current data provided by advisory organisations and of legislation from local and national governing bodies in regards to acceptable standards for water discharge into natural waterways. Project-specific monitoring may also be necessary to be able to establish and compare pre- and post-water quality condition of water surface run-off.

Further planning and design phases of the busway corridor should include water quality modelling and further design of stormwater quality improvement devices. A number of existing properties which may need to be acquired to secure the corridor width may be utilised for stormwater quality improvement devices in the future. It may be beneficial to adopt a more regional approach to the provision of stormwater quality infrastructure along the corridor and liaison with the Local Authority and community organisations concerned with the local waterways may be beneficial in that a coordinated approach may give wider environmental benefits into the future.

10.5 References

Logan City Council 2006, Planning Scheme Policy number 5 (Design and Construction of Work).

Logan City Council 2006, Planning Scheme Overlay Map 2 (Flood Plain Management).

Logan City Council 2006, Planning Scheme Overlay Map 6 (Wetland and Waterway Areas).

Queensland Department of Main Roads 2002, *Road Design Drainage Manual*, Queensland Department of Main Roads.

Queensland Department of Natural Resources and Water 2008, *Queensland Urban Drainage Manual*, Queensland Department of Natural Resources and Water.

The South East Queensland Healthy Waterways Partnership, '2006/2007 Report Card for the Ecosystem Health Monitoring Program'.

The Stormwater Manager's Resource Center, 'Pollution Prevention Fact Sheet: Bridge and Roadway Maintenance', Center for Watershed Protection, Maryland, USA.

Queensland Environmental Protection Agency 2007, *Logan River Environmental Values and Water Quality Objectives Basin No. 145 (part) including all tributaries of the Logan River estuary*, Queensland Environmental Protection Agency.

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