N20142952 14.20.2.2

Port Lincoln

Stormwater Management Plan

City of Port Lincoln

February 2014

Ref No. 20070307RA2I

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Document History and Status

Rev	Description	Author	Reviewed	Approved	Date
A	Draft	TCR/TAK	TAK	DJ	13/2/08
B	Final	TCR/TAK	TAK	DJ	08/09/08
C	Revised Final	JO/TAK	TAK/JO	TAK	20/06/13
D	Revised Final	JO/TAK	TAK/JO	TAK	24/6/13
E	Revised Final	JO/TAK	TAK/JO	TAK	08/10/13
F	Revised Final	JO/TAK	TAK/JO	TAK	31/10/13
G	Revised Final	JO/TAK	TAK/JO	TAK	13/02/14

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1 Introduction

The City of Port Lincoln has identified the need to conduct a formal investigation to prepare an integrated Stormwater Management Plan for the Port Lincoln Township. The preparation of this Plan will assist in prioritising works within the township and has been prepared in accordance with the Stormwater Management Planning Guidelines (2007) document.

The township area is typically quite steep with a general gradient from west to east. The western edge of the catchment is formed by a ridgeline a few kilometres in from the ocean. All stormwater ultimately discharges into the ocean. The catchment contains some well-defined valleys passing through undeveloped areas before passing through the developed areas of the township, which are generally closer to the coastline.

Development is continuing within the township and is providing increased pressure on the existing drainage infrastructure. A number of known trouble spots have already been identified.

This study sets out a range of stormwater management related objectives and sets out a plan of actions and strategies to meet the objectives. A prioritised 10-year plan of capital works has been developed.

2 Study Area Description

2.1 Sub-catchment Descriptions

The township is comprised of a broad strip of land along the coastline surrounding Porter Bay and Boston Bay. The township is generally comprised of steeply graded areas and is bounded by hills to the west. The only flat area of the township is within the valley between Kirton Point and the centre of the township. All runoff from the township enters the ocean.

The township is made up of a number of distinct catchments. They are described below and shown within Figure 2.1. This figure also includes an aerial photo of the township, which shows that in general terms that the coastal section of each sub-catchment is the area where development is located.

2.1.1 Milton Avenue Catchment (Rustlers Gully)

Milton Avenue Catchment (Rustlers Gully) is located in the far northern region of Port Lincoln and is approximately 200 hectares in size. The grade of the land is steep, ranging from 30% in the west of the catchment to 10% in the east. Elevations in Milton Avenue catchment range from just above sea level to 230 metres. Land use is predominantly rural with a small amount of residential.

2.1.2 Kurla Street Catchment

In the northern region of Port Lincoln, Kurla Street Catchment consists of a steep valley, falling in an eastern direction. Elevations range from 90 metres to less than 5 metres above sea level. Typical grades throughout the catchment range from approximately 5 to 6%. The catchment is 11 hectares in size and is mainly residential.

2.1.3 Bayview Road Catchment

Bayview Road Catchment is located in the northern region of the township and is approximately 80 hectares in size. The catchment consists of a large valley with a steep grade ranging from 15% in the western end to 6% further towards the eastern end. Land use within the catchment is mainly residential and rural. Runoff from the Bayview Road catchment drains into the creek at the base of the valley.

2.1.4 Smith Street Catchment

Smith Street Catchment is a steeply sloping valley, grading in an eastern direction. Land use within the catchment is mainly residential and rural properties. The catchment is approximately 40 hectares in size. Slopes within this catchment range from above 20% in the west to less than 3% in the east.

2.1.5 Shaen Street Catchment

Shaen Street catchment is a large 410 hectare catchment in the northern region of the township. The catchment is mainly rural in the west with a small amount of residential in the east. This catchment drains in an easterly direction and contains a detention basin located in the eastern section. Typical slopes within the Shaen Street catchment are relatively steep, ranging from 12% in the western portion of the catchment to less than 3% in the east.

2.1.6 Normandy Place Catchment

Normandy Place catchment is approximately 70 hectares in size and located in the northern region of Port Lincoln. It is relatively steep and grades at approximately 8% to the east. Ground levels range from just above sea level to 95m above sea level. Land use for Normandy Place Catchment is almost entirely residential.

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Scale: 1:30,000 @ A3

Job Number: 2007.0307
Filename: Figure2.1.wor
Revision: E
Date: 20/12/2007
Drawn: TR
Technical Approval: TAK

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MAJOR SUB-CATCHMENTS

Figure 2.1

2.1.7 Flinders Highway Catchment

Flinders Highway Catchment is approximately 70 hectares in size and located in the mid-northern region of the township. The catchment consists of a steeply sloping valley, grading in an eastern direction typically from 6% to less than 3%. This catchment is mostly residential.

2.1.8 New West Road Catchment

This catchment is approximately 210 hectares in size located from central Port Lincoln to the western outskirts of the town. The catchment grades relatively steeply in the western section, grading to a relatively flat area at the eastern end. The top end of the catchment is rural. Residential properties cover most of the remainder of the catchment; however it does enter the commercial district in the town centre near the coast line. The catchment includes some detention basins.

2.1.9 Mortlock Terrace North Catchment

Mortlock Terrace North Catchment is 350 hectares in size. The western portion is undeveloped while the eastern portion is largely made up of residential, commercial and industrial areas. The west of the catchment is very steep, slowly grading to a shallower slope further east.

2.1.10 Mortlock Terrace South Catchment

This catchment, Mortlock Terrace South, is 95 hectares in size and relatively flat. Land use within the catchment is mainly made up of residential and industrial sites. This catchment also contains a splitter box, directing stormwater either down Mortlock Terrace or into the Mallee Park basin. The catchment grades from 3% in the west and north to less than 1% in the south-east.

2.1.11 Barley Road Catchment

Barley Road Catchment is approximately 190 hectares in size and is steep at the top, and gradually flattens out. It is predominantly rural but contains some industrial and residential properties towards the eastern end of the catchment. It grades steadily from west to east. Unlike the majority of the township which drains into Boston Bay, this catchment drains into Proper Bay to the south of the township.

2.1.12 Liverpool Street Catchment

This catchment located in the centre of the town is very flat. Ground levels vary from 2 to 10 metres above sea level. The slope of the land is typically less than 1%. Land use within the catchment is almost entirely commercial and is approximately 35 hectares in size. The catchment discharges into the Mortlock Terrace North Catchment via a pump station in Liverpool Street.

2.1.13 Le Brun Street Catchment

Le Brun Street catchment is relatively flat with slopes ranging from 3% to less than 1%. Land use includes residential, industrial, and the rail yards. All water in the catchment drains to a pump station (located in Le Brun Street) which discharges into the Mortlock Terrace drain. The Le Brun Street Catchment is 40 hectares in size.

2.1.14 Brougham Place Catchment

Brougham Place Catchment has a relatively flat grade and is located to the southeast of the town centre. Land use is mainly industrial, but also includes residential, commercial and the rail yards. This catchment is approximately 22 hectares in size.

2.1.15 Stevenson Street Catchment

Stevenson Street Catchment is located to the east of the town centre. It typically has a moderate grade, with slopes ranging from 3% to 5% typically towards the north west. Almost the entire catchment is residential and is 70 hectares in size.

2.1.16 Ravendale Catchment

Ravendale Catchment is relatively flat with a grade of less than 1%. It is made up of industrial and residential allotments and is 50 hectares in size. It includes the Ravendale Racecourse. This catchment drains via an open channel into Proper Bay to the south of the township.

2.1.17 Marina West Catchment

This catchment surrounds the western part of the marina and is comprised of a number of small drains that discharge straight into the Lincoln Cove Marina. It includes a residential area between the marina and the southern portion of Kirton Point. This residential area is relatively steep. The total catchment is 85 hectares in size.

2.1.18 Marina East Catchment

This small 33 hectare catchment surrounds the eastern part of the marina and is comprised of a number of small drains that discharge straight into the marina.

2.1.19 Kirton Point Catchment

The 65 hectare catchment is predominantly residential and spills directly into the ocean along the eastern and northern edges of the catchment. Due to its steep nature the road network forms a high surface flow capacity and hence the catchment has only a few underground drains.

2.2 Existing Infrastructure

The township is served by an integrated underground stormwater drainage system. The majority of the systems are gravity systems, but in some low-lying areas pumps are required.

Details of stormwater assets and infrastructure were obtained from the City of Port Lincoln. Design and construction plans were used to input and compile data regarding the size, location and grade of stormwater infrastructure. The Port Lincoln Township Stormwater Drainage Study (Kinhill Engineers, 1994) was also used to obtain details of existing infrastructure.

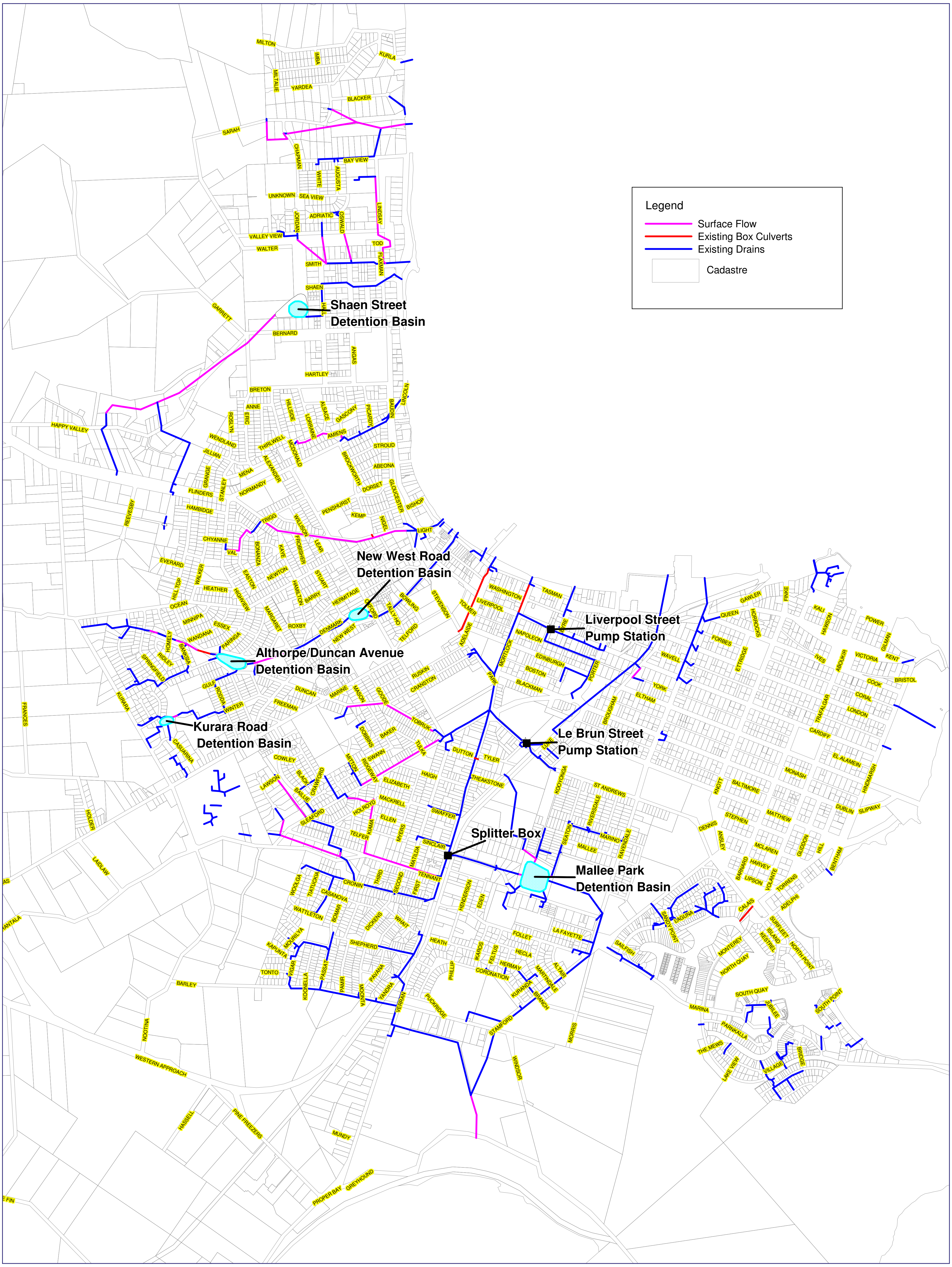
A plan showing all existing infrastructure is shown in Figure 2.2.

Pumping Stations

Two pumping stations exist at the low points located in the Liverpool Street and Le Brun Street catchments. The Liverpool Street pump station has a capacity of 750L/s and pumps water into the downstream section of the Mortlock Terrace drain. Le Brun Street pumping station also has a capacity of 750L/s and draws water from the Le Brun Street low point into the Mortlock Terrace drain.

Splitter Box

A splitter box exists on the Mortlock Terrace drain at the intersection with Sinclair Street. Stormwater enters the splitter box from the south in twin 1350mm diameter pipes. During small rainfall events, base flows will pass into a single 900mm diameter pipe, which runs north down the length of Mortlock Terrace, discharging into Boston Bay. During large rainfall events the flows exceed the capacity of the 900mm pipe and are drained by twin 1275mm pipes into the Mallee Park detention basin, and eventually into the Stamford Terrace drain, discharging into Proper Bay to the south of the township.



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Date:	20/12/2007
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EXISTING INFRASTRUCTURE

Figure 2.2

Detention Basins

Five detention basins exist in the township and are at the following locations:

- Kurara Road
- Shaen Street
- Althorpe Avenue / Duncan Avenue Creek.
- Mallee Park (Aboriginal Reserve)
- New West Road / Oxford Terrace

Kurara Road detention basin is located on the corner of Bethany and Kaitlin Court and has a capacity of 1,700m^3 with a 225mm diameter outlet pipe. The outlet pipe discharges into a council drain within Rodda and Gulf Avenue and discharges into the New West Road Catchment creek.

Shaen Street detention basin is located to the east of Shaen Street towards the downstream end of the Shaen Street Catchment. This basin detains stormwater runoff primarily from the rural portion of this catchment. The basin has a capacity of approximately 2,400m^3 with a 1950mm diameter outlet drain.

Althorpe Avenue Creek detention basin is located between Althorpe Avenue and Duncan Avenue. The detention basin has a capacity of approximately 10,000m^3, with a single 675mm diameter outlet drain.

Mallee Park detention basin is located within the Mortlock Terrace South Catchment on Bel-Air Drive. It has a capacity of approximately 12,000m^3 with a 900mm outlet drain.

The New West Road / Oxford Terrace basin is formed by Oxford Terrace being built well above the invert of the natural gully. Detention storage is available in the gully until water spills over Oxford Terrace. The outlet to the basin is a 1050mm drain that continues down New West Road.

3 Stormwater Runoff – Quantity

To investigate issues associated with the quantity of stormwater runoff, hydrological and hydraulic modelling was undertaken. The key inputs and outcomes are summarised in this section.

3.1 Model Construction

The following input factors were used within the hydrological model and are described in detail below:

- Subcatchment delineation
- Rainfall parameters
- Runoff coefficients
- Times of concentration
- Rainfall loss parameters

3.2 Subcatchment Delineation

The major catchments have been broken down into a number of smaller sub-catchments. The catchment boundaries have been drawn based on survey information, 5 metre contours and the location of the drainage infrastructure. In some instances additional field investigations were required to determine the flow directions, particularly in the flatter areas of the township. The sub-catchments are shown in Figure 3.1.

3.3 Rainfall Parameters

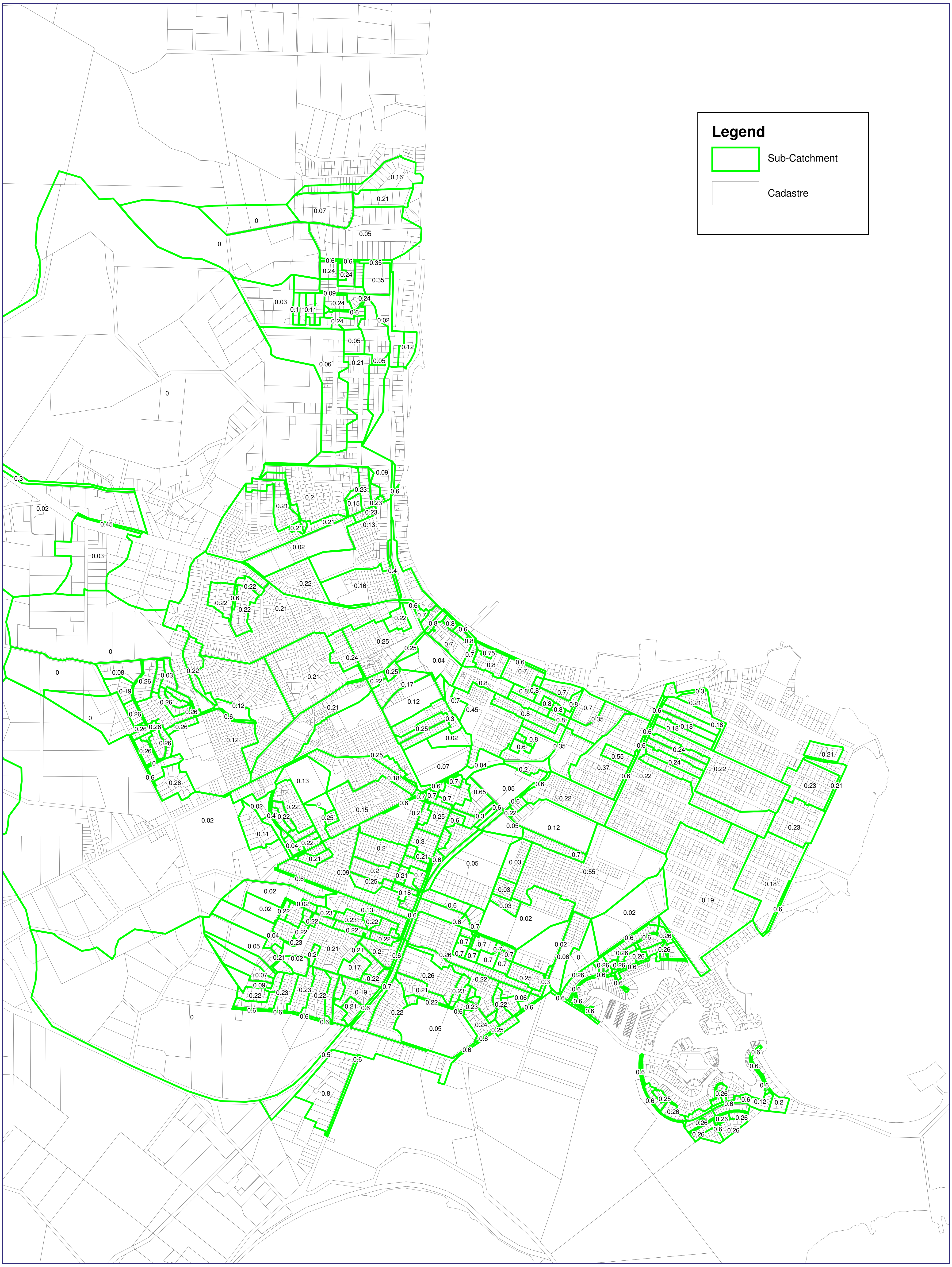
The rainfall Intensity-Frequency-Duration (IFD) data were taken from the Australian Bureau of Meteorology for the catchment centroid. The parameters used to generate the IFD data are shown in Table 3.1 below.

Table 3.1 Rainfall Intensity Frequency Duration Parameters

Parameter	2 year average recurrence interval	50 year average recurrence interval
1 hour Rainfall Intensity (mm/hr)	14.50	34.00
12 hour Rainfall Intensity (mm/hr)	2.95	5.50
72 hour Rainfall Intensity (mm/hr)	0.75	1.35
Average Skew Coefficient	0.65	
Short Duration Geographic Factor F2	4.51	
Short Duration Geographic Factor F50	15.09	
Latitude	-34.764	
Longitude	135.836	

3.4 Runoff Coefficients

Runoff coefficients have been determined from analysis of land use, aerial photography and site inspections. An estimate of the amount of directly connected impervious areas has been made based on a survey of a number of randomly selected areas throughout the township. This included older and newer areas of the township.



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Date:	20/12/2007
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EXISTING CONNECTED IMPERVIOUS AREA COEFFICIENTS

Figure 3.1

The percentage of directly connected impervious area used in the modelling for each of the sub-catchments is shown in Figure 3.1. Some areas have not been shown. This is because in these areas the runoff either discharges directly to the ocean via overland surface flow paths or discharges into the marina via localised drainage systems.

Runoff coefficients have been modified to reflect new development that is likely to occur within the township. This includes large increases in runoff in the areas likely to be rezoned residential (refer Section 4.2). In additional it is likely runoff from existing residential areas will increase due to building extension and subdivisions. It has been estimated that runoff coefficients from residential areas will increase by 30% based on a 40-50 year time horizon. This is based on similar work undertaken for other residential areas where rates of building approvals have been projected into the future. Future runoff coefficients are shown in Figure 3.2.

3.5 Times of Concentration

Times of concentration have been calculated for each sub-catchment based on the longest length of the flow path to the outlet of the sub-catchment with an allowance made for the slope of the land. Due to the general steep nature of the township the times of concentration were generally relatively short (10-15 minutes). The times of concentration from the larger rural areas to the west of the township were typically in the range of 30 to 60 minutes.

3.6 Rainfall Loss Parameters

An initial loss / continuing loss model was used to model runoff from the pervious portions of the catchment. Initial losses of 30mm and a continuing loss of 3mm/hr were applied for all events. These values have been selected to produce runoff consistent with steeply graded undeveloped areas.

These are consistent with similar parameters used for steeply graded areas to the east of the Adelaide Plains. These parameters are also similar to those used in the 1994 Kinhill study (25mm initial loss and 2mm/hr continuing loss).

3.7 Verification of flow rates

Some key flow rates calculated in the model have been verified using the rational method and regression formulas for Adelaide. This is assumed to be a valid comparison as IFD charts in Port Lincoln are typically within 10% of values for the Adelaide area.

A comparison of the flow calculation methods at key areas is shown in Table 3.2 along with a comparison of flows from the 1994 Kinhill Study. Direct comparisons in some areas are not valid as detention basins and changes to runoff coefficients due to new development have changed since 1994 and current conditions (in 2013).

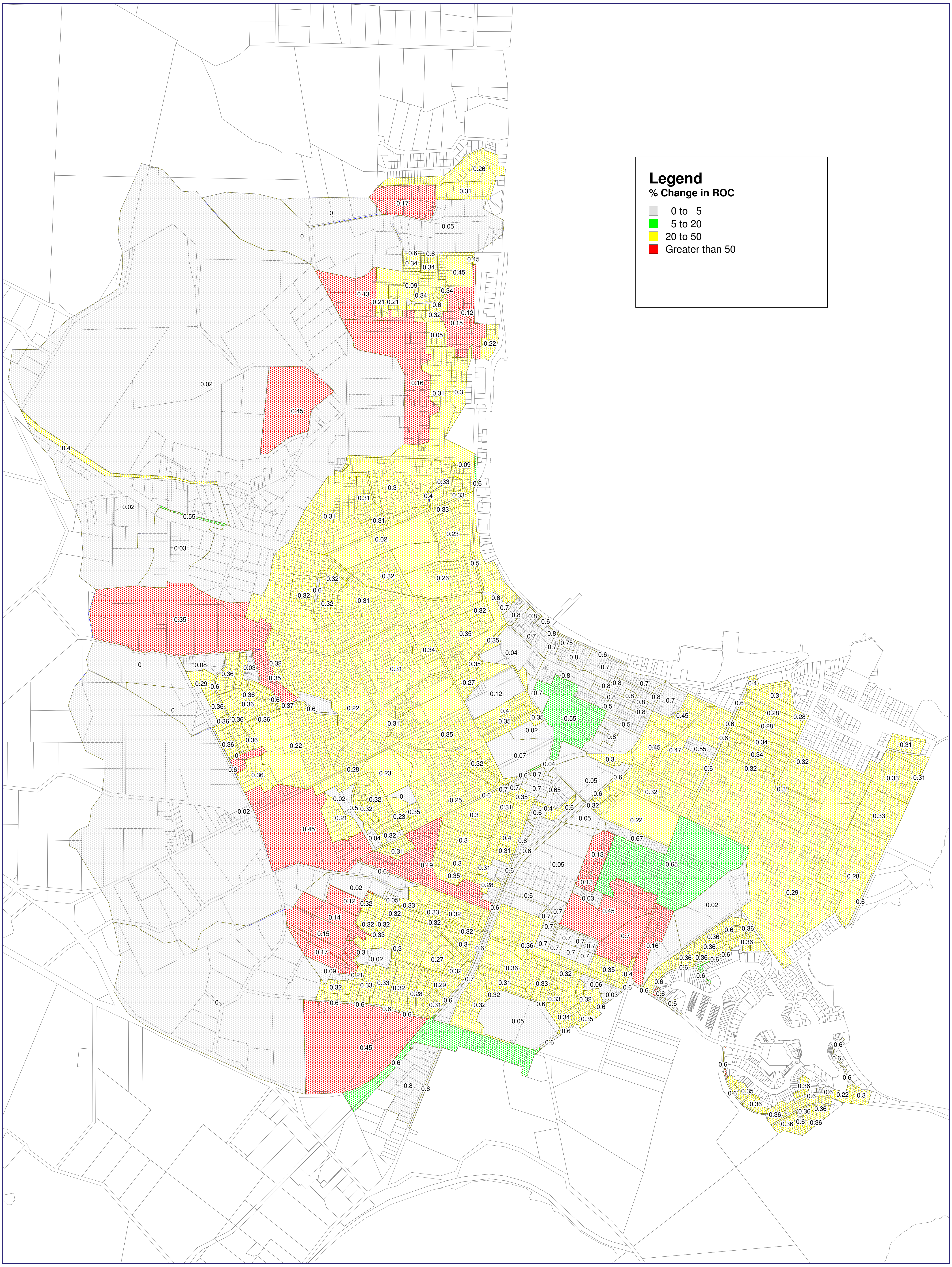
Table 3.2 Comparison of flow calculation method at key areas

Location and ILSAX Reach Name	ARI*	Flow Rate (m^3/s)			
		ILSAX	Rational	Regional Regression	Kinhill 1994 Report
Shaen Street (Rural) (AGK 021)	100	11.2	-	10.6	16.1
New West Road Outlet (AFI 040)	100	10.4	-	8.5	12.3
Flinders Highway Outlet (AFY 019)	5	2.06	2.24	-	2.0
Seaton Avenue (ABA 006)	5	1.56**	1.64	-	1.76
Mortlock Tce U/S of splitter box (AAF 021)	5	1.90#	1.3	-	1.15

* The 5 year and 100 year ARI was modelled in the Kinhill report, thus these ARIs have been used for comparison.

** Flow taken from refined hydrological model undertaken as part of the design work for this drain

\# Includes the new Chicken Farm Development



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Filename: Figure3.2.wor
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Date: 20/12/2007
Drawn: TR
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INCREASE IN FUTURE DIRECTLY CONNECTED IMPERVIOUS AREA COEFFICIENTS

Figure 3.2

Generally, the flows are comparable and within acceptable tolerance levels.

3.8 Pipe Capacity Assessment

An ILSAX hydrological model of each sub-catchment was developed to assess the standard of the existing drainage systems and to investigate drainage upgrade proposals.

Model Assumptions

To assess the capacity of the pipe network, the ILSAX modelling assumed that the inlet pits have an unlimited capacity. There are several areas where the drainage is shown to be adequate, but additional pits may be needed to capture the flow arriving at an inlet. Local effects such as pit blockage will also increase the occurrence of observed flooding at local inlet pits above what is predicted by the hydraulic model.

The ILSAX model was run in “Design mode”. This mode assumes that all flows in a catchment (both surface and pipe flows) are able to reach the downstream extents of the system. Hence, there is no assumed storage in the catchment, and flows are not subject to being ‘held back’ due to natural surface gradients in the system. This approach allows the existing pipe capacity to be assessed based on the assumption that all flows are able to arrive at the upstream inlet of each pipe segment in the catchment. Again this allows the capacity of the pipework to be assessed against an ideal “design” case whereas in reality it is likely that upstream constraints and storage limit the true flows arriving at the downstream parts of the network.

3.8.1 Model Results

The ILSAX model was run for the 1, 2, 5, 10, 20, 50 and 100 year ARI storm events to assess the standard of each drain. The model was run in design mode (no restrictions in the pipe network) to provide estimates of the design flow for each pipe for each ARI. The model was then run in “review mode” to provide estimates of the capacity for each drain based on its grade and size. The capacity was then compared with the design flows for each ARI to determine the point at which the design flow exceeded the pipe capacity and hence to determine the standard of each pipe. The results were loaded into the GIS pipe database and colour mapped by standard to provide a visual assessment of the pipe network and highlight sections that may require a more detailed assessment and future upgrade works. These results are shown in Figure 5.1 as part of the section on existing drainage issues.

3.8.2 Implementation of Model Results

The main 2 ARIs that have been used in the preliminary sizing of infrastructure as part of this study are the 5 year and 100 year. The 5 year ARI output is used to size new underground drainage infrastructure while the 100 year ARI output has been used for sizing detention basins

The results shown in Appendix B show the 5 and 100 year ARI storm run in design mode. In this mode all pipes are assumed upgraded and flood flows can reach the downstream system. It is not intended that these flows be used for estimating 100-yr ARI peak flows rates within the catchment for the reasons outlined above. However they would provide a relatively accurate estimate of 5-yr ARI flows as the majority of the drainage system has at least a 5-yr ARI standard.

4 Stormwater Runoff – Quality

4.1 Physical Changes to the Coast

The development of a system that rapidly transports stormwater to the marine environment, combined with the impervious surfaces and human activities and industry that has been increasing since European settlement, have all significantly altered the quantity, temporal distribution and quality of water discharged to the marine environment.

The direct discharge of stormwater carries the following pollutants to the marine environment:

- Turbidity which reduces the clarity of water and is implicated in the decline of seagrasses. It also results in a degradation of the aesthetics of the marine environment as well as reducing the safety of bathing by reducing visibility into the water. Fine particulate material can be resuspended during storm events so that its impact lasts for longer than just the initial event.
- Pollutants such as tyre and brake wear products and hydrocarbons from road surfaces
- Litter and debris including leaves and other vegetation
- Nutrients, particularly nitrogen which can result in changes in the plant and animal communities and the degradation of water and sediment quality
- Pesticides and chemicals
- Bacteriological contamination which can reduce the quality of bathing waters.

4.2 Available Data

The EPA conducted ambient water quality monitoring in the Boston and Proper Bay areas from 1997 to 2008 (EPA, 2009). This was in response to environmental impacts experienced in the bay area such as the depletion of seagrass and death of tuna stock.

Using the guidelines for Fresh and Marine Water Quality, the water quality in the bay has broadly been classified as good, with only chlorophyll a (indicative of nutrient pollution) classified as moderate.

The EPA website (http://www.epa.sa.gov.au/reports_water/jussieu-ecosystem-2010) has also prepared an aquatic ecosystem condition report based on sampling in 2010 which covers the Port Lincoln area as part of the Jussieu Nearshore Marine Biounit. It indicated that the overall quality of the ecosystem was good but also highlighted areas under stress due to nutrient enrichment.

The elevated nutrient loads may be impacted by urban stormwater, however large potential nutrient sources are from the tuna processors that discharge wastes into the bay and the Billy Lights Point wastewater treatment plant effluent.

4.3 Model for Urban Stormwater Improvement Conceptualisation (MUSIC)

A water quality model of Port Lincoln using the computer software MUSIC Version 5 has been developed and is depicted in Figure 4.1.

MUSIC is a continuous simulation model developed by the Cooperative Research Centre for Catchment Hydrology, and used to simulate the performance of stormwater treatment measures that could form part of an urban drainage system.

MUSIC predicts the performance of stormwater quality management systems as a conceptual design tool only. It is intended to help in the planning and design (at a conceptual level) of appropriate urban stormwater management systems. By simulating the performance of water quality improvement measures, MUSIC determines if proposed systems can meet specified water quality objectives. MUSIC will simulate the performance of a group of stormwater management measures, with appropriate rainfall and soil parameter data as input.

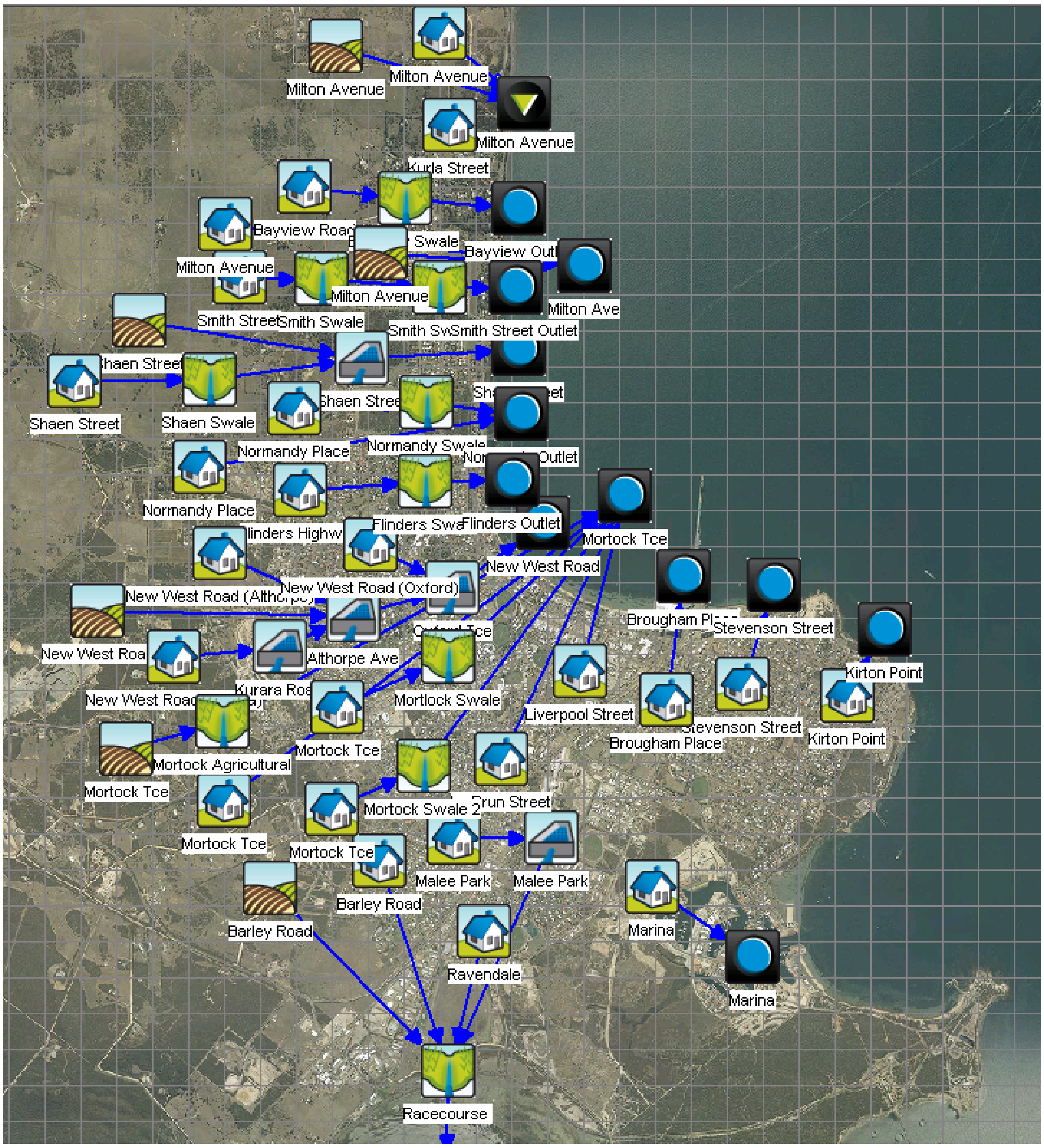


Figure 4.1 MUSIC Model Interface

4.3.1 Inputs and Assumptions

Catchments

The sizes of catchments in the MUSIC model have been taken from the hydrological modelling carried out as part of the preparation of the stormwater management plan. Catchments have been amalgamated to apply to each of the existing ocean outfalls within the study area.

Imperviousness

The impervious percentage for each catchment has been taken from the hydrological modelling undertaken as part of the stormwater management plan. The imperviousness for each catchment area differs according to the density and type of development.

Soil Storage Capacity

The soil storage parameters input into the MUSIC model are set out in the Table 4.1. These are consistent with the parameters used in the hydrological modelling.

Table 4.1 Soil Storage Parameters

Parameter	Unit	Value
Impervious area properties:		
Rainfall Threshold	mm/day	1
Pervious area properties:		
Soil Storage Capacity	mm	30
Initial Storage (% of Capacity)	%	25
Field Capacity	mm	30
Infiltration Capacity Coefficient (a)	Unit	200
Infiltration Capacity Exponent (b)	Unit	1
Groundwater Properties:		
Initial Depth	mm	10
Daily Recharge Rate	%	25
Daily Baseflow Rate	%	5
Daily Deep Seepage Rate	%	0

Rainfall Data

The rainfall data has been taken from the Bureau of Meteorology (BOM) 6 minute time step data points for Port Lincoln 'North Shields AWS' from 2000 to 2004. The 6 minutes time step allows the pollutant generation due to rainfall to be calculated more accurately.

Pollution Generation

The MUSIC default pollution generation parameters for base flow and storm flow have been used in the model.

Water Treatment Devices

There are a number of existing open channels and detention basins in the system that provides some water quality improvement. These have been included in the model. The location and type of these have been taken from the Stormwater Management Plan and survey from the site.

4.4 Results

A summary of the MUSIC model results are presented in Section 5.3. The complete MUSIC results per sub-catchment are given in Appendix C.

5 Drainage Issues

5.1 Existing Drainage Network

The existing drainage system has been modelled using ILSAX. The standard of the existing drainage network is shown in Figure 5.1 and is based on the results of the ILSAX modelling as outlined in Section 3.8.1.

A number of drainage issues have been identified that are generally due to localised drainage capacities being inadequate. These are discussed below and shown in Figure 5.2.

5.1.1 Stamford Terrace System

The section of drain near Stamford Terrace and Coronation Drive is currently of a low standard and results in frequent surface flows and flooding.

Modelling has indicated this drain, from Mallee Park, along Stamford Terrace to its outlet south of the racecourse has less than a 2 year ARI standard. The slope of this drain is approximately 0.03% with a diameter of 900mm upstream, to a 1200mm diameter further downstream.

5.1.2 Liverpool Street System

This system drains towards the Liverpool Street pump station and also accepts flood flows from adjacent catchments. There is currently inadequate pump capacity and detention storage. This is resulting in the regular surface ponding of stormwater following large rainfall events with between 25-30 properties at risk of inundation in the 100-yr ARI rainfall event.

The current pump station is comprised of three pumps. Two of these run on mains power while a generator is required to run the third pump. Therefore during a blackout only one of the three pumps can operate. Therefore there is a moderate risk of flooding as power failures have the potential to coincide with thunderstorms (from lightning strikes) that potentially generate significant runoff.

Modelling has indicated the existing stormwater drainage on Liverpool Street is of less than 2 year ARI standard. The pump station has a capacity of 750L/s.

5.1.3 Brougham Place

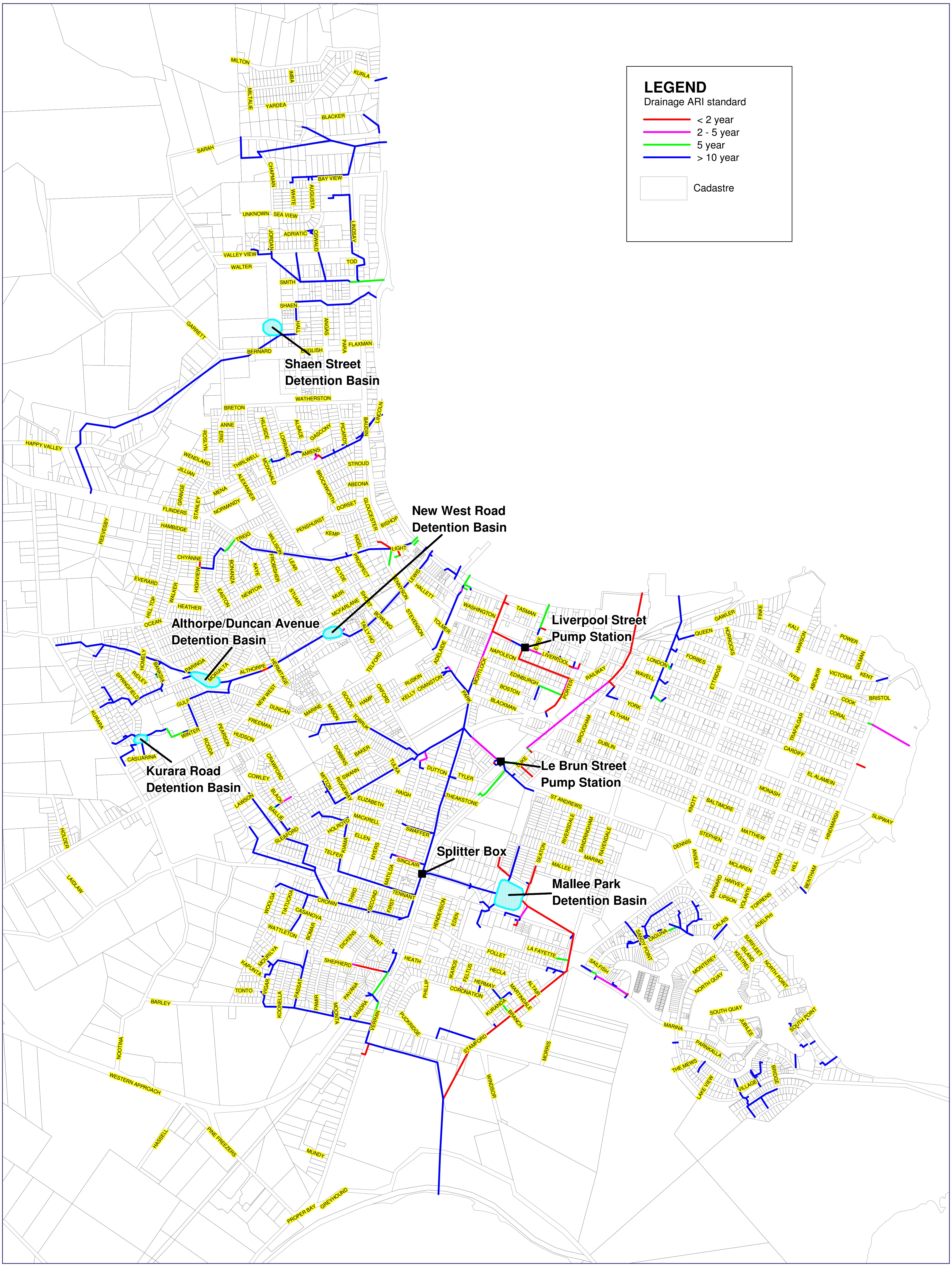
The Brougham Place drain (ranging in size between a 450mm and 600mm diameter pipe) currently runs through the rail yards in the commercial district of the township. There is currently inadequate drainage capacity with modelling of the existing catchment showing the drain is currently below a 2 year ARI standard.

5.1.4 Seaton Avenue

Seaton Avenue drain currently receives large surface flows from a relatively large, mostly industrial catchment area. According to Council, gutters in the lower end of Seaton Avenue are running full during rainfall events, and could potentially cause damage for up to 15-20 industrial properties. Existing drainage on Seaton Avenue consists of a 375mm diameter drain on the lower eastern side of the road. Modelling has indicated that this drain is below a 2 year ARI standard.

5.1.5 Hallett Place

Due to the large upstream catchment and limited drainage system in the area large surface flood flows arrive in the vicinity of Hallett Place and have been known to historically cause localised flooding problems within the trapped low spot within Hallett Place. 2-3 properties have historically been impacted on the north eastern side of the low spot.



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Filename:	Figure5.1.wor
Revision:	E
Date:	18/12/2009
Drawn:	TR
Technical Approval:	TAK

Data Acknowledgement:
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EXISTING DRAINAGE STANDARDS

Figure 5.1

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Drawn: TAK
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CURRENT PROBLEM AREAS

Figure 5.2

5.1.6 Grantala Road Gully (Chicken Farm Backfilling)

Backfilling near the former chicken farm in the Grantala Road Gully has caused natural flow through the channel to be interrupted. This is causing water to become detained behind the filled area and could potentially cause flooding during a large rainfall event.

5.1.7 Western Approach Road

Water generated by the large upstream catchment passes under the Western Approach Road via a series of culverts. These flows subsequently drain towards the rail reserve and Proper Bay Road in an uncontrolled manner and cause occasional flooding to adjacent areas.

5.2 Future Development / New Development

New areas of development are proposed for a number of areas throughout the township. These are generally located to the west of existing development and due to the natural fall of the land to the east will result in increase runoff through the existing developed areas increasing the pressure on the existing drainage network.

Figure 5.3 shows the areas that have been identified for future development.

5.2.1 Western Approach Road

Up to an additional 240 new allotments are proposed along the Western Approach Road. Runoff from this area will discharge towards the Barley Road drainage system which discharges behind the Port Lincoln Race Course.

5.2.2 Former Chicken Farm

Approximately 220 new allotments are proposed for an area bounded by New West Road, Grantala Road and Nootina Road. This area discharges into the Mortlock Terrace drainage system. Design for the development has been undertaken but no actual on ground works have been completed other than for Stage 1 which only comprises of a small proportion of the total development.

5.2.3 Hilltop Drive

Up to 160 new allotments are proposed for an area bounded by Hilltop Drive, Roberston Road and Whillas Road. Runoff will feed into the New West Road drainage system which discharges into Boston Bay.

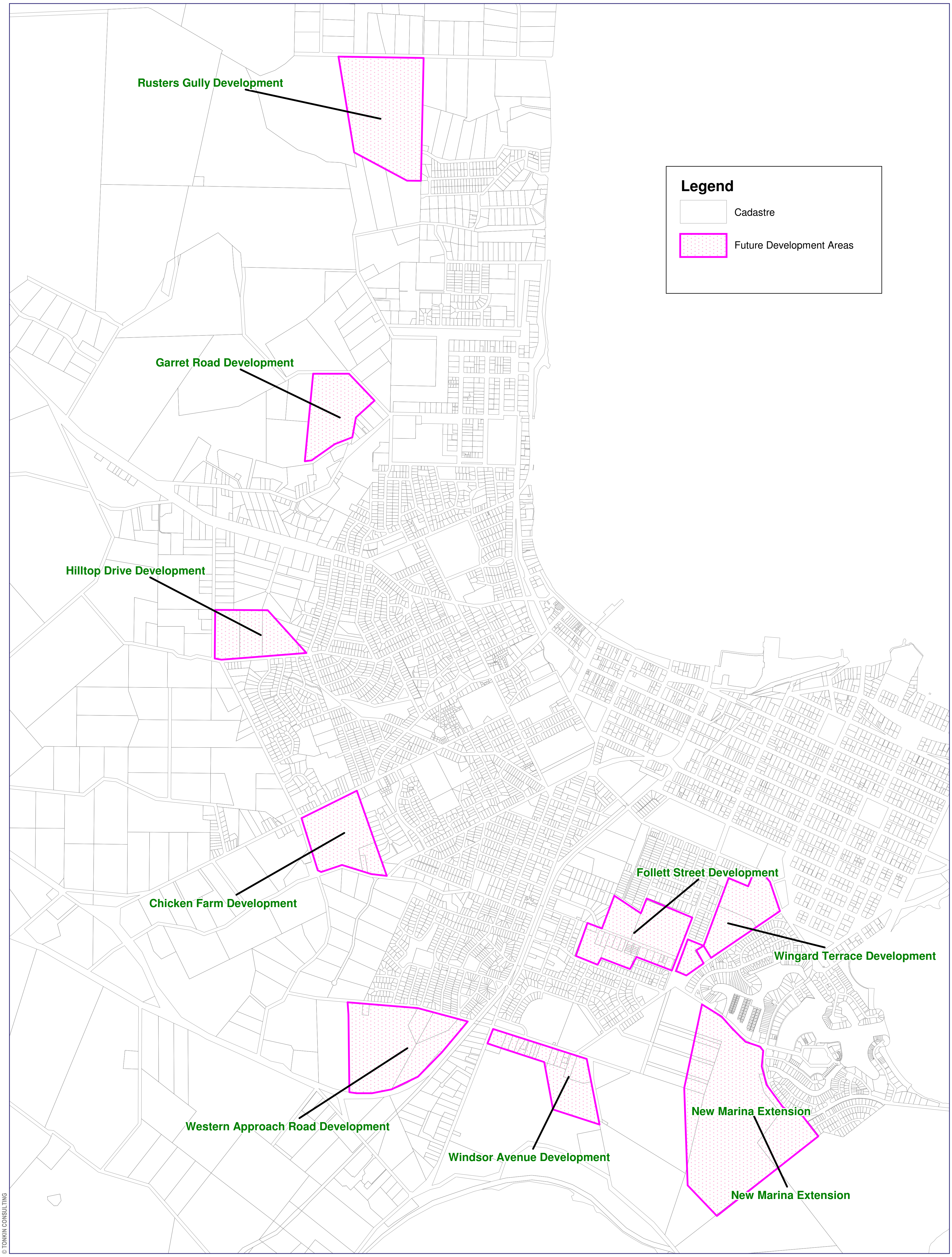
5.2.4 Garrett Road

An area bounded by Garrett Road and Happy Valley Road is earmarked for up to 150 new allotments. This area discharges into the Shaen Street drainage system which discharges into Boston Bay.

5.2.5 Rustlers Gully

Up to 150 new allotments are proposed for an area on the northern outskirts of the township to the west of Milton Avenue. The site will discharge into an existing natural valley that discharges directly into Boston Bay.

Modelling has indicated that the new development in Rustlers Gully, due to its relatively small scale in comparison to the larger catchment, will not cause peak flows within the gully to increase dramatically. The twin 900mm diameter outlet pipes at the downstream end of the gully have been modelled and found to be of a 20-50 year ARI standard. This standard has shown not to be reduced due to the proposed development. Therefore, upgrade of the twin 900mm diameter outlet pipes at the downstream end of the gully or construction of a new detention basin is not warranted.



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Filename:	Figure5.3.wor
Revision:	E
Date:	20/12/2007
Drawn:	TR
Technical Approval:	TAK

Data Acknowledgement:
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Stormwater Management Plan

AREAS OF FUTURE DEVELOPMENT

Figure 5.3

5.2.6 Windsor Avenue

The area south of Windsor Avenue is earmarked for rezoning from recreational allotments to industrial. Windsor Avenue is within the Ravendale Catchment.

5.2.7 Follett Street

Re-development from residential allotments to industrial is proposed for the area bounded by Follett Street, Ravendale Road and Mallee Crescent. This area discharges into the Mallee Park detention basin within the Mortlock Terrace South catchment.

5.2.8 Marina Extension

The existing marina at the southern end of the township is to be extended to the west. Stages 2b and 3 are proposed for this area, which include a number of new allotments and an extension of the marina channels.

5.2.9 Wingard Terrace

This parcel of land is located to the north-west of the existing Lincoln Cove Marina. It is zoned as residential with space for up to 170 allotments. The site generally grades from the north-east to the south-west towards the Sandy Point Drive / Stamford Terrace intersection. The only large drainage infrastructure adjacent to the site is within Ravendale Road. However this drain would have inadequate capacity to accept runoff from development of this site.

5.3 Existing Water Quality Discharge

The existing water quality in the catchments has been modelled using MUSIC. The total pollutant discharge for the study area is given in Table 5.1.

Table 5.1 Pollutant Loads

Area (ha)		Flow (ML/yr)	Pollutant Concentration (kg/yr)			
Urban	Agricultural		Total Suspended Solids	Total Phosphorus	Total Nitrogen	Gross Pollutants
1075	870	1370	300464	663.12	4494	39280

The complete MUSIC model results for each sub-catchment are given in Appendix C.

There are minimal formalised water quality improvement elements within the catchment to improve the quality of discharge to the marine environment. Where possible, water quality improvement devices should be retrofitted in the catchments and included as a requirement in new development.

6 Stormwater Management Objectives

6.1 Introduction

The Stormwater Management Planning Guidelines published by the Stormwater Management Authority includes the following in relation to stormwater management objectives:

Catchment specific objectives for the management of stormwater within the area are to be set and are to be based on the problems and opportunities identified. The objectives should provide measurable goals for the management of stormwater in the catchment.

As a minimum, the objectives are to set goals for:

- an acceptable level of protection of the community and both private and public assets from flooding;
- management of the quality of runoff and effect on the receiving waters, both terrestrial and marine where relevant;
- extent of beneficial use of stormwater runoff;
- desirable end-state values for watercourses and riparian ecosystems;
- desirable planning outcomes associated with new development, open space, recreation and amenity;
- sustainable management of stormwater infrastructure, including maintenance.

6.2 Stormwater Management Goals

The key issues to be addressed in the development of the Stormwater Management Plan for the management of stormwater runoff from an urban catchment are:

- Flooding
- Water quality
- Water use
- Environmental protection and enhancement
- Asset management.

Arising from these issues, broad objectives for management of urban stormwater runoff can be developed and are commonly identified as follows:

Goal 1: Flood Management

Provide and maintain an adequate degree of flood protection to existing and future development.

Goal 2: Water Quality Improvement

Improve water quality to meet the requirements for protection of the receiving environment and downstream water users where possible.

Goal 3: Water Use

Maximise the use of stormwater runoff for beneficial purposes while ensuring sufficient water is maintained in creeks and rivers for environmental purposes.

Goal 4: Amenity, Recreation & Environmental Enhancement

Where possible, develop land used for stormwater management purposes to facilitate recreation use, amenity & environmental enhancement.

Goal 5: Asset Management

Ensure the condition of stormwater infrastructure is suitable for its intended purpose.

The development of a Stormwater Master Plan for the Port Lincoln catchment requires these broad objectives to be further refined to identify catchment specific management objectives. These specific objectives have enabled targeted management strategies to be identified and assessed.

6.3 Catchment Specific Objectives

6.3.1 Flood Management

Existing Drainage Standard

Components making up the existing drainage system can be broadly categorised into three components:

- Lateral or Feeder Drains

  These drains collect runoff from streets within the catchment and have the primary function of preventing nuisance flooding of roadways.

- Main or Trunk Drains

  These drains form the main spines of the underground drainage system and act as the discharge point for the lateral drainage systems. The main drains can carry substantial flows and have the primary purpose of preventing property damage due to concentrated flood flows.

- Open Channels and Gullies

  The open channels and gullies collect flows from the main drains and have the primary purpose of transferring floodwaters to the catchment outlet without damage to property.

The existing standard for each of these components varies across the catchment. Based on previous upgrading works carried out within the Council area the following standards have been catered for:

- Lateral Drains 2-5 year ARI
- Main Drains 5 year ARI
- Open Channels and Gullies 100 year ARI

As a part of this Stormwater Master Plan, it is appropriate that these design standards be reviewed to ensure that they are consistent with current practice and that they take account of likely changes to the nature of development within the catchment.

Currently Accepted Design Standards

Australian Rainfall and Runoff (IE Aust, 2000) provides some guidance on design standards for urban stormwater drainage. The design standard is embodied in the major-minor principle, which aims to ensure that development is protected from inundation in a 100 year ARI event. Under the major-minor principle, the drainage system is considered to be comprised of a minor (generally underground) component that prevents nuisance flooding of roadways resulting from relatively frequent storm events, and a major component (generally along surface flow paths such as roads and reserves) that carries excess runoff during more substantial storm events. The combined capacity of the minor and major system components should be sufficient to carry the peak flow produced by a 100 year ARI event. A design standard of between 2 and 5 years is generally adopted for the minor system.

Within areas that are already developed, the ability to provide the same level of protection from flooding as in an area of new development is generally limited by the layout of existing roads and reserves and by the topography.

In these areas the selection of an appropriate design standard to protect property that is at risk of inundation therefore requires the exercise of engineering judgement to balance the cost of the works against the benefits obtained.

Proposed Drainage System Design Standard

Main Drains and Outfall

The design standard for upgrading works on the open channels and main drains within the catchment was based on an assessment of physical constraints, construction costs and the consequences of the drainage system surcharging. The main drains form the outfall for lateral drainage systems serving the catchment and their capacity therefore needs to match or exceed the capacity of these systems to enable them to function adequately.

As a result it is considered that the current proposed standards for the main drains and outfall channel should not be altered. However, it should be noted that these design standards are the minimum that is considered acceptable and should not be reduced by future development.

Lateral Drains

In accordance with generally accepted practice, the historical use of a 5 year ARI design standard for new lateral drainage systems in the catchment should be continued. While this standard is considered to be an appropriate objective, there is some scope to reduce the standard to a 2 year ARI on roads that are not used as major transport routes, if adequate surface flow paths are available for major flows. This is particularly suitable in the steeper areas of the catchment where surface flood flow capacities within the road network are generally high.

Where property is likely to be inundated as a result of overflow of the underground drainage system (for example at a trapped low point), a higher design standard (up to a 100 year ARI) is appropriate. However in some instances it may not be economically viable to provide a 100-yr ARI level of protection if the cost of the works would greatly exceed the likely magnitude of the flood damages.

Flood Management Objectives

Based on the above, the following catchment specific objectives for management of flooding within the Port Lincoln catchment have been set. Due to the different constraints that are present in new and existing areas of development, different objectives have been set for each of these areas.

For new development undertaken within the catchment the following flood management objectives will apply:

Objective 1.1

- Protect all properties from inundation in a 100 year ARI event.

Objective 1.2

- Provide an underground drainage system having a minimum capacity sufficient to carry a 5 year ARI flow.

Objective 1.3

- Ensure that runoff from any new development does not increase the degree of flood risk to other properties for all events up to a 100 year ARI.

Objective 1.4

- New development must be constructed so as to not cause an increase in 5 year ARI flow rates.

Objective 1.5

- New stormwater infrastructure must not increase the risk of flooding in downstream areas.

Within areas of existing development within the catchment, the following flood management objectives will apply:

Objective 1.6

- Where economically and practically viable, protect existing development from inundation in a 100 year ARI event. A lower standard of flood protection may be adopted where physical and economic constraints limit the ability to achieve a 100 year ARI level of protection. Where a lower standard is adopted, this should be justified based on an assessment of the saving in construction costs relative to the increase in flood damage costs.

Objective 1.7

- Where economically and practically viable, provide an underground drainage system having sufficient capacity to carry a 5 year ARI event. A lower underground drainage standard (as low as 2 year ARI) may be adopted in existing developed areas provided that adequate surface flow paths are available to carry major flows and the consequences of nuisance flooding of roadways are not significant.

6.3.2 Water Quality Improvement

Existing Water Quality

All water from Port Lincoln discharges into the ocean. A large portion discharges into Boston Bay, which is the major feature of Port Lincoln. Poor water quality within the Bay will reduce the general amenity of the area and potentially impact on the aquaculture industry within the Bay. Specific water quality issues within the catchment include:

Gross Pollutant Management

Virtually the entire township discharges directly into the ocean. Gross pollutants reduce visual amenity, particularly in the main commercial foreshore area. Gross pollutants can also be a hazard to marine fauna.

Sediment Export

Large quantities of sediment can reduce the quality of water in the ocean and prevent sunlight penetration which can impact on the health of sea grass in Boston Bay. Stormwater high in sediment discharging into the ocean will also reduce amenity.

Nutrient Export

Large quantities of nutrients could potentially result in algal blooms.

Pollutant Point Sources

Spill of contaminants that would detrimentally affect the ocean should be managed within the catchment.

Currently Accepted Design Standards

To ensure that this stormwater management plan aligns with other strategies and guidelines, stormwater targets from other documents have been reviewed. These include the recommendations made in Australian Runoff Quality: A Guide to Water Sensitive Urban Design

(Engineers Australia, 2006), the Water Sensitive Urban Design Technical Manual (Government of South Australia, 2010) and the Department for Water's Water Sensitive Urban Design Consultation Statement. These are summarised below;

Australian Runoff Quality

Guidelines on the reduction of pollutant loads for new developments are set out for Victoria and New South Wales in the Australian Runoff Quality (ARQ) Guidelines. Stormwater treatment objectives are as follows:

- Total suspended solids (TSS) – 80% reduction of the average annual load
- Total phosphorus (TP) – 45% reduction of the average annual load
- Total nitrogen (TN) – 45% reduction of the average annual load
- Litter – Retention of litter greater than 50 mm for flows up to the 3 month Average Recurrence Interval (ARI) peak flow
- Coarse sediment – Retention of sediment coarser than 0.125 mm for flows up to the 3 month ARI peak flow
- Oil and grease – No visible oils for flows up to the 3 month ARI peak flow.

Department for Water

Treatment objectives have been recently included in the Department for Water's Water Sensitive Urban Design Consultation Statement (Department for Water, 2012). Objectives for water quality improvement are requested in land subdivisions and new development as follows:

Table 6.1 Department for Water Quality Objectives

Pollutant	Current best practice performance objective
Suspended solids	80% reduction in average annual pollutant load compared to an equivalent urban catchment with no water quality management
Total phosphorus	60% reduction in average annual pollutant load compared to an equivalent urban catchment with no water quality management
Total nitrogen	45% reduction in average annual pollutant load compared to an equivalent urban catchment with no water quality management
Litter / gross pollutants	90% reduction in average annual pollutant load compared to an equivalent urban catchment with no water quality management

The above targets for suspended solids and total nitrogen have also been referenced by 2010 DesignFlow report with the assumption of 30% impervious area within the Port Lincoln township.

Guidelines Used in Modelling

Target values have not been set in the modelling, however the Australian Runoff Quality Guidelines have been used as a guide in the modelling as they represent a recognised Australian water quality standard.

Water Quality Improvement Objectives

The township is comprised of a number of catchments. Without a significant investment it would be difficult to achieve water quality targets across all catchments. However based on the current water quality issues that have been identified the following catchment specific objectives for management of water quality have been set:

Objective 2.1

- Stormwater discharged to the marine environment should meet targets set by the state and other regional plans within Council's control and responsibility, where economically and practically viable.

Objective 2.2

- Intercept pollutants at source from land uses and activities having a high potential for pollutant generation, in particular sediment and nutrients.

These are broadly consistent with the EPNRMB's priorities (EPNRMB, 2009) which include a strategy to minimise the impact of runoff from towns and cities to cost, estuarine and marine environments.

6.3.3 Water Use

There are only limited areas of available open space to capture and harvest stormwater downstream of the developed areas of the township. A number of basins exist but are generally used to temporarily detain large rural flows. As they predominantly detain flood flows from rural areas the annual volume of flow through them is relatively low.

Some opportunities may existing for a regional scale water harvesting facility at the Mallee Park Reserve and within detention basins required for new subdivisions.

Rainfall at Port Lincoln is relatively high (~500mm/year). Therefore yields from the capture and on-site reuse of stormwater runoff will be relatively good.

Water for the township is harvested from the Uley Basin which is located to the west of the township. Harvested stormwater will reduce the volume of water extracted from the basin and may help to improve its long-term viability.

Based on the above the following objectives for water use have been adopted:

Objective 3.1

- Encourage on-site use of stormwater runoff to minimise discharges to the downstream stormwater system, particularly in areas where existing drainage infrastructure is of a low standard.

Objective 3.2

- Where economically viable, utilise stormwater runoff for beneficial purposes within catchment scale facilities.

These strategies reflect the EPNRMB's priorities (EPNRMB, 2009) which include a strategy to maximise the uptake of water sensitive urban design in existing and new developments.

6.3.4 Amenity, Recreation & Environmental Enhancement

There are no existing natural water bodies of significance within the catchment. As a result, opportunities for environmental enhancement in association with management of stormwater will be limited to those that may be associated with construction of new stormwater management facilities on areas of open space, or along existing natural gullies.

Development of multiple use drainage open space requires a careful consideration of the interaction between drainage provision, environmental enhancement, water quality and recreation provision. By application of appropriate principles and implementation of suitable guidelines it is possible to serve a range of needs while at the same time providing a suitable drainage system. In doing so, advantages can be compounded beyond those which may be achieved if each component were considered in isolation.

The following general objectives have therefore been set:

Objective 4.1

- New development should be planned to minimise its impact on downstream stormwater systems and to capitalise on opportunities for provision of open space incorporating WSUD and other stormwater management systems. The developments should also encourage the use of open space provided for drainage infrastructure for other purposes such as amenity enhancement, passive or active recreation and environmental enhancement.

Objective 4.2

- Where new stormwater management facilities are constructed on existing open space, maximise the community use and benefit derived from the facility and ensure that opportunities for biodiversity, amenity and environmental enhancement are realised.

Objective 4.3

- Where possible provide linear open space running parallel with major open channel drainage routes.

Objective 4.4

- Enhance the biodiversity of existing natural gullies.

6.3.5 Asset Management

Stormwater drainage forms a considerable financial asset for the City of Port Lincoln. Considering that a large portion of the existing drainage infrastructure was constructed over 30 years ago, some degree of structural degradation is likely. Degraded infrastructure will reduce the ability of the drainage system to act as per its original design intent.

Without careful planning structural failure of existing infrastructure may necessitate immediate and expensive rectification. Careful asset management will allow for future planning to determine the timeline for replacement of assets.

The following general objectives have therefore been set:

Objective 5.1

- Maintain up to date information on the age and condition of existing drainage infrastructure by undertaking;
  - CCTV inspections of drains
  - Visual inspections and condition reports of pump stations
  - Visual inspection of basins and other water sensitive urban design infrastructure

Objective 5.2

- Plan for the strategic replacement of infrastructure nearing the end of its design life, with a particular focus on major assets such as trunk drainage systems and major pump stations.

Objective 5.3

- All stormwater infrastructure including WSUD schemes are to be maintained in accordance with cost-effective maintenance management plans.

Objective 5.4

- Stormwater infrastructure is to be managed sustainably.

7 Stormwater Management Strategies

7.1 Flood Management

A number of potential strategies have been identified to achieve the objectives for Flood Management set out in Section 6 above. These strategies are described below together with a description of potential options for implementation.

The proposed works are shown in Figure 7.1. The works are costed and prioritised in Section 8. Concept drawings of the proposed works are shown in Appendix D.

7.1.1 Strategy 1: Upgrade Existing Underground Drainage Systems

The review of existing drain capacities within the catchment has shown that the standard of the existing underground systems varies across the catchments. An indication of drainage standards based on the ILSAX modelling was shown in Figure 5.1. The following summary provides a broad overview of the main drain capacities (if applicable) in the eight areas that have the lowest drainage capacity.

- Liverpool Street — Less than 2-year ARI
- Mortlock Terrace (North) — 2-5 year ARI
- Stamford Terrace — Less than 2-year ARI
- Le Brun Street — 2-5 year ARI
- Brougham Place — Less than 2-year ARI
- Seaton Avenue — Less than 2-year ARI
- Rustlers Gully — N/A
- Chicken Farm — N/A

To meet the objective of achieving a 5-year ARI design standard for each of these underground systems, upgrading work will be required, as described below.

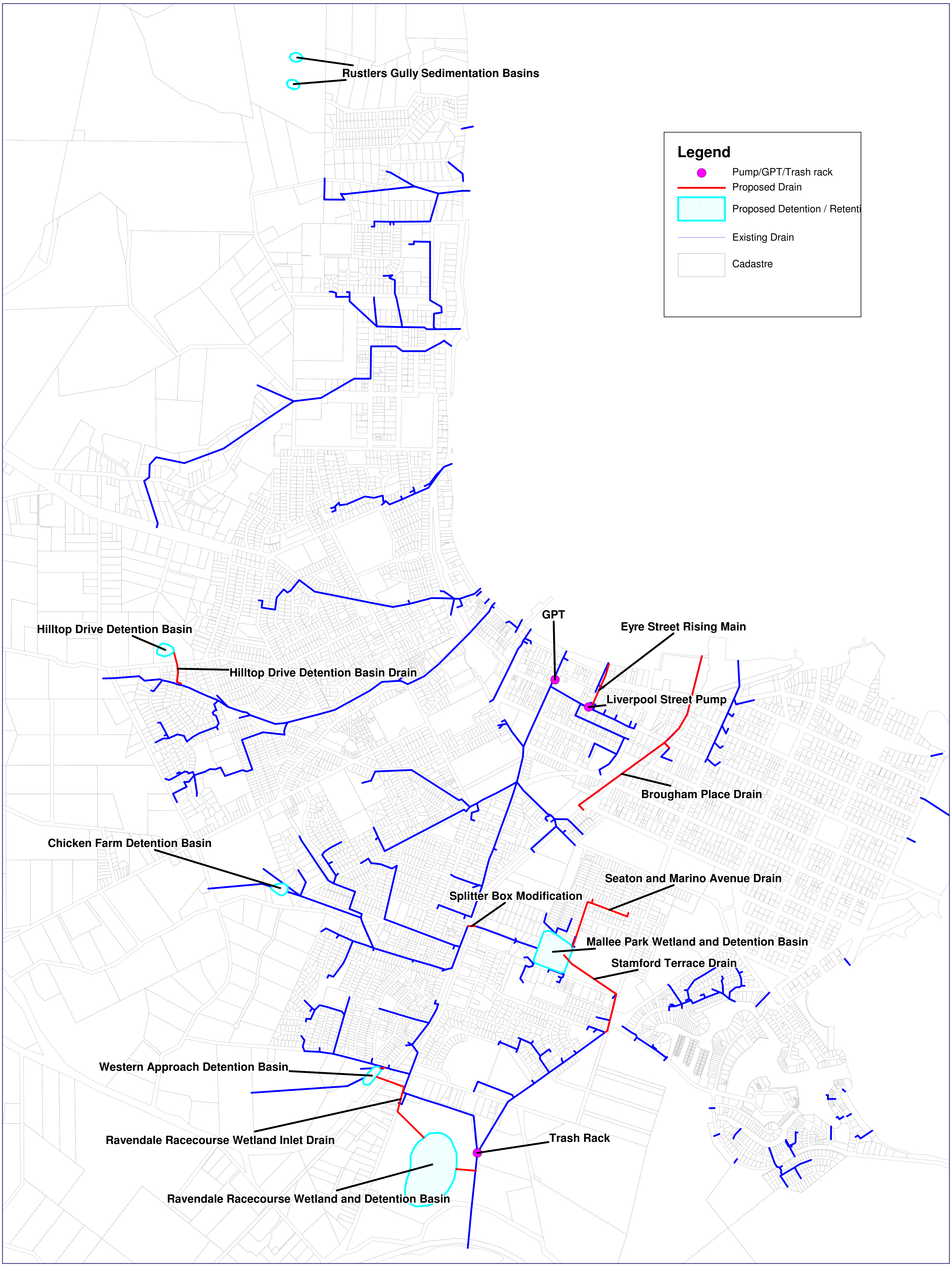
Liverpool Street Catchment

Due to the inadequate capacity of the Liverpool Street pump station, it is recommended that a second pump be installed to work in conjunction with the existing Liverpool Street pump.

The ILSAX model of the area has been modified to include all of the overland flood flow paths that drain towards the low spot at the pump station. This has enabled an estimate of the volume of flood flows that pond at the low spot to be determined. Digital terrain model (DTM) data of the low spot has been acquired enabling an estimate of the volume of storage available at the low spot to be calculated. Whilst building floor levels have not been surveyed, an indicative level has been calculated by adding 0.2m to the DTM level at the centre of each building.

Table 7.1 summarises the results of the above work and details the flood level, and estimated number of buildings that are likely to be inundated, for various ARI events. Figure 7.2 shows the 27 properties assessed to be flood prone during a 100-yr ARI flood event based on the existing pump configuration.

The assessment indicates that the existing pump station has capacity to provide a 5-yr ARI level of protection. The system can be upgraded to a 10-yr ARI standard of protection by increasing the pump station capacity to 1500L/s, or alternatively close to a 20-yr ARI level of protection if capacity is increased to 2500L/s. It would not be viable to further increase the system capacity without a significant upgrade to the pump station.



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Job Number: 2007.0307
Filename: Figure7.1.wor
Revision: F
Date: 3/10/2013
Drawn: TAK
Technical Approval: TAK

Data Acknowledgement:
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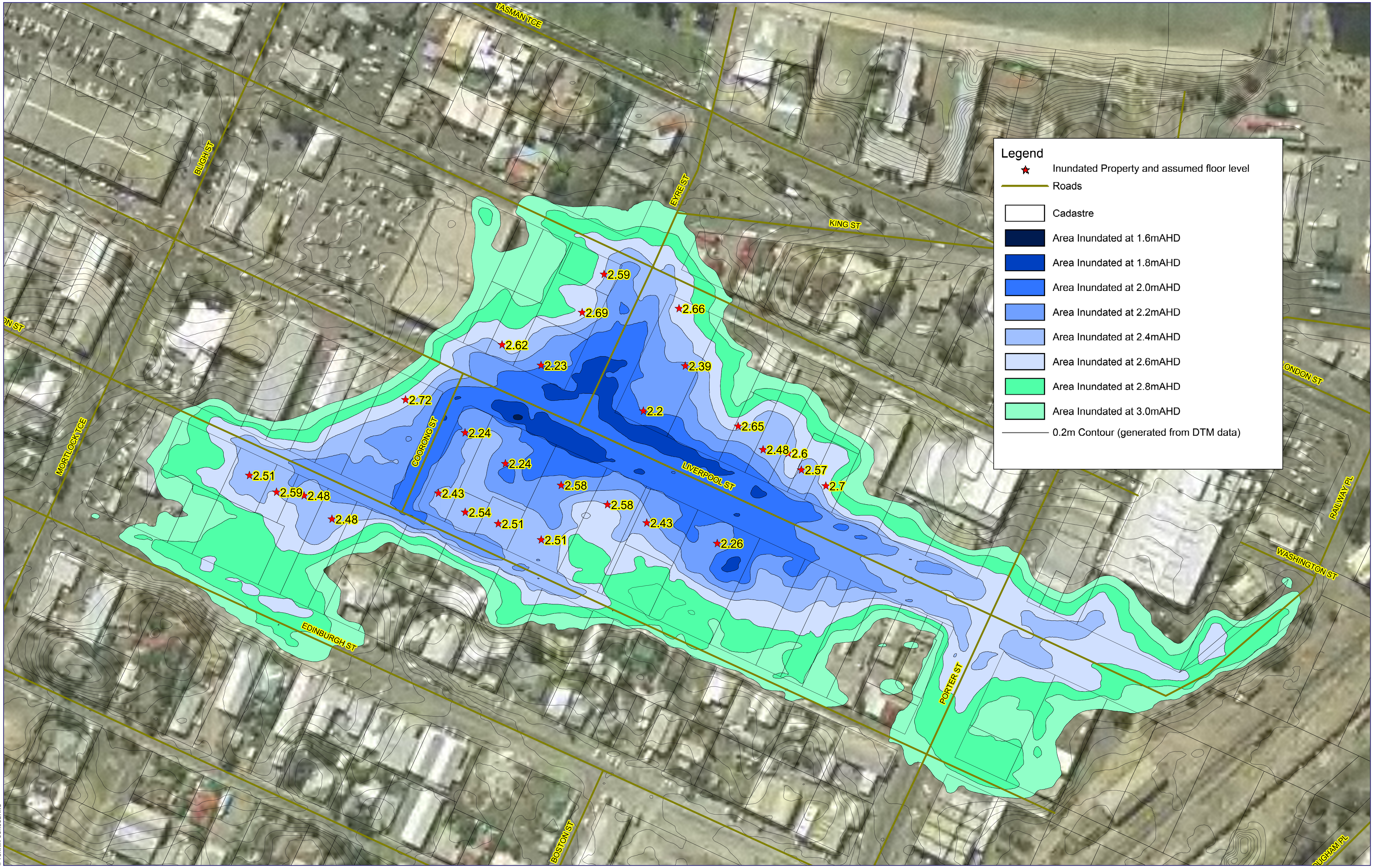
PROPOSED MAJOR WORKS

Figure 7.1



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Scale: 1:2,000 @ A3

Job Number: 2007.0307
Filename: Figure7.2.wor
Revision: F
Date: 30/10/2013
Drawn: EJ
Technical Approval: TAK

Data Acknowledgement:
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LIVERPOOL STREET PUMP STATION INUNDATION ASSESSMENT

Figure 7.2

The existing discharge point for the pump station (the Mortlock Terrace drainage system) is unlikely to have adequate capacity to take the additional flows generated from a pump station upgrade. Therefore, a new rising main (acting in parallel with the existing system) discharging down Eyre Street and directly into the ocean, would be required.

Table 7.1 Flood Inundation Levels (in meters) and Flooded Properties for Various Pump Rates (number of properties assessed to be flood prone shown in brackets)

ARI	Existing (750L/s)	1500L/s pump rate	2500L/s pump rate
2	1.948 (0)	1.792 (0)	1.715 (0)
5	2.105 (0)	1.969 (0)	1.813 (0)
10	2.265 (5)	2.144 (0)	2.008 (0)
20	2.448 (8)	2.352 (5)	2.232 (2)
50	2.623 (22)	2.536 (15)	2.432 (8)
100	2.780 (27)	2.684 (25)	2.595 (21)

It is recommended the proposed new pump system have a capacity of 750L/s with a 600mm diameter rising main. By increasing the combined pump capacity to 1500L/s, the pumps will have adequate capacity to prevent property damage in a 10-year ARI event and reduce the depth of flooding during large events by approximately 100mm. As is evident Table 7.1, further reductions are possible but the 1500L/s option appears to be an adequate balance between capital cost and flood damages.

It is recommended that drains on Liverpool Street, Napoleon Street and Coorong Street are not upgraded, although they are below 5-year ARI standard. This is to prevent excessive flows reaching the pump station too quickly. Overland flows down Liverpool Street will continue to occur, however, runoff will not pool in the low point of the pumps during a 2-year ARI event with no property damage likely for events up to the 20-year ARI event. Installation of a rising main along the entire length of Eyre Street, with an outlet next to the Yacht Club will be required to accommodate flows from the pump station.

In addition to the upgrade to the pump station it is recommended that the generator is able to operate all three existing pumps. This would therefore allow the existing pump station to operate at full capacity during a power failure. This is a key recommendation of the Liverpool Street Pump Station Report on Power Supply (Secon Consulting Engineers, 2013).

It should be noted that the above analysis in relation to the works required to upgrade the Liverpool Street pump station is only to a preliminary level based on the output of an ILSAX model. The model limitations mean that it has not accurately taken into account pipe hydraulics, catchment storage and flood flow directions. A more detailed study is recommended to further refine the recommendations outlined above. The detailed study could include further works to cover the following areas:

- Confirm that a gravity discharge option discharging directly to the ocean along Eyre Street would not be viable
- A detailed 2D flood model (refer recommendations outlined in Section 7.1.5) is constructed to better understand likely flood risks at the Liverpool Street pump station low spot
- The hydraulics of the drainage networks in the area are modelled in further detail (potentially as part of the 2D flood model which can incorporate the 1D pipe network into the model)
- Obtain floor level survey to more accurately determine flood damages based on predicted flood levels

- Undertake scenario modelling in the 2D flood model for various pump rates and also for potential modifications to the Mortlock Terrace splitter box (refer next section) to enable comparison between each scenario to be made
- Optimise the proposed upgrade solution based on a more thorough cost benefit analysis.

A concept sketch of the proposed works on Liverpool Street based on the current level of assessment is shown in Figure D.1 within Appendix D.

Mortlock Terrace South

It is recommended the splitter box be re-configured such that base flows arriving at the splitter box are directed into the Mallee Park basin. ILSAX modelling has indicated that the optimum level of base flow to be directed into the basin is 0.4m^3/s. The splitter box is to be designed such that once the 0.4m^3/s base flow is reached, a further 70% of the peak flow is to be directed into the basin. The remaining 30% is to be directed into the existing 900mm Mortlock Terrace drain. The reduction in peak flows expected in the Mortlock Terrace drain as a result of these works is shown in Table 7.2.

The table indicates the re-configured splitter box will have its largest impact, when peak flows arriving at the splitter box are less than 5m^3/s. Once peak flows become larger than 5.8m^3/s, it is expected that both the Bel-Air Drive and Mortlock Terrace systems will be at capacity, and ponding within Mortlock Terrace will occur.

Table 7.2 Mortlock Tce splitter box flows

Q approach (m^3/s)	Q Mortlock Terrace (existing) (m^3/s)	Q Mortlock Terrace (proposed) (m^3/s)	Reduction (%)
≤ 0.4	≤ 0.4	0	100
1.0	1.0	0.18	82
1.5	1.5	0.33	78
2.0	1.6	0.48	70
5.0	1.6	1.38	14
≥ 5.8	1.6	1.6 (max)	0

This new arrangement will remove a large proportion of the peak flow passing through the Mortlock Terrace drain during the short duration storm events when peak flow rates are less than 5m^3/s. These are the critical events for flooding in the Mortlock Terrace drain downstream of the splitter box, near the town centre. By reducing the flow arriving in the downstream Mortlock Terrace drain in shorter intense events the capacity is increased for the drain to accept flows from local catchments in the town centre, particularly those from the Liverpool Street pump station.

The proposed upgrade works are shown in Figure D.2 within Appendix D.

Brougham Place

Due to the inadequate size of the Brougham Place drain, and subsequent flooding within the catchment, an upgrade of the length of the drain is recommended. The existing 450mm diameter drain is to be upgraded to a 600mm drain in the upstream section of the drain (between Cardiff Street and Luke Street). The inlet drain at the southern end of the catchment on Luke Street is to be upgraded from a 300mm drain to a 450mm drain. The downstream end of the drain is to be upgraded from a 600mm to a 900mm diameter pipe. A concept sketch of the proposed works on Brougham Place is shown in Figure D.3 in Appendix D.

Seaton and Marino Avenue

In order to reduce gutter flows down Seaton Avenue, it is proposed that a new drain is constructed up the western side of the road. A section of 1050mm diameter pipe downstream of a 900mm pipe is to run in along the lower end of Seaton Avenue up to Marino Avenue. A new trunk drain is to pass along the full length of Marino Avenue ranging in size from 825mm and 600mm with laterals systems at Riversdale Avenue, Sandringham Avenue and Ravendale Road. The system will discharge into the Mallee Park Basin. A detailed design of the proposed works within Seaton Avenue and Marino Avenue is shown in Figure 2008.0344.5 sheets 1 to 6 (Rev A) in Appendix D.

Grantala Road Gully (Chicken Farm Filled Area)

Three sections of fill have been placed within the Grantala Road gully. It is recommended that a pipe with a 5-year ARI standard be installed within the two upstream sections of fill. The invert of the pipe should be set some distance above the invert of the gully to allow for some retention storage within the base of the gully and to reduce the depth of the excavation required to install the pipes. A new swale should be formed within the downstream section of site filling with the swale invert matching the gully invert.

In larger events the pipes will restrict the flow rate as water will be detained behind the areas of fill. This will reduce the peak downstream flow rates. We cannot confirm if the existing areas of fill have been engineered to act as the downstream embankment of a detention basin. This should be investigated to prevent the potentially catastrophic risk of embankment failure.

A detailed design of the proposed option is shown in Figure 2008.0344.1 sheets 1 and 2 (Rev A) in Appendix D.

Western Approach Road

A combination of refinements to the road verge drainage and new underground drains will be required to transfer flows between the Western Approach Road and downstream of Bay Road into the proposed wetland within the Ravendale Racecourse.

In order to mitigate flooding on the southern side of Western Approach Road and to accommodate the additional runoff that will be generated by the proposed development in the area, it is recommended Council take the following actions:

- Remove culverts conveying stormwater to the southern side of Western Approach Road.
- Construct an open channel along the northern side of Western Approach Road from the intersection of Barley Road to the intersection with Nootina Road within new drainage easements.
- Approximately 1 hectare of land acquisition is required at the intersection of Western Approach Road and Barley Road.
- Construct a detention basin at the intersection of the Western Approach Road and Barley Road (to manage for runoff from the new development proposed in the area – refer Section 7.1.2).
- Construct a stormwater drain from the detention basin outlet, through the industrial properties, to the existing Proper Road drain. Both the new drain and the existing Barley Road catchment outfall drain are to be diverted into the proposed Ravendale Racecourse wetland.

Removing the culvert crossings will result in all stormwater generated from the Western Approach Road catchment culminating at the intersection of Barley Road. A detention basin is required to restrict flow at the intersection to manageable levels downstream of the Western Approach Road Catchment.

A concept for the scheme is shown in Figure D.5 of Appendix D.

7.1.2 Strategy 2: Provide Detention Basins at Key Locations

This strategy involves the construction of strategically located detention basins to reduce flows in downstream drainage systems due to increased runoff from newly developed areas. Proposed size, shape and location of the following detention basins is subject to detailed design.

Areas of existing open space located within the Study Area suitable for detention are:

- Intersection of Robertson Road and Hill Top Drive
- Corner of Grantala Road and Sleaford Terrace (Former Chicken Farm)
- Corner of Western Approach Road and Barley Road
- The Ravendale Racecourse
- Mallee Park (Aboriginal Reserve)

Hilltop Drive and Robertson Road

A proposed development of 160 new residential allotments will require a detention basin to reduce peak flow into the New West Road Catchment. A detention basin with a capacity of 7,000m^3 will be required to maintain flow downstream of the Catchment at pre-development levels during a 100-year ARI event. The headwall height for this basin has been estimated to be 3m with a 900mm diameter outfall pipe.

A pipe will also be required down the length of Springfield Drive to deliver discharged stormwater into the downstream creek. A 750mm diameter pipe is recommended to connect into the 900mm outfall pipe from the Hilltop Drive detention basin. The pipe will extend from the Basin at the intersection of Hilltop Drive and Robertson Road and discharge into the existing gully downstream of Springfield Drive. Concept drawings of the proposed Hilltop Drive detention basin and Springfield Drive stormwater pipe are shown in Figure D.6 of Appendix D.

Former Chicken Farm

The former chicken farm at the intersection of Grantala Road and Nootina Road is marked for development of 220 new allotments. This region forms part of the Mortlock Terrace (north) Catchment, and a detention basin needs to be constructed in order to reduce flows through the Cronin Street Drain, and ultimately, to reduce flows through the Mortlock Terrace and Stamford Terrace Drains which are currently over capacity. The land division has been designed and includes modifications and upgrades to the existing informal basin that is currently located in the natural gully at the downstream end of the land division. The proposed works are shown on Greenhill Engineers drawing 08-328-114 in Appendix D. It includes a new engineered upstream face to the existing embankment and a new pipe through the embankment.

Western Approach Road

Development of 240 new allotments, within a 30 hectare area, is earmarked for the area north of the Western Approach Road, in the south-western region of the township. Rainfall runoff from this region will contribute to the Barley Road Catchment. In order to reduce flows to pre-development levels a detention basin of approximately 9,000m^3 is needed to be constructed, with an outfall drain diameter of 750mm. A cut off drain is also recommended on the western edge of the new development to prevent flows from the rural portion of the catchment entering the detention basin. The basin is sized to detain runoff from the area of development. The proposed Western Approach Road Detention Basin is shown in Figure D.5 of Appendix D.

Mallee Park (Aboriginal Reserve) Expansion

The Mallee Park detention basin, located in the Mortlock Terrace (south) catchment is designed to reduce flows in the Stamford Terrace drain which, in its existing state, is under capacity. To maximise the capacity of Mallee Park, the basin is to be deepened and widened. To enable the basin to freely drain after an event the existing 900mm basin outlet could be lowered or a new smaller diameter drain could be constructed at the invert of the basin.

Based on a review of the 'As Constructed' plans of the existing 900mm outfall pipe the pipe can be relayed such the basin's invert can be lowered down from the original invert of 3.2mAHD to 1.9 mAHD (and still discharge via gravity).

The new hydraulic capacity of the basin outlet was calculated, with a basin invert of 1.9 mAHD and top water level of 4.7 mAHD to be 0.96m^3/s.

Potential service clashes and groundwater conditions are to be further investigated during detailed design. Preliminary groundwater testing indicates that an invert level of 1.9mAHD may be below water table level and therefore reduce the amount of flood storage that would be available within the basin.

Survey of the existing basin area has indicated that the maximum capacity in the available Mallee Park land parcel, with an invert of 1.9mAHD, is approximately 77,300m^3. This is a significant increase from its current capacity of approximately 12,000m^3. A 5 metre buffer area was assumed from the boundary edge and the maximum side slope was 1V:5H, considered safe for ease of general maintenance.

Construction of a 400mm high bund will be required on the south-eastern edge of the basin to prevent water from flooding the nearby sports sheds on the Mallee Park Oval in the 100 year ARI event. The bund is to be raised to 5.0 mAHD, allowing for a 300 mm freeboard from the 100 year peak level within the basin.

It is recommended that a small channel at the base of the basin take frequent minor flows from all inlets to the outlet.

The reconfiguration of the splitter box will ensure that all base flows from the upstream region of Mortlock Terrace North Catchment will enter Mallee Park. It is also proposed to construct a wetland at this site (refer Section 7.2.1). Concept drawings for the proposed Mallee Park Basin works are shown in Figure D.2 of Appendix D. Council has commissioned the preliminary design of the Mallee Park basin which will enable the concept design to be refined.

Ravendale Racecourse

The proposed wetland within the Ravendale Racecourse will provide some level of detention storage such that the discharge from the wetland is in a controlled manner during a flood event. However due to the limited amount of development downstream of the wetland specific requirements for limiting downstream discharge are not considered important. The basin in shown in Figure D.5 of Appendix D.

Potential Future Upgrades

As the rural fringe of the township becomes further developed, there will be a greater need for long term upgrades to the stormwater drainage system. Strategies such as additional detention basins and stormwater drain extensions will be required to ensure long term flood protection.

A number of sites throughout the outskirts of the township have been identified as potential locations for detention basins. Deep gullies have been selected in order to maximise the basins' catchment area and reduce peak runoff rates to downstream stormwater infrastructure. The following Catchment areas have been identified as strategic locations for detention basins. Specific locations are shown in Figure 7.3.

- Shaen Street Catchment (x2)
- Mortlock Terrace North Catchment
- New West Road Catchment
- Barley Road Catchment

Discharge from these future potential basins will need to connect into the existing drainage systems. This may require the extension of existing systems.

The majority of these sites are upstream of existing areas where there is a continuous overland flood flow path to the coast. However the additional volume of runoff from the Mortlock Terrace North Catchment has the potential to impact on the proposed upgrades to the Mallee Park basin and the trapped low spots at the Le Brun Street and Liverpool Street pump stations. Therefore controls in this catchment may be required to manage the increase in volume that development will produce in the catchment. This will increase the size of the regional basin that is required compared to a conventional detention basin. The basin could be configured to empty slowly over a number of days once the potential downstream volume related flooding issues have abated. This would allow the majority of the basin's storage to be available for any future rainfall events.

Areas with the potential for future stormwater upgrades are shown in Figure 7.3.

7.1.3 Floor Level Controls

Council should look to implement floor level controls for new development in known flood prone areas. Without detailed flood modelling it is difficult to determine actual required floor levels. However careful consideration should be given to reviewing proposed floor levels for new development in these areas, particularly in trapped low spots within the Township such as at Hallett Place, Le Brun Street and at Liverpool Street. Specific preliminary information in relation to Liverpool Street site can be derived from Table 7.1 and Figure 7.2. Some consideration would also need to be made for predicted sea level rise which may impact on flood risk in some areas (refer Section 7.1.4).

7.1.4 Planning for the Potential for Sea Level Rise

The entire township discharges into the sea via various outlets. This has the long term potential to reduce the hydraulic capacity of the lower reaches of the various drainage systems. This is of particular concern in the lower lying portions of the township where the capacity of the existing systems could be reduced if large rainfall events coincide with high tides. This would include portions of the Liverpool Street, Mortlock Terrace North, Barley Road and Ravendale catchments where some portions are only 2-3m above sea level. It is recommended that the potential for these impacts should be assessed. The most appropriate method to assess these impacts would be through detailed 2D flood modelling. Interim measures could involve constructing detailed hydraulic 1D models of the outfall drains and assessing the reduction in capacity based on various downstream control levels and giving consideration to the floor levels of any future development.

Additional monitoring and maintenance may also be required to ensure any sand build up at the outlets is removed before it causes hydraulic impacts.

7.1.5 Detailed 2D Floodplain Modelling

While the majority of the catchments within Port Lincoln are steeply graded to the coast with well defined valleys a number of critical areas within the Township are low lying or relatively flat. In these areas detailed 2D flood modelling is required to enable a better understanding of the extents and depths of flooding due to various rainfall events. The model will accurately represent overland flood flows and natural storage within the catchment. The catchments that would benefit most from 2D modelling would be the low lying catchments outlined above in Section 7.1.4 as well as some of the flatter catchments which would include Mortlock Terrace South and Le Brun Street.

7.2 Water Quality Improvement

Port Lincoln consists of a town centre, which is a built-up urban area and large suburban and rural allotments and water quality improvement opportunities do not exist or are unfeasible in some parts of the catchment. However, water quality improvement should be considered where possible, and included as a requirement in new development.

7.2.1 Strategy 1: Wetlands at Strategic Sites

Mallee Park (Aboriginal Reserve) Expansion

The existing Mallee Park reserve currently only receives large volumes of flow when the capacity of the base flow pipe of the splitter box in Mortlock Terrace is exceeded. It is proposed to divert the majority of annual flows into the basin (as discussed in Section 7.1.1). Therefore the annual volume of water passing through the basin will increase significantly. The basin will also intercept low flows and the first flush, which are known to transport the majority of the annual pollutant load. The site is quite flat which makes it well suited for the construction of a wetland.

The Mallee Park site is approximately 3.8 hectares in size. This is approximately 1.2% of the upstream catchment. As a general design guide, the area required to provide a high level of water quality improvement is approximately 2% of the upstream urbanised catchment area. As the upstream catchment is only approximately 40% urbanised the 1.2% size of the site indicates that it is large enough to provide a large improvement in water quality.

Additional investigation would be required to determine the viability of a wetland at the site. This would include determining if local groundwater levels would impact on the viability of the wetland and that the excavation would not require excessive excavation through rock.

The outlet to the basin is via the Stamford Terrace drain. This discharges via an earthen channel before discharging into the ocean. Therefore the above configuration will improve the quality of water discharged into the ocean compared to the existing configuration.

The MUSIC modelling indicates that if a wetland were included in the Mallee Park Expansion area, the reduction in pollutants could be expected to be broadly as Table 7.3.

Table 7.3 Mallee Park Wetland Pollutant Reduction

	Flow (ML/yr)	Total Suspended Solids (kg/yr)	Total Phosphorus (kg/yr)	Total Nitrogen (kg/yr)	Gross Pollutants (kg/yr)
In	259	561000	122	856	8770
Out	174	164000	41	388	0
% Reduction	32.7	71	66	55	100

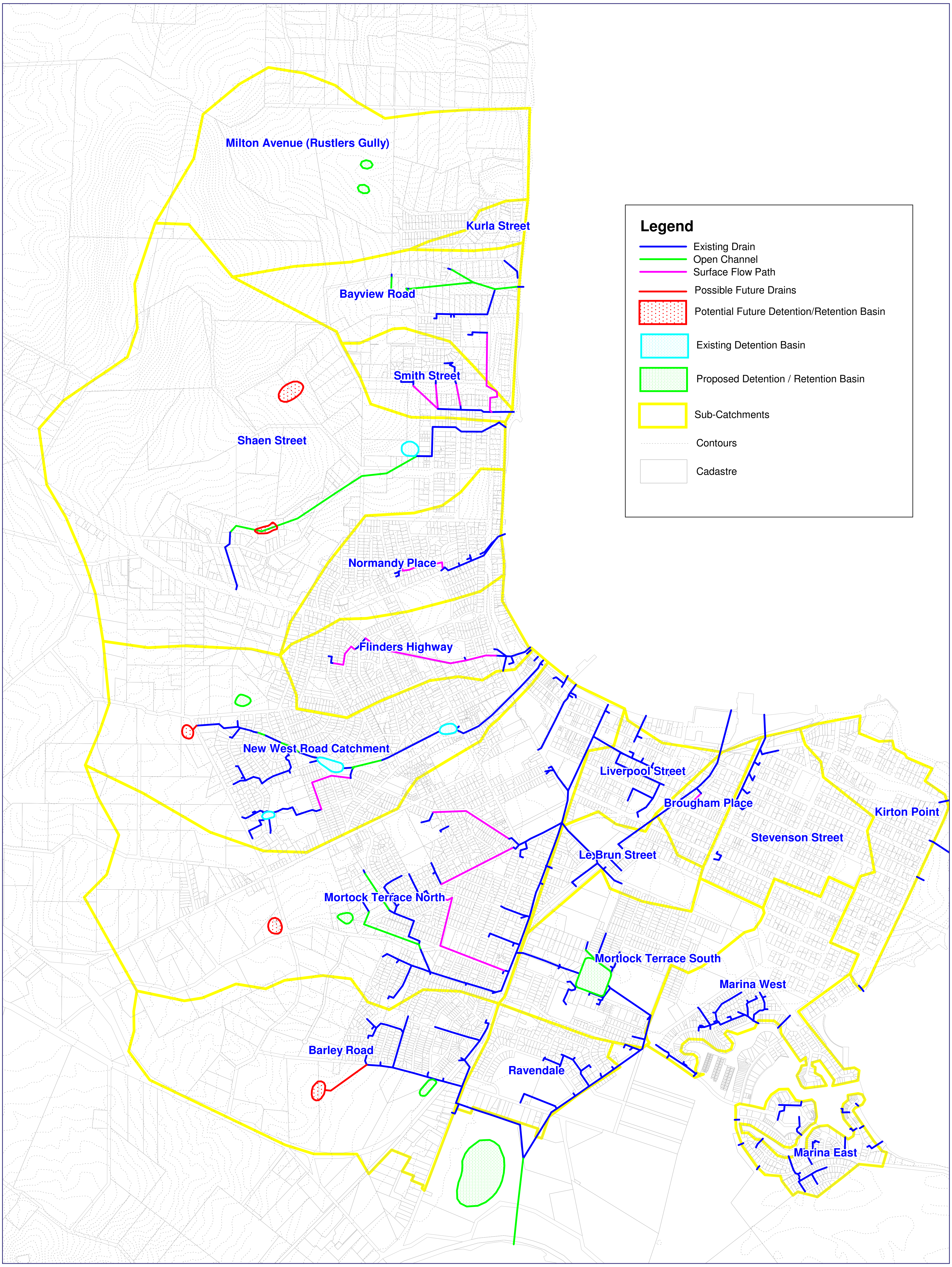
This is in line with the target values for water quality improvement, except for the percentage of nitrogen removal. This could be further refined in the detailed design stage.

Ravendale Park Racecourse

The proposed Western Approach Road scheme discussed in Section 7.1.1 will receive large volumes of stormwater from the upstream catchment. The volumes will increase due to large amounts of new development in the catchment. Therefore a wetland is proposed for the area.

Based on survey undertaken of the area, it is recommended the wetland be located in the flatter lower lying south eastern corner of the Racecourse. There is adequate space within the racecourse to ensure that the wetland is appropriately sized in comparison to the contributing catchment. There is the option to stage construction such that the wetlands increase in size as the upstream catchment becomes more developed.

Similarly to the wetland at the Mallee Park Reserve additional investigation would be required to determine the viability of a wetland at this site. This would include determining if local groundwater levels would influence the viability of the wetland and that the hard rock would not be encountered during excavation.



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Filename:	Figure7.3.wor
Revision:	F
Date:	30/10/2013
Drawn:	TAK
Technical Approval:	TAK

Data Acknowledgement:
Cadastre supplied by PBBI Australia Pty Ltd

City of Port Lincoln
Stormwater Management Plan

FUTURE DRAINAGE INFRASTRUCTURE

Figure 7.3

The MUSIC modelling indicates that if a wetland were included in the Racecourse area, the reduction in pollutants could be expected to be broadly as per Table 7.4. However, there is no shortage of open space in the racecourse area and higher pollution reduction could be achieved if economic restraints were not considered.

Table 7.4 Racecourse Wetland Pollutant Reduction

	Flow (ML/yr)	Total Suspended Solids (kg/yr)	Total Phosphorus (kg/yr)	Total Nitrogen (kg/yr)	Gross Pollutants (kg/yr)
In	276	41000	95	741	5240
Out	200	12000	34	370	0
% Reduction	27.5	71	64	50	100

Future Detention Basins

The base of the detention basins recommended for the areas of future development (refer Section 7.1.2) may be viable wetlands in some areas. However these basins are generally located in relatively steep areas of the township which would reduce the viability of wetlands at these sites. Some permanent water storage at the base of each basin would allow for some sedimentation to occur before the stormwater passes through the basins.

The modelling indicates that the inclusion of permanent water storage (sedimentation removal) in the base of the future basins as described in Section 7.1.2 would improve the pollutant removal efficiency by approximately 70% for the pollutants measured (based on the basin footprints recommended in Section 7.1.2). A breakdown of the model results is given in Appendix C.

Ephemeral Wetlands

Ephemeral wetlands could be incorporated into the base of existing detention basins at the Althorpe Avenue and Shaen Street basins (DesignFlow, 2010). These would not require any additional use of open space. Water would temporarily pond within the base of the basins that would be fully vegetated to assist in filtering the water that passes through it.

7.2.2 Strategy 2: Interception of Gross Pollutants at Strategic Sites

Wherever technically feasible and without compromising flood protection objectives, all stormwater outlets discharging to the coast should be fitted with gross pollutant traps. Gross Pollutants collection at other strategic locations (where collection at the outlet is not feasible) should also be considered.

The MUSIC modelling indicates that if Gross Pollutant Traps are correctly sized and maintained, over 95% of Gross Pollutants in the catchment can be removed. A formal plan needs to be prepared to ensure the regular maintenance of the gross pollutant traps and is discussed in more detail in Section 7.5.2.

Specific areas of Gross Pollutant collection are detailed below.

Mortlock Terrace Drain

A number of large trunk drains discharge into the high amenity areas of Boston Bay. The largest drainage network is the Mortlock Terrace Drain. This drain also services areas of the catchment that are likely to produce the highest source of gross pollutants and includes the majority of the commercial areas. A gross pollutant trap (GPT) close to the outlet of this drain would intercept a large proportion of the gross pollutants that currently discharge into Boston Bay. Due to the current limited capacity of this drainage system careful consideration would need to be given to the hydraulic losses through the GPT unit. The low invert level of the main drain may require the

GPT to be located part way upstream in the catchment where it would not be impacted by seawater intrusion.

An alternative option to installing a GPT that is recommended in the DesignFlow report is to include pit inserts into a number of key inlet pits that serve catchments that have a high gross pollutant generation potential. While these are only suited to trapping gross pollutants (as supposed to gross pollutants, sediments and free oils in a GPT) they require less up front capital expenditure and would allow areas directly adjacent to the coast to be provided with some degree of protection.

Barley Road / Ravendale Catchment

A large portion of the township discharges via an open drain into Proper Bay, downstream of the junction of the Barley Road and Ravendale catchments. A trash basket installed on this drain will intercept gross pollutants from a large proportion of the township. A concrete structure would be required such that there was a suitable structure available for the installation of the baskets.

New Marina Extension

Stormwater generated from the new marina stages is to discharge directly into the water reserve. GPT's installed at each of the new stormwater outlets will prevent the majority of gross pollutants generated from the new allotments from entering the marina environment.

7.2.3 Strategy 3: Intercept Sediment at Strategic Sites

As space is at a premium with the town centre portion of the township the only viable method of removing sediments in these areas is through the installation of proprietary gross pollutant traps or through the retrofitting of WSUD devices into existing developed areas (refer Section 7.2.4). They will have the added benefit of intercepting gross pollutants. As described in Section 7.2.2 the highest priority drains for the installation of a GPT is on the Mortlock Terrace drain. A silt trap should be installed in the vicinity of the trash basket proposed in Section 7.2.2, at the inlet to the proposed Mallee Park and Ravendale Racecourse wetlands, and at the outlets of the proposed developments in the new marina extension and the Rustlers Gully development.

The MUSIC modelling indicates that if Gross Pollutant Traps are properly sized and maintained, over 95% of sediment greater than 200 microns size can be removed in the catchment areas indicated.

7.2.4 Strategy 4: Incorporation of WSUD devices as part of the Redevelopment of open space

Redevelopment of road reserves, open spaces and other community facilities should incorporate WSUD devices that strive to meet the water quality improvement requirements for stormwater required by the Department for Water and other relevant state government agencies.

To the extent that it is technically possible and financially viable, the installation of WSUD devices such as rain gardens and vegetative buffer strips should be considered in the redevelopment of areas under the control of Council. A recent DesignFlow report (DesignFlow, 2010) indicated that rain gardens or buffer strips would be potentially viable in the following catchments and locations to improve water quality and reduce discharge volumes into the ocean:

- Marina Inlet (raingarden proposed)
- Kirton Point (buffer strip proposed)
- Brougham Place (raingarden proposed)
- Liverpool Street (downstream of new pump station outlet point) (raingarden proposed)
- Sleaford Terrace (raingarden proposed)
- New West catchment (raingarden proposed)

- Flinders Highway (raingarden proposed)
- Smith Street (buffer strip proposed)
- Existing boat ramp and car park areas (buffer strips and raingardens proposed)

Concept designs for each device can be found in the Section 8 of the DesignFlow report. The report also provides preliminary construction cost estimates.

7.2.5 Strategy 5: Manage Pollutant Point Sources

Within any urban catchment, particular activities and types of development are likely to generate higher than average pollutant loads. While it is difficult to list all potential sources within a diverse township such as the Port Lincoln, the following provides a broad identification of key land uses and activities that are likely to constitute higher than average pollutant sources:

- Car parking
- Storage yards
- Industrial land uses
- Construction sites.

An integrated approach is required to manage pollutants from these land uses and activities through implementation of the following:

- Development Plan provisions
- Education and Awareness programs
- Enforcement programs.

The various aspects of this strategy are discussed below.

Development Plan Requirements

Requirements should be incorporated into the Development Plan requiring provision and maintenance of pollutant capturing facilities in association with key types of development including:

- Car parking
- Land divisions
- Storage Yards
- Industrial land uses.

The particular pollutants targeted from these types of development should be litter, sediment, oil and grease. The development types listed above have been targeted as they are likely to be the major sources (other than road pavements) of these types of pollutants in the catchment.

The quantity of pollutants entering the drainage network should be minimised by maintaining an effective program for:

- cleaning and maintenance of gross pollutant traps
- street sweeping
- installation and regular emptying of rubbish bins, particularly in commercial precincts
- management of unpaved road verges to minimise sediment transport.

In addition, provisions requiring the implementation of effective sediment and erosion control measures during any development work should also be included, as construction activity is known to be significant generator of sediment within an urban catchment.

Education and Awareness Programs

New WSUD elements that are constructed in Port Lincoln can have an educational component associated with them through careful signposting and attractive landscaping to attract people to the area.

The Council and other relevant authorities can actively promote water quality management and educate the community on what they can do as an individual with objectives including:

- Increase local residents' awareness of stormwater pollution and catchment management issues
- Improve household practices to minimise impacts on stormwater
- Reduce the amount of gross pollutants entering the stormwater drainage system.

The education can be in a number of forms including the following:

- School programs
- Local media articles
- Letter drops
- Drain stencilling
- Fridge magnets
- Promotion of web based material

Enforcement

Legislative requirements relating to pollution of surface waters are set out in the Environment Protection Act. Enforcement of the requirements set out in the Act is carried out by authorised officers of the EPA.

Where specific requirements relating to the management of stormwater runoff from a particular development are set out in the Development Approval, these requirements are able to be enforced by Council through the Development Act.

The quantity of pollutants entering the drainage network should be minimised by maintaining enforcement programs to ensure compliance with:

- anti-littering laws
- codes of practice for building sites and the construction industry
- responsible chemical use.

7.2.6 Strategy 7: Monitoring for Non-Stormwater Discharges

Monitoring for non-stormwater related discharges should be undertaken to prevent further degradation of water quality and to locate the source of any contamination within the catchments. Gross pollutants, construction sites and septic tanks are the most likely sources of non-stormwater discharges.

Monitoring for high pollutant and nutrient loads at key locations such as detention basins, wetlands and outlet points will give a good indicator if non-stormwater discharges are occurring within the catchment. Septic tanks throughout the catchment should be periodically monitored to ensure effluent is not entering the stormwater system.

7.2.7 Strategy 8: Manage Coastal Discharge Points

Stormwater discharge points along the coastline of the township may cause erosion and cause impacts on the coastal environment. The DesignFlow report recommends a number of actions to manage this erosion risk including, where possible, the incorporation of WSUD measure in the catchments to reduce the volume, frequency and energy of the coastal flows. In other areas where WSUD measures are not viable physical works, such as rock reinforcement or soil stabilisation to manage the erosion risk are recommended.

7.3 Water Use

The Eyre Peninsula NRM Board's has set out a number of strategic priority areas for towns and cities in the peninsula (EPNRMB, 2009) which includes a strategy to maximise the use of stormwater. Opportunities exist for capture and beneficial reuse of runoff. These options include:

- ASR Systems
- Rainwater tanks
- Rain gardens and other WSUD techniques where they supplement landscape plantings, for example street trees
- Capture and reuse for irrigation of large open spaces.

It should be noted that there are synergies between objectives for reuse and water quality, for example water quality strategy 4 which is to implement WSUD devices for water quality improvements for road runoff in the development of open space will also provide water for landscape improvement.

Similarly, there are synergies with flood management objectives to enable water reuse through retention and detention.

7.3.1 Strategy 1: Implement Aquifer Storage and Recovery Schemes

Provision of a wetland within the potential detention basin sites would provide an opportunity for implementation of an aquifer storage and recovery (ASR) scheme at each site. This recharge scheme could be used to replenish the aquifers in the catchment and allow for the reuse of the water for irrigation of parks and gardens.

The major wetlands proposed for the Study Area are within the Mallee Park Reserve and the Ravendale Racecourse (refer Section 7.1.2). Due to the steep topography of the detention basins proposed for the new subdivisions, wetland cannot be easily incorporated into their design.

Mallee Park ASR

Given the large developed area upstream of the site there is the potential to harvest large volumes of water at this site. The estimated annual flow through the wetland (once the splitter box is modified to direct the majority of annual flows through the basin) is estimated to be 250 ML per year based on 450mm/year yield from impervious areas and 30mm/year from pervious areas. Provided the site is suitable for ASR and 25% of annual flows are treated and captured, 65ML of water can be harvested each year. If ASR is not viable, the wetland is still likely to be able to provide some water harvested directly from it. However the annual volume will be significantly smaller than through ASR.

Ravendale Racecourse ASR

The amount of water that could be harvested will increase with time as the catchment becomes more developed. Current annual flow volumes are estimated to be equivalent to 85ML a year but could potentially increase to 290ML per year with full development of the catchment (based on 450mm/year yield from impervious areas). As a result potential annual yields could increase from approximately 20ML/year currently up to 75ML/year, provided ASR is viable at the site and assuming 25% of flows are harvested.

7.3.2 Strategy 2: On-Site Use of Stormwater

The existing Development Plan encourages the on-site use of stormwater runoff through the use of rainwater tanks. Rainwater tanks can reduce the total demand for mains water if water from the tanks is used for toilet flushing, laundry, shower or the household hot water system. Rainwater tanks used in this way can have an impact on minor flows (less than 5 year ARI) in the downstream drainage system. They will also reduce the total volume of stormwater discharged from allotments and as a result are likely to have some effect in reducing the impact of stormwater on the downstream receiving environment.

The installation of 1kL tanks to all new dwellings is now compulsory. These tanks are required to be plumbed into the house and supply, as a minimum, the toilet, laundry or hot water system and drain at least $50m^2$ of roof area.

This should be considered a minimum and Council should consider requiring new development to connect larger proportions of new dwellings into tanks and increasing the size of the tanks. Modelling undertaken for the Murray-Darling Basin Natural Resources Management Board for areas of similar rainfall as Port Lincoln recommend tanks of between 9 to 13kL in size such that they are able to supply the majority of in-house non-potable demand (toilets, laundry and shower) provided it is connected to at least $150m^2$ of roof area.

The relatively high rainfall at Port Lincoln (500mm/year) results in relatively high yields from rainwater tanks.

As a result, a continuation of the current policy of encouraging installation of tanks, particularly if they are larger than the legislated minimum size, is considered to be appropriate.

7.3.3 Strategy 3: Development of Open Space

The Councils should consider WSUD techniques as part of the redevelopment of open spaces and community facilities. These should be assessed on a project-by-project basis with specific options outlined in Section 7.2.4.

7.4 Amenity, Recreation & Environmental Enhancement

7.4.1 Strategy 1: Utilisation of Open Space

Where opportunities exist for the establishment of wetland or detention systems or other WSUD elements, biodiversity, improved amenity, access for education and recreation as well as provision of habitat for fauna should be considered in the design.

This should be considered for the proposed Mallee Park and Ravendale Racecourse wetlands system, as part of the proposed detention basins for the new subdivisions and also as part of the other various WSUD elements proposed as part of Section 7.2.

7.4.2 Strategy 2: Water Sensitive Urban Design

The adoption of Water Sensitive Urban Design (WSUD) principles will improve amenity while also providing environmental enhancement.

To reduce both the peak and volume of discharge there is the opportunity to implement elements of WSUD into either new or reconstructed roadways.

Elements of WSUD include:

- Swale drains

  These are shallow grassed lined channels that can reduce the velocity of stormwater flows and also improve the quality of the stormwater and improve visual amenity.

- Cross-fall design

  One way cross fall on roads ensures that the entire pavement surface is able to freely drain to an adjacent swale drain.

- Infiltration devices

  Swales or small basins can be lined with highly permeable material to encourage the infiltration of stormwater into the soil. Where space permits, small localised basins can increase the rate of recharge. Infiltration will reduce both the peak flow and the volume of stormwater discharge.

The elements outlined above could also be landscaped and used to enhance the overall streetscape.

It is considered that the continued implementation of the above is warranted in the township area of Port Lincoln, particularly in the areas of new development with a number of specific examples outlined in the 2010 DesignFlow report and summarised in Section 7.2 of this report.

7.4.3 Strategy 3: Retention of Existing Natural Gullies

Existing natural gullies and watercourses throughout the township should be protected from further filling and development. Replacing existing watercourses with stormwater pipes and filling within gullies may lead to future drainage problems and cause an added flood risk to private property. Retaining natural gullies will maintain the local amenity, provide green corridors, increase biodiversity and improve water quality.

Rustlers Gully

Increased impervious surface area from the new development draining into the gully will result in an increased frequency of flow through the gully. Monitoring of the gully for erosion is therefore recommended. The effects of increased flow frequency may require the planting of vegetation through the gully and the possible construction of rock weirs.

For water quality purposes, GPT's should be installed at the outlets from the new development into Rustlers Gully. Small detention basins should also be installed to further improve water quality.

7.5 Asset Management

7.5.1 Strategy 1: Assess Condition of Existing Infrastructure

As part of this project Council will be provided with a GIS copy of its drainage assets. Additional data, such as drain age, can be added to this data. This will allow a plan to be developed which indicates the construction date of the various drainage assets. This would allow for an assessment to be made as to which drains within the Council area are the oldest.

Detailed site inspections involving CCTV and physical inspection by structural engineers will enable an estimation of the residual design life for various section of the drainage system to be made. Priority should be given to inspecting drains that have at least two or three of the characteristics described in Table 7.5.

Table 7.5 CCTV Inspection Priority

Drain Characteristic	Discussion
Large drain size (larger than 750mm diameter)	Large drains comprise the largest component of Council's drainage assets and the unplanned replacement of a section of large drain would have a large impact on Council's financial resources.
Old drain (more than 30 years old)	The older the drain the more likely that it will be nearing the end of its design life.
Prominent location	Some drains are located in prominent locations such as the centre of the business district. Should these drains fail it would result in major traffic disruptions (if the area was no longer trafficable) and the potential for flood damages is highest.

Based on the outcomes of these investigations, future works can be prioritised to ensure that the drainage system is replaced prior to the end of its design life. If replacement works are deemed necessary, a hydrological and hydraulic assessment of the system should be made to determine if the replacement system should be enlarged to meet the drainage standard objectives outlined within Section 6.3.1.

Money should be set aside to initially prioritise which drains should be inspected and then recurring funding should be made available to undertake CCTV inspections of the drainage assets.

7.5.2 Develop an Asset Maintenance Plan

A number of recommendations of this plan include infrastructure that will require regular maintenance to ensure that it will continue to function as intended. It is recommended to develop a maintenance plan to cover the long term management of the Council's drainage assets. It would need to include the following key areas:

- The location and description of the asset
- The likely frequency (or event trigger such as a heavy rainfall event) that maintenance will be required
- The type of maintenance that will be required (e.g removal of silt, weeding, etc.)

Council will also need to allow for adequate resourcing and budgets to maintain the infrastructure.

8 Priorities and Responsibilities

A number of strategies to meet the objectives detailed in Section 6 have been developed. This section prioritises the strategies that best meet the objectives in an economic manner. They are discussed below and are shown in Table 8.1. This table outlines the estimated cost of each strategy. More detailed cost estimate breakdowns are shown in Appendix E. Benefits have been quantified, based on the work done to date.

A 10-year capital works program has been developed. This is shown in Table 8.2 and is based on an average capital expenditure (by Council) on stormwater infrastructure of approximately $150,000 – $300,000 per year. Based on estimated costs only four of the five high priority works projects can be completed over the next 10 years. Therefore only some of the items shown in Table 8.1 are shown in Table 8.2.

The subtotal row of Table 8.2 shows the total expenditure each year while the total expenditure (bottom row of the table) shows the total expenditure if SMA funding is granted for the eligible projects. If SMA funding is not obtained it will delay the implementation of the capital works program unless additional capital is provided by Council.

8.1 High Priority Works

8.1.1 Seaton Avenue Drain

The Seaton Avenue drain is known to be under capacity with large surface flows and a known flood risk to properties in the catchment. The proposed works along Seaton Avenue to the intersection with Marino Drive are considered high priority. This drain will reduce the risk of flooding on the western side of Seaton Avenue, providing added protection to approximately 20 allotments.

Actions required to implement this priority are:

- site inspections to determine the most viable drainage alignment
- obtain survey of the drainage alignment
- depth services to quantify any service clashes
- refine drain hydrology and hydraulics to finalise drain sizing
- finalise horizontal and vertical alignment
- refine construction costs
- document the detailed design of the drain and associated works

8.1.2 Mallee Park Basin Scheme

The Mallee Park Basin is considered to be high priority work as it meets a number of stormwater management objectives.

Firstly the basin will help to reduce the peak flows at the bottom end of the Mortlock Terrace System and will reduce the potential for surface flood flows to arrive at the low spot at the Liverpool Street pump station. The new outlet into the Marina will also reduce the loading on the Stamford Terrace drain. The amount of detention storage at the site can be increased significantly such that the size of the outfall pipe is at a realistic scale while still providing a satisfactory drainage standard.

Incorporation of wetlands into the base of the detention basin has a number of added benefits. This includes a large increase in water quality and the potential for moderate to high levels of water harvesting (depending on the viability of an ASR scheme).

The basin and wetland could potentially be turned into an attractive landscape feature and make more use out of this currently underutilised section of open space.

Actions required to implement this priority are:

- assess the viability of ASR
- wetland configuration design
- hydraulic modelling of flows through the wetland for both base flow and flood flow conditions
- water balance and yield modelling
- develop a landscaping plan
- water quality modelling
- refine construction costs
- document the detailed design of the wetland and associated works.

8.1.3 Liverpool Street Pump Station

The Liverpool Street pump station is known to be well under capacity with deep flooding being reported within a central part of the township. The proposed works are to partially intercept a large portion of the flows that currently arrive at the pump station with the construction of a new pump station adjacent to the existing system. The new rising main will pass down Eyre Street. This will reduce the loading on the bottom of the Mortlock Terrace drain while reducing flood risk at the trapped low spot at the pump station. An upgrade to the new generator will also allow the existing pump station to operate at full capacity during a power failure.

Actions required to implement this priority are:

- Additional detailed modelling to optimise the proposed design solution
- site inspections to determine the most viable drainage alignment
- obtain survey of the drainage alignment
- depth services to quantify any service clashes
- refine drain hydrology and hydraulics to finalise rising main and pump sizing (assuming a gravity discharge option will not be viable)
- finalise horizontal and vertical alignment of outfall
- refine construction costs
- document the detailed design of the pump, rising main and associated works

8.1.4 Western Approach Road Drain Upgrade

The works proposed in the vicinity of the Western Approach Road will help to mitigate the existing flooding problems within the Western Approach Road / Pine Freezers Road precinct. The new infrastructure will also help to provide an outlet for new development that is proposed in the area and potentially work well in conjunction with the option of constructing a wetland within the Ravendale Racecourse.

Actions required to implement this priority are:

- site inspections to determine the most viable drainage alignment
- obtain survey of the drainage alignment and basin location
- depth services to quantify any service clashes
- refine drain hydrology and hydraulics to finalise basin and gravity main sizing

- finalise horizontal and vertical alignment of new drain
- refine construction costs
- document the detailed design of the drains, basins and associated works

8.1.5 2D Flood Plain Mapping

2D flood plain mapping of the lower lying or flatter catchments in the township would allow for an improved degree of understanding of flood risk for these areas and provide an improved assessment of setting works priorities. Some of the above recommended works could be modelled to gain a better understanding of the benefits of the works and allow for a refinement of the proposed works. Flood plain mapping would also allow for the potential for sea level rise impacts to be assessed and allow for an improved cost-benefit assessment of works to be undertaken. It would also allow the impacts of future development to be assessed.

8.2 Medium Priority Works

8.2.1 Hallett Place Drain Upgrade

The Brougham Place drain upgrade is a medium priority, with relatively few properties at risk of flood damage. The drain upgrade will prevent the frequency and extent of water ponding in the low spot in Hallett Place.

8.2.2 Detention Basins for Future Development

Detention basins are to be constructed in four areas of future development in order to reduce peak flows caused by increased runoff. They will reduce flood risk downstream of the developments and reduce the likelihood of any property damage. The construction of the basins is to be an ongoing process to be built in conjunction with the new developments. They are designed with a capacity for a 100-year ARI event.

8.2.3 Brougham Place Drain Upgrade

The Brougham Place drain upgrade is a medium priority, with relatively few properties at risk of flood damage. The drain upgrade will prevent the frequency and extent of water ponding in Brougham Place.

8.2.4 Ravendale Racecourse Wetlands

The Ravendale Racecourse Wetlands have the potential to improve the quality of discharge into Proper Bay and provide the opportunity for water harvesting. However given the location at the downstream end of the catchment the wetlands would provide little flood protection benefit. Further design development is required to confirm the viability of ASR at the site to determine groundwater levels.

8.2.5 Marino Avenue

An extension of the Seaton Avenue drain along Marino Avenue is a medium priority due to the relatively low risk of many properties sustaining flood damage. Installation of the drain will provide properties in the area added protection against flood damage.

8.2.6 CCTV Inspection Program

Money should be set aside to develop a plan showing the current age of Council drainage assets. Recurring money should then be spent on CCTV inspections of drains that are considered a high priority for inspection based on Table 6.1.

8.2.7 Grantala Road Gully (Chicken Farm Filled Area)

The Chicken Farm pipe is a medium priority as it has the potential to damage a moderate number of properties. Installation of this drain will ensure flood risk in the Chicken Farm locality is minimised due to filling of the gully and the downstream pipe on Grantala Road is used to its designed capacity.

8.2.8 Installation of Stormwater Quality Improvement Devices

A number of opportunities exist for installing stormwater quality improvement devices at the outlet to a number of the main drains before they discharge into the ocean. The largest improvement would be from installing a proprietary gross pollutant trap near the Mortlock Terrace drain outlet and a set of trash racks downstream of the junction of the Barley Road and Ravendale catchments. These will treat the majority of the commercial and industrial areas of the township which have the highest pollutant generation potential.

8.2.9 Installation of Water Sensitive Urban Design Devices

A number of WSUD opportunities exist at various locations throughout the township such as the installation of filter strips and rain gardens, as outlined in Section 7.2.4. Installation of these devices should be undertaken as opportunities arise (such as during a road resurfacing project) and as funding become available.

8.2.10 Develop a Maintenance Plan

Once some more infrastructure has been constructed that requires more regular maintenance (such as wetlands, raingardens or GPTs) a formal maintenance plan should be put together to ensure that the assets are able to continue to function as originally intended. Council would need to allow for a recurring maintenance budget and allocate adequate resources to maintain the infrastructure.

8.3 Funding Opportunities

Stormwater Management Authority

The main stormwater related funding opportunity is with the Stormwater Management Authority (SMA). They will potentially fund schemes that provide a wide range of benefits including reduced flood risk, improvements in water quality and water reuse. They will not fund projects that only have water quality and reuse benefits. The SMA only has a limited amount of funding each year and assesses projects with prime regard to the level of quantified benefits for the cost.

Eyre Peninsula NRM Board

The Eyre Peninsula NRM Board has funding that can be used to help support measures that will improve the quality of water within Port Lincoln or increase stormwater reuse. They could potentially help to co-fund some of the recommended works as part of the SMP or provide in kind support.

Developer Contribution

As part of any future development of new subdivisions, Council should add a condition of development requiring the developer to provide on-site detention sized to Council specifications.

8.4 Responsibilities

The City of Port Lincoln will be primarily responsible for implementing the recommendations of the SMP. They will typically be required to provide the majority of the funding for the projects with the potential assistance as outlined in Section 8.3. They can also call upon the assistance of the Eyre Peninsula NRM Board and other government agencies such as the EPA or DEWNR.

Table 8.1 Summary of Priority Works

Priority	Project/ Activity Title	Capital Cost ($)	SMA / NRMB Funding eligible	Reference Document No	Recurrent Cost ($ / annum)	Flood Mitigation Benefit		Water Harvesting Benefit		Water Quality Benefit		Other Benefits	
						Measure used?	Quantification or Description of Benefit	Measure used?	Quantification or Description of Benefit	Rating	Qualitative Description of Benefit	Rating	Qualitative Description of Benefit
						(D) – AAD Reduction (P) – Properties Affected (Q) – Qualitative		(V) Volumetric (Q) Qualitative		(H) – High (M) – Med (L) - Low		(H) – High (M) – Med (L) – Low	
High	Seaton Avenue	$500,000	No	–	–	P	Reduce the extent and frequency of flooding of properties in Seaton Avenue. Approximately 15–20 properties affected	n/a		n/a		n/a	
High	Mallee Park basin scheme #	$1,675,000	Yes (SMA & NRMB)		$10,000	Q	Reduce the peak flow and potential surface flood flows into other catchments. Improve the standard of downstream drains. Larger drains reduce the frequency and risk of flooding.	V	65,000kL/year if ASR scheme is viable	H	Provides improvements in water quality through sedimentation and biofiltration.	M	Improve the amenities of the area and provides habitat.
Medium/ High	Liverpool Street pump station #	$610,000	No*	–	$8,000	P	Reduce the frequency of pooling of stormwater in the low point in Liverpool Street and reducing the risk of flooding in the commercial district for up to 25–30 properties.	n/a		n/a		n/a	
High/ Medium	Western Approach Road basin and outlet pipes #	$1,210,000	Yes (SMA)	–	–	P	Reduce frequency of flooding through private property south of Western Approach Road.	n/a		L	Silt traps at base of basins would remove a portion of the sediment from the stormwater	L	Landscaping of the basins would improve amenity
High/ Medium	2D Flood Plain Mapping of Key areas	$120,000	Yes (SMA)	-	-	Q	Will allow a better understanding of flood risk and allow for a better prioritisation of works to be made.	n/a		n/a		n/a	
Medium	Detention basins for future development	Variable. Likely to be developer funded.	Variable	–	–	Q	Reduce the peak flow and flood risk of properties downstream of the basin.	n/a		L	Silt traps at base of basins would remove a portion of the sediment from the stormwater	L	Landscaping of the basins would improve amenity
Medium	Hallett Place	$220,000	Yes (SMA)	–	–	Q	Reduce flooding experienced regularly at the trapped low spot in Hallett Place. 2–3 properties regularly affected.	n/a		n/a			
Medium	Ravendale Racecourse Wetlands	$1,560,000	Yes (SMA / NRMB)						20,000kL/year if ASR scheme is viable (currently). Up to 75,000kL/year if the	H	Provides improvements in water quality through sedimentation and	M	Improve the amenities of the area and provides habitat.

Priority	Project/ Activity Title	Capital Cost ($)	SMA / NRMB Funding eligible	Reference Document No	Recurrent Cost ($ / annum)	Flood Mitigation Benefit		Water Harvesting Benefit		Water Quality Benefit		Other Benefits	
						Measure used?	Quantification or Description of Benefit	Measure used?	Quantification or Description of Benefit	Rating	Qualitative Description of Benefit	Rating	Qualitative Description of Benefit
						(D) – AAD Reduction (P) – Properties Affected (Q) – Qualitative		(V) Volumetric (Q) Qualitative		(H) – High (M) – Med (L) - Low		(H) – High (M) – Med (L) – Low	
									catchment becomes fully developed		biofiltration.		
Medium	Marino Avenue	$480,000	No	–	–	P	Reduce the extent and frequency of flooding of properties in Marino Avenue. Approximately 10–15 properties affected.	n/a		n/a		n/a	
Medium	Brougham Place	$1,110,000	Yes (SMA)	–		Q	Reduce both the extent and frequency of flooding of residential and industrial properties on Brougham Place, Luke Street and the rail yards.	n/a		n/a		n/a	
Medium	Grantala Gully Works	$350,000	Yes (SMA)	–	–	Q	Formalises the capacity through the gully where large amounts of fill have blocked the original flow path	n/a		L	Silt traps at base of gully would remove a portion of the sediment from the stormwater	n/a	
Medium	CCTV Inspection Programme		No	–	$10,000	Q	Ensures drains are replaced before they fail and subsequently cause an unexpected flood risk.	n/a		n/a		L	Prevent potential disruption in the event of pipe failure and prevent unexpected costs incurred on council to repair drains which have failed.
Medium	WSUD installations	Various, refer DesignFlow (2010) report	Yes (NRMB)	DesignFlow (2010)	Various	Q	Assist in reducing peak flows by retaining water within the catchment.	Q	Will potentially allow for the passive irrigation of landscaped areas.	H	If adequately sized and maintained can provide significant water quality improvements	M	Improve aesthetics of an area.
Medium	Mortlock Terrace GPT	$189,000	Yes (NRMB)	–	$5,000	n/a		n/a		M	Removes gross pollutants, free oils and silt before discharging into Boston Bay	n/a	
Medium	Barley Terrace/ Ravendale Catchment silt basin and trash rack	$75,000	Yes (MRMB)		$3,000	n/a		n/a		M	Removes gross pollutants and silt before discharging into Proper Bay	n/a	

						Flood Mitigation Benefit		Water Harvesting Benefit		Water Quality Benefit		Other Benefits	
Priority	Project/ Activity Title	Capital Cost ($)	SMA / NRMB Funding eligible	Reference Document No	Recurrent Cost ($ / annum)	Measure used?	Quantification or Description of Benefit	Measure used?	Quantification or Description of Benefit	Rating	Qualitative Description of Benefit	Rating	Qualitative Description of Benefit
						(D) – AAD Reduction (P) – Properties Affected (Q) – Qualitative		(V) Volumetric (Q) Qualitative		(H) – High (M) – Med (L) - Low		(H) – High (M) – Med (L) – Low	
Medium	Onsite rain water tanks	–	No	–	–	Q	Provides onsite retention of stormwater and provides a slight reduction in downstream flood risk.	V	Provides water for personal use, drinking, gardening, etc. Estimated to be 50kL/year	n/a		n/a	
Medium	Asset Maintenance Plan	$20,000	No		-	n/a		Q	Will ensure that any harvesting scheme will be able to operate close to maximum capacity	Q	Will ensure that water quality improvement infrastructure is able to continue to provide water quality improvements	Q	Will ensure that the aesthetics of WSUD elements is maintained.

* Pump Station likely to receive overland flood flows from a much larger catchment which may make it eligible.

Includes preliminary design stages prior to capital works commencing.

Table 8.2 10-year Capital Works Plan

Priority	Task	2013–14	2014–15	2015–16	2016–17	2017–18	2018–19	2019–20	2020–21	2021–22	2022–23
1	Seaton Avenue Drain	$400,000									
2	Mallee Park scheme preliminary design study	$45,000									
3	Mallee Park scheme detailed design		$50,000								
4	Mallee Park basin scheme **			$520,000	$540,000	$520,000	$10,000	$10,000	$10,000	$10,000	$10,000
5	Western Approach Road Capital Works preliminary design study		$30,000								
6	2D Floodplain Mapping		$120,000								
7	Liverpool Pump Station upgrade optimisation study		$50,000								
8	Liverpool Pump Station Upgrade **						$280,000	$280,000	$8,000	$8,000	$8,000
9	Western Approach Road drainage works **								$250,000	$250,000	$250,000
10	CCTV		$20,000			$10,000		$10,000		$10,000	
	SUBTOTAL (ex GST)	$445,000	$270,000	$520,000	$540,000	$530,000		$300,000	$268,000	$278,000	$268,000
	Less Stormwater Management Authority (SMA) Funding *		$100,000	$260,000	$270,000	$260,000			$125,000	$125,000	$125,000
	TOTAL (ex GST)	**$445,000**	**$170,000**	**$260,000**	**$270,000**	**$270,000**	**$290,000**	**$300,000**	**$143,000**	**$153,000**	**$143,000**

* SMA funding subject to relevant approvals.

** Capital costs subject to outcomes of preliminary design study / optimisation study.

9 Consultation

9.1 Summary of Consultation

As part of the preparation of this Stormwater Management a number of bodies have been consulted. This has included the following:

- Initial comments on the SMP were provided by David Kemp (Principal Hydrologist, Department of Planning, Transport and Infrastructure) in letter format dated 30 January 2009. These comments were subsequently superseded within the attachment to an email sent by Bill Lipp on 16/1/12 which reviewed revision B of the plan. It provided a number of comments outlining additional work that would be required to ensure that the SMP would comply with the Stormwater Management Plan checklist. A fee offer was subsequently sent through and approved by the City of Port Lincoln to undertake the additional work that has now been incorporated into the SMP.
- Martin Fidge provided thorough commentary on the revision D of the plan in September 2013. A number of changes were made to the plan following his comments.
- The Eyre Peninsula Natural Resources Management Board provided comments on Revision A of the plan in a letter dated 29/5/2008. A number of the items were incorporated into a revised copy of the plan. They subsequently provided additional commentary on the revision D of the plan in September 2013 which results in further material being included into the plan
- The City of Port Lincoln has provided responses on revisions A, B and C of the SMP. The majority of these comments have been incorporated into the revised SMP. Revision D of the plan has been submitted to the elected members and received Council endorsement in August 2013.
- Ruth Ward of the EPA provided commentary on revision D of the plan in September 2013. Her comments were taken on board with a number of revisions incorporated in a revised copy of the plan.

10 Summary

A thorough review of the existing stormwater system of the City of Port Lincoln has been made. All aspects have been reviewed including existing infrastructure, known flood prone areas and where future development will place additional pressure on existing drainage assets.

A number of stormwater management objectives have been tailored to the City of Port Lincoln covering the main areas of flood risk, water quality, water re-use, asset management and environment and amenity.

A number of strategies have been developed to meet the various objectives. These have been prioritised based on the range of benefits derived. Each of the key recommendations to meet the goals is listed below. Each item is listed in descending order of priority under each heading.

Goal 1: Flood Management

- Seaton Avenue drain
- Mallee Park Basin
- Liverpool Street pump station and generator upgrade
- Western Approach Road drainage upgrade
- 2D floodplain modelling
- Hallett Place drain
- Marino Avenue drain
- Brougham Place stormwater upgrade
- Grantala Gully works
- Detention basins within new subdivisions

Goal 2: Water Quality Improvement

- Mallee Park Basin
- Ravendale Racecourse Wetland
- Mortlock Terrace GPT
- Barley Road/ Ravendale Catchment trash baskets and silt basin
- WSUD devices at various locations

Goal 3: Water Use

- Mallee Park Basin
- Ravendale Racecourse Wetland
- Increasing rainwater tank size requirements

Goal 4: Amenity, Recreation & Environmental Enhancement

- Mallee Park Basin
- WSUD for new development
- Retain and upgrade existing natural gullies/watercourses

Goal 5: Asset Management

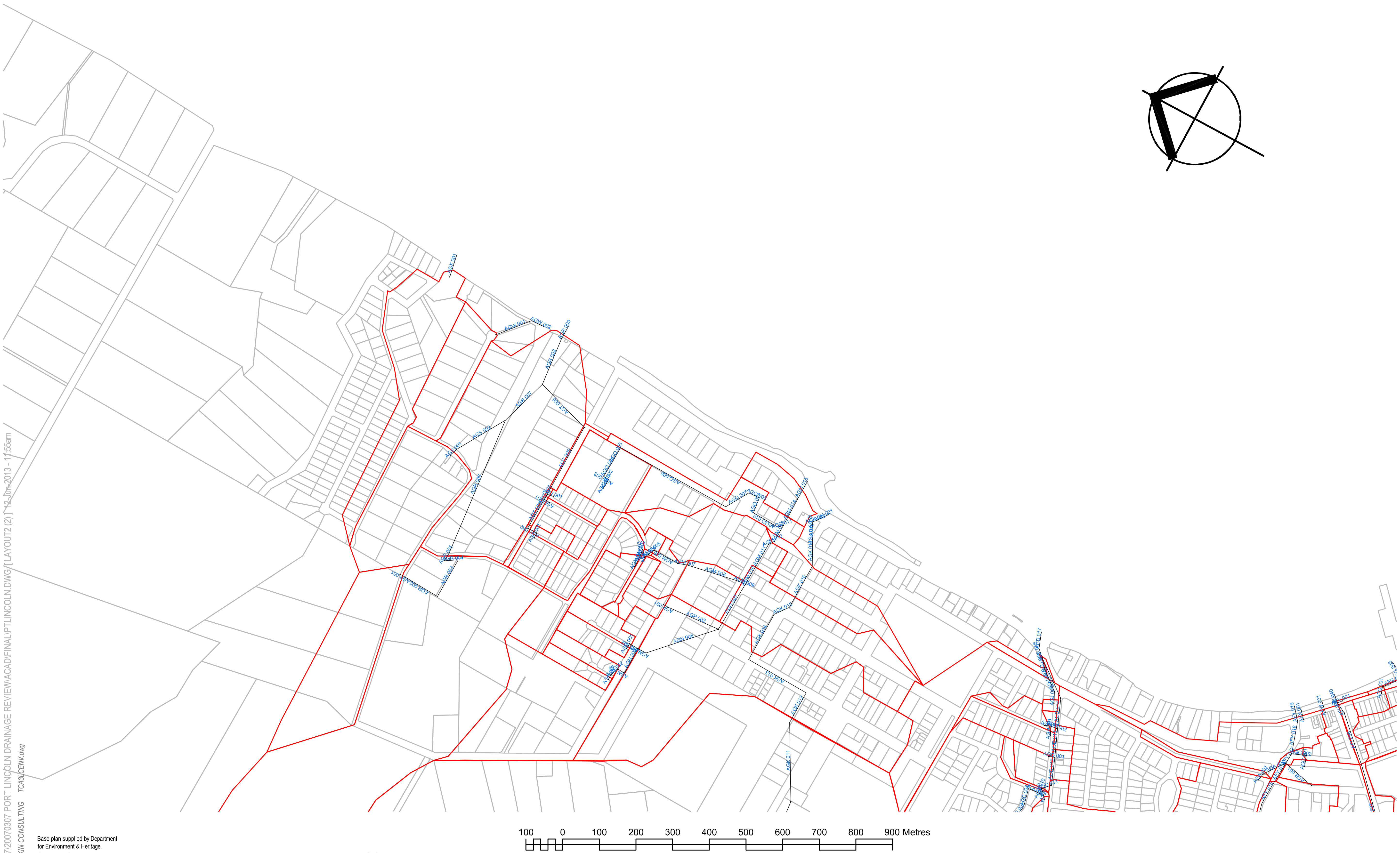
- Prioritise drains for CCTV inspections and commence a CCTV inspection program
- Develop a maintenance plan

11 References

- DesignFlow (2010) “Port Lincoln: Reducing stormwater impacts on coast and marine environments” Ref # 5054, Version 1.0.
- EPA (2009) “Ambient water quality of Boston and Proper Bays, Port Lincoln 1997-2008” December 2009
- EPNRMB (2009) “Managing Our Resources. Strategic Plan for the Management of the natural resources of Eyre Peninsula”. Eyre Peninsula Natural Resources Management Board.
- Department for Water (2012) “Water Sensitive Urban Design Consultation Statement”
- Engineers Australia (2006) “ Australian Runoff Quality, A guide to Water Sensitive Urban Design”
- Government of South Australia (2010) “Water Sensitive Urban Design – Greater Adelaide Region – Technical Manual”, December 2010.
- Kinhill (1994), “Port Lincoln Township Stormwater Drainage Study” Ref AE3053.C.DO.002 Rev 0
- Secon Consulting Engineers (2013) “Report on Power Supply Liverpool Street Pumping Station” Ref B0205 Rev 1

Appendix A

ILSAX Catchment Plans



Base plan supplied by Department
for Environment & Heritage.
Coords to MGA 54

ALL LEVELS TO A.H.D.

REV	AMENDMENT / REASON FOR ISSUE	DATE	DES.	SA DWN.	DWGCHK.	VERIFIED	APPROVED

Figure A.1

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a better approach

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Survey Date: -
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City of Port Lincoln
Ilsax Model Reach Names
Port Lincoln Drainage Review
1 OF 4

100 0 100 200 300 400 500 600 700 800 900 Metres

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Figure A.2

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City of Port Lincoln
Ilsax Model Reach Names
Port Lincoln Drainage Review
2 OF 4

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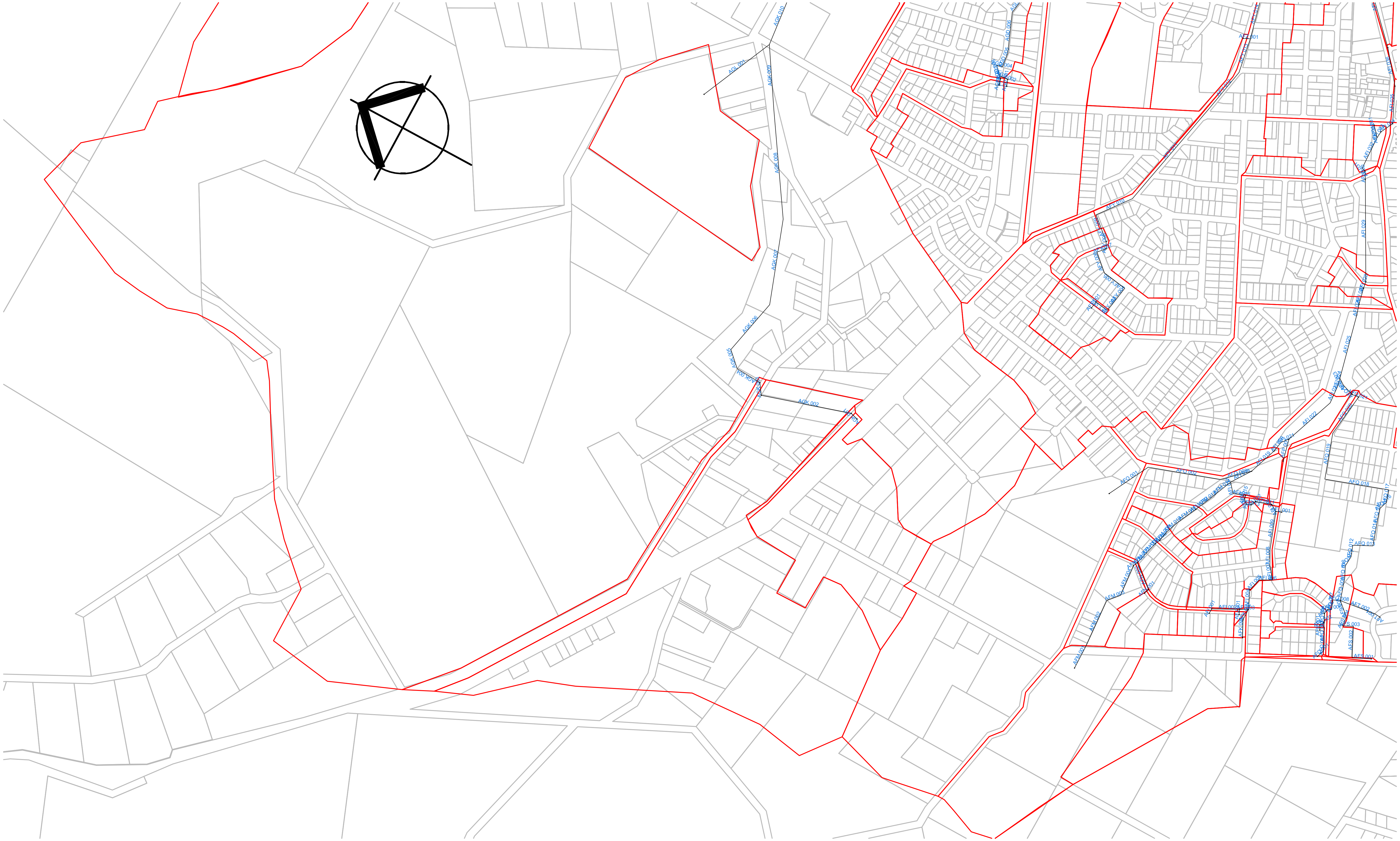

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Figure A.3

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Figure A.4

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City of Port Lincoln
Ilsax Model Reach Names
Port Lincoln Drainage Review
4 OF 4

Appendix B

ILSAX Output

ILSAX OUTPUT: 5 and 100-year ARI

	Flow in Drain (m^3/s)	
Drain Name	5-year ARI	100-year ARI
AFB 001	0.311	0.755
AAA 001	0.295	0.797
AAA 002	0.556	1.465
AAB 001	0.077	0.182
AAA 003	0.629	1.647
AAC 001	0.053	0.128
AEZ 001	0.07	0.176
AEZ 002	0.56	1.373
AEZ 003	0.556	1.373
AFA 001	0.059	0.14
AFA 002	0.087	0.206
AFA 003	0.084	0.201
AEZ 004	0.633	1.572
AEZ 005	0.632	1.572
AEZ 006	1.025	2.574
AEZ 007	1.162	2.897
AEZ 008	1.162	2.897
AEZ 009	1.283	3.214
AEZ 010	1.283	3.214
AAA 004	0.719	1.973
AAD 001	0.057	0.157
AAA 005	0.756	2.087
AAE 001	0.097	0.237
AAE 002	0.238	0.6
AAA 006	0.98	2.664
AAA 007	0.968	2.651
AAA 008	0.962	2.644
AAA 009	0.951	2.555
AAF 001	0.209	0.599
AAF 002	0.254	0.74
AAF 003	0.294	0.864
AAF 004	0.33	0.952
AAG 001	0.045	0.13
AAF 005	0.371	1.073
AAH 001	0.039	0.111
AAF 006	0.413	1.186
AAI 001	0.003	0.089
AAI 002	0.003	0.089
AAI 003	0.011	0.164
AAF 007	0.455	1.331
AAF 008	0.514	1.492
AAF 009	0.51	1.492
AAF 010	0.503	1.492
AAF 011	0.526	1.551
AAJ 001	0.139	0.509
AAJ 002	0.136	0.509
AAK 001	0.211	6.806
AAK 002	0.211	6.806

	Flow in Drain (m^3/s)	
Drain Name	5-year ARI	100-year ARI
AAL 001	1.766	4.873
AAJ 003	0.792	7.928
AAF 012	1.058	8.351
AAF 013	1.051	8.336
AAF 014	1.064	8.499
AAM 001	0.113	0.447
AAM 002	0.191	0.613
AAM 003	0.197	0.632
AAM 004	0.228	0.714
AAM 005	0.221	0.714
AAM 006	0.217	0.714
AAM 007	0.214	0.714
AAM 008	0.224	0.744
AAN 001	0.027	0.077
AAN 002	0.08	0.299
AAO 001	0.065	0.186
AAN 003	0.143	0.457
AAM 009	0.366	1.22
AAM 010	0.362	1.22
AAM 011	0.358	1.22
AAP 001	0.063	0.178
AAF 015	1.384	8.851
AAF 016	1.421	8.924
AAQ 001	0.064	0.183
AAF 017	1.48	9.04
AAF 018	1.507	9.099
AAR 001	0.045	0.128
AAF 019	1.535	9.162
AAF 020	1.535	9.151
AAS 001	0.07	0.245
AAS 002	0.069	0.245
AAS 003	0.068	0.242
AAS 004	0.066	0.239
AAS 005	0.063	0.239
AAS 006	0.057	0.234
AAS 007	0.055	0.225
AAT 001	0.131	0.494
AAS 008	0.35	1.557
AAF 021	1.885	10.593
AAF 022	1.885	10.592
AAF 023	1.879	10.573
AAF 024	1.877	10.556
AAF 025	1.871	10.536
AAU 001	0.256	0.708
AAV 001	0.215	0.575
AAF 026	2.254	10.839
AAF 027	2.242	10.813
AAW 001	0.12	0.368

	Flow in Drain (m^3/s)	
Drain Name	**5-year ARI**	**100-year ARI**
AAW 002	0.203	0.569
AAW 003	0.201	0.569
AAW 004	0.481	1.297
AAW 005	0.623	1.7
AAW 006	0.602	1.621
AAW 007	0.652	1.829
AAW 008	0.645	1.822
AAX 001	0.066	0.317
AAX 002	0.092	0.418
AAW 009	0.715	2.116
AAY 001	0.071	0.196
AAY 002	0.152	0.416
AAY 003	0.198	0.534
AAY 004	0.242	0.648
AAY 005	0.253	0.67
AAY 006	0.26	0.683
AAZ 001	0.061	0.168
AAZ 002	0.203	0.56
AAY 007	0.464	1.229
AAY 008	0.464	1.185
AAF 028	3.752	13.909
ABA 001	0.202	0.6
ABA 002	1.095	3.274
ABB 001	0.536	1.467
ABA 003	1.602	4.554
ABA 004	1.759	4.986
ABA 005	1.759	4.958
ABC 001	0.064	0.165
ABC 002	0.059	0.156
ABD 001	0.01	0.139
ABA 006	1.792	5.046
ABA 007	1.777	5.034
ABA 008	1.756	5.034
AAF 029	2	6.765
ABE 001	0.129	0.327
ABE 002	0.252	0.637
ABF 001	0.024	0.062
ABE 003	0.332	0.844
ABE 004	0.329	0.84
ABG 001	0.149	0.377
ABG 002	0.163	0.412
ABE 005	0.495	1.255
AAF 030	2.325	7.047
ABH 001	0.641	1.732
AAF 031	2.686	7.698
ABI 001	0.132	0.374
ABI 002	0.13	0.372
AAF 032	2.713	7.969

	Flow in Drain (m^3/s)	
Drain Name	**5-year ARI**	**100-year ARI**
AAF 033	2.713	7.936
ABJ 001	0.011	0.088
ABJ 002	0.258	1.029
ABK 001	0.003	0.042
ABJ 003	0.276	1.139
ABJ 004	0.274	1.139
AAF 034	2.952	9.083
ABL 001	0.017	0.043
ABM 001	0.017	0.043
ABM 002	0.017	0.043
ABM 003	0.016	0.042
ABN 001	0.013	0.032
ABN 002	0.021	0.055
ABN 003	0.021	0.054
ABN 004	0.021	0.053
ABO 001	0.027	0.122
ABO 002	0.121	0.423
ABO 003	0.12	0.422
ABP 001	0.064	0.21
ABQ 001	0.141	0.522
ABP 002	0.227	0.781
ABO 004	0.368	1.272
ABO 005	0.37	1.317
ABO 006	0.366	1.313
ABO 007	0.37	1.402
ABR 001	0.025	0.075
ABO 008	0.389	1.455
ABO 009	0.489	1.719
ABS 001	0.082	0.236
ABS 002	0.081	0.236
ABS 003	0.157	0.449
ABS 004	0.187	0.52
ABT 001	0.103	0.318
ABS 005	0.293	0.856
ABO 010	0.776	2.507
ABO 011	0.766	2.507
ABO 012	0.78	2.543
ABU 001	0.072	0.217
ABU 002	0.223	0.694
ABO 013	1.003	3.221
ABV 001	0	4.235
ABV 002	0	4.235
ABW 001	1.611	5.488
ABO 014	1.444	7.092
ABX 001	0.062	0.199
ABO 015	1.493	7.239
ABO 016	1.493	7.231
ABY 001	0.121	0.362

	Flow in Drain (m^3/s)	
Drain Name	**5-year ARI**	**100-year ARI**
ABY 002	0.193	0.57
ABY 003	0.225	0.659
ABY 004	0.22	0.659
ABZ 001	0.357	1.126
ABZ 002	0.44	1.381
ABZ 003	0.436	1.379
ABZ 004	0.486	1.533
ABY 005	0.713	2.211
ACA 001	0.132	0.395
ACB 001	0.068	0.197
ABY 006	0.931	2.838
ABY 007	0.931	2.829
ABY 008	1.11	3.318
ABO 017	2.593	9.436
ABO 018	2.593	9.436
ACC 001	0.787	2
ACC 002	0.836	2.134
ABO 019	3.355	11.005
ABO 020	3.355	11.005
ABO 021	3.355	11.005
ABO 022	3.347	11.005
ACD 001	0.028	0.084
ACE 001	0.273	0.919
ACD 002	0.391	1.292
ACD 003	0.438	1.406
ACF 001	0.009	0.023
ACD 004	0.467	1.494
ACG 001	0.025	0.07
ACD 005	0.496	1.596
ACH 001	0.015	0.042
ACD 006	0.507	1.663
ACI 001	0.016	0.045
ACI 002	0.152	0.594
ACD 007	0.627	2.238
ACD 008	0.627	2.238
ACD 009	0.627	2.238
ACJ 001	0.043	0.137
ACJ 002	0.048	0.148
ACK 001	0.066	0.196
ACK 002	0.065	0.194
ACJ 003	0.106	0.331
ACD 010	0.765	2.684
ACL 001	0.095	0.304
ACD 011	0.865	2.999
ACM 001	0.182	0.683
ACM 002	0.18	0.683
ACM 003	0.244	1.442
ACD 012	1.071	4.214

	Flow in Drain (m^3/s)	
Drain Name	**5-year ARI**	**100-year ARI**
ACD 013	1.071	4.214
ACD 014	1.759	6.267
ABO 023	4.916	17.256
ABO 024	4.864	17.173
ACN 001	0.102	0.418
ACN 002	0.101	0.656
ACN 003	0.188	0.823
ACN 004	0.212	0.847
ACO 001	0.026	0.071
ACN 005	0.239	0.88
ACP 001	0.013	0.034
ACP 002	0.029	0.073
ACP 003	0.036	0.092
ACN 006	0.27	0.934
ACQ 001	0.027	0.074
ACN 007	0.284	0.979
ACR 001	0.002	0.012
ACR 002	0.021	0.058
ACS 001	0.057	0.161
ACS 002	0.073	0.202
ACT 001	0.046	0.137
ACT 002	0.06	0.176
ACU 001	0.028	0.08
ACU 002	0.028	0.079
ACU 003	0.027	0.078
ACV 001	0.081	0.225
ACV 002	0.089	0.247
ACV 003	0.088	0.245
ACW 001	0.03	0.083
ACW 002	0.052	0.145
ACW 003	0.051	0.143
ACV 004	0.145	0.402
ACX 001	0.049	0.137
ACX 002	0.048	0.133
ACV 005	0.242	0.664
ACV 006	0.249	0.684
ACV 007	0.247	0.681
ACY 001	0.032	0.085
ACV 008	0.28	0.762
ACV 009	0.332	0.911
ACV 010	0.36	1.001
ACZ 001	0.027	0.076
ACZ 002	0.031	0.087
ACZ 003	0.029	0.082
ACZ 004	0.029	0.081
ADA 001	0.023	0.063
ACZ 005	0.057	0.158
ACZ 006	0.056	0.155

	Flow in Drain (m^3/s)	
Drain Name	5-year ARI	100-year ARI
ACZ 007	0.054	0.153
ADB 001	0.065	0.184
ADB 002	0.115	0.311
ACZ 008	0.162	0.463
ADC 001	0.028	0.076
ADE 001	0.039	0.139
ADE 002	0.091	0.292
ADE 003	0.09	0.289
ADF 001	0.018	0.046
ADG 001	0.009	0.025
ADG 002	0.016	0.043
ADG 003	0.015	0.04
ADH 001	0.115	0.343
ADG 004	0.159	0.469
ADI 001	0.016	0.046
ADG 005	0.176	0.525
ADJ 001	0.014	0.039
ADJ 002	0.037	0.103
ADK 001	0.004	0.01
ADK 002	0.007	0.019
ADJ 003	0.055	0.151
ADL 001	0.025	0.682
ADL 002	0.075	0.721
ADM 001	0.027	0.07
ADJ 004	0.158	0.787
ADG 006	0.337	1.105
ADG 007	0.359	1.152
ADN 001	0.028	0.079
ADN 002	0.028	0.078
ADG 008	0.385	1.232
ADO 001	0.032	0.09
ADG 009	0.418	1.3
ADP 001	0.057	0.158
ADP 002	0.056	0.157
ADP 003	0.091	0.254
ADP 004	0.09	0.252
ADG 010	0.492	1.513
ADQ 001	0.034	0.095
ADR 001	0.006	0.016
ADQ 002	0.039	0.108
ADQ 003	0.039	0.107
ADS 001	0.048	0.134
ADQ 004	0.099	0.276
ADQ 005	0.098	0.274
ADQ 006	0.109	0.304
ADQ 007	0.144	0.393
ADG 011	0.622	1.844
ADT 001	1.328	4.568

	Flow in Drain (m^3/s)	
Drain Name	5-year ARI	100-year ARI
ADU 001	0.515	1.762
ADU 002	0.563	1.849
ADV 001	0.357	1.053
ADW 001	0.365	1.076
ADW 002	0.437	1.297
ADX 001	0.106	0.308
ADY 001	0.11	0.322
ADY 002	0.336	1.206
ADZ 001	0.057	0.154
ADY 003	0.386	1.322
ADY 004	0.402	1.348
AEA 001	0.089	0.261
AEA 002	0.182	0.536
ADY 005	0.574	1.841
ADY 006	0.587	1.863
AEB 001	0.09	0.274
AEB 002	0.559	2.199
ADY 007	1.117	4.028
AEC 001	0.078	0.24
AEC 002	0.156	0.48
ADY 008	1.251	4.45
AED 001	0.08	0.237
AED 002	0.194	0.599
AED 003	0.749	3.178
ADY 009	1.933	7.686
ADY 010	1.99	7.823
AEE 001	0.137	0.372
AEE 002	0.132	0.37
AEE 003	0.837	2.58
AEF 001	0.334	1.128
AEF 002	0.363	1.206
AEF 003	0.363	1.206
AEE 004	1.141	3.575
AEE 005	1.141	3.575
AEE 006	1.141	3.575
AEE 007	1.141	3.575
AEG 001	0.175	0.49
AEH 001	0.036	0.098
AEG 002	0.238	0.631
AEI 001	0.134	0.588
AEI 002	0.133	0.588
AEI 003	0.133	0.587
AEI 004	0.133	0.584
AEI 005	0.405	1.822
AEI 006	0.442	1.974
AEJ 001	0	0.074
AEJ 002	0	0.073
AEK 001	0.037	0.103

	Flow in Drain (m^3/s)	
Drain Name	5-year ARI	100-year ARI
AEJ 003	0.036	0.125
AEJ 004	0.035	0.125
AEJ 005	0.34	1.308
AEJ 006	0.367	1.351
AEI 007	0.744	3.308
AEL 001	0.037	0.106
AEL 002	0.297	0.956
AEL 003	0.323	1.002
AEL 004	0.361	1.091
AEI 008	1.093	4.337
AEI 009	1.708	6.452
AEI 010	1.717	6.468
AEI 011	1.724	6.479
AEM 001	0.093	0.272
AEM 002	0.23	0.691
AEM 003	0.259	0.781
AEN 001	0.041	0.125
AEM 004	0.362	1.06
AEM 005	0.384	1.145
AEO 001	0.192	0.608
AEO 002	0.214	0.667
AEO 003	0.232	0.726
AEP 001	0.051	0.145
AEO 004	0.529	1.431
AEM 006	0.894	2.591
AEM 007	1.008	3.006
AEQ 001	0.101	0.265
AEM 008	1.091	3.256
AEM 009	1.117	3.301
AEM 010	1.303	3.805
AEM 011	1.32	3.842
AER 001	0.254	0.888
AER 002	0.516	1.488
AES 001	0.043	0.122
AER 003	0.565	1.633
AER 004	0.622	1.795
AET 001	0.039	0.117
AET 002	0.036	0.115
AET 003	0.049	0.14
AEU 001	0.065	0.166
AER 005	0.772	2.216
AEV 001	0.078	0.216
AEV 002	0.368	0.97
AEV 003	0.363	0.96
AER 006	1.117	3.123
AER 007	1.113	3.123
AER 008	1.087	3.123
AEI 012	4.092	12.703

	Flow in Drain (m^3/s)	
Drain Name	5-year ARI	100-year ARI
AEI 013	4.089	13.061
AEW 001	0.172	0.518
AEW 002	0.349	0.977
AEX 001	0.086	0.262
AEY 001	0.083	0.253
AEX 002	0.164	0.505
AEW 003	0.541	1.581
AEW 004	0.539	1.581
AEI 014	4.554	14.485
AEI 015	5.424	16.639
AEI 016	7.027	20.514
AFC 001	0.248	0.687
AEI 017	7.427	21.631
AEI 018	7.449	21.706
AFD 001	0.141	0.679
AFD 002	0.265	1.075
AFD 003	0.292	1.408
AFD 004	0.281	1.408
AFD 005	0.588	1.955
AFE 001	0.094	0.236
AFD 006	0.699	2.115
AFF 001	0.075	0.189
AFF 002	0.088	0.223
AFD 007	0.794	2.25
AFG 001	0.068	0.166
AFG 002	0.073	0.179
AFH 001	0.059	0.145
AFG 003	0.141	0.344
AFI 001	0.061	0.171
AFI 002	0.074	0.202
AFJ 001	0.004	0.011
AFI 003	0.079	0.208
AFK 001	0	0.583
AFK 002	0.011	0.59
AFI 004	0.119	0.724
AFI 005	0.136	0.745
AFI 006	0.134	0.743
AFI 007	0.129	0.743
AFI 008	0.127	0.741
AFI 009	0.124	0.741
AFL 001	0.05	0.141
AFI 010	0.354	1.228
AFI 011	0.353	1.232
AFI 012	0.358	1.246
AFI 013	0.425	1.41
AFI 014	0.459	1.502
AFI 015	0.489	1.583
AFI 016	0.492	1.591

	Flow in Drain (m^3/s)	
Drain Name	5-year ARI	100-year ARI
AFI 017	0.49	1.591
AFM 001	0.038	0.88
AFM 002	0.036	0.867
AFM 003	0.035	0.862
AFM 004	0.035	0.862
AFM 005	0.066	1.067
AFN 001	0.094	0.286
AFN 002	0.105	0.31
AFM 006	0.181	1.239
AFM 007	0.178	1.239
AFM 008	0.332	1.438
AFM 009	0.386	1.514
AFM 010	0.384	1.512
AFM 011	0.383	1.497
AFM 012	0.386	1.575
AFM 013	0.384	1.568
AFM 014	0.378	1.565
AFI 018	0.846	3.036
AFO 001	1.328	4.957
AFO 002	0.875	2.525
AFO 003	0.875	2.525
AFI 019	1.472	5.729
AFI 020	1.522	5.939
AFI 021	1.522	5.931
AFP 001	0.014	0.04
AFI 022	1.525	6.05
AFI 023	1.141	4.174
AFI 024	1.141	4.138
AFQ 001	0.023	0.059
AFQ 002	0.023	0.059
AFQ 003	0.023	0.058
AFR 001	0.075	0.209
AFR 002	0.096	0.267
AFQ 004	0.117	0.322
AFQ 005	0.189	0.524
AFQ 006	0.243	0.678
AFQ 007	0.242	0.675
AFQ 008	0.239	0.667
AFS 001	0.017	0.042
AFS 002	0.015	0.041
AFS 003	0.014	0.04
AFS 004	0.014	0.039
AFS 005	0.013	0.039
AFT 001	0.226	0.632
AFT 002	0.225	0.628
AFQ 009	0.493	1.375
AFQ 010	0.121	0.731

	Flow in Drain (m^3/s)	
Drain Name	5-year ARI	100-year ARI
AFQ 011	0.121	0.731
AFQ 012	0.121	0.731
AFQ 013	0.121	0.731
AFQ 014	0.12	0.715
AFQ 015	0.12	0.715
AFQ 016	0.12	0.715
AFQ 017	0.12	0.715
AFQ 018	0.12	0.715
AFQ 019	0.12	0.707
AFQ 020	0.12	0.686
AFQ 021	0.604	2.544
AFQ 022	0.636	2.588
AFQ 023	0.63	2.585
AFI 025	1.51	5.32
AFI 026	1.84	6.471
AFI 027	1.856	6.532
AFI 028	1.875	6.602
AFI 029	1.883	6.635
AFI 030	2.314	7.956
AFI 031	2.357	8.124
AFI 032	2.357	8.124
AFU 001	0.17	0.486
AFU 002	0.169	0.484
AFI 033	2.425	8.503
AFI 034	2.415	8.526
AFI 035	2.84	10.006
AFI 036	2.855	10.103
AFI 037	2.871	10.203
AFI 038	2.898	10.322
AFI 039	2.946	10.418
AFV 001	0.011	0.028
AFI 040	2.952	10.432
AFW 001	0.114	0.276
AFX 001	0.25	0.77
AFY 001	0.15	0.429
AFY 002	0.174	0.483
AFY 003	0.168	0.477
AFY 004	0.167	0.475
AFY 005	0.166	0.459
AFY 006	0.154	0.456
AFY 007	0.152	0.445
AFY 008	0.277	0.888
AFY 009	0.3	1.033
AFY 010	0.292	1.033
AFY 011	0.287	1.007
AFY 012	0.278	0.999
AFY 013	0.264	0.993
AFZ 001	0.259	0.839

	Flow in Drain (m^3/s)	
Drain Name	5-year ARI	100-year ARI
AFY 014	0.421	1.733
AFY 015	0.395	1.725
AFY 016	1.444	6.004
AGA 001	0.355	1.136
AGA 002	0.398	1.233
AGB 001	0.089	0.254
AFY 017	1.667	7.471
AGC 001	0.468	1.5
AGC 002	0.518	1.633
AFY 018	2.063	9.013
AFY 019	2.063	9.013
AGD 001	0.021	0.062
AGD 002	0.031	0.091
AGE 001	0.202	0.599
AGE 002	0.254	0.752
AGD 003	0.284	0.833
AGD 004	0.281	0.833
AGD 005	0.271	0.818
AGD 006	0.269	0.807
AGD 007	0.243	0.804
AGD 008	0.239	0.787
AGD 009	0.229	0.777
AGD 010	0.687	2.444
AGF 001	0.674	2.16
AGD 011	1.32	4.649
AGD 012	1.348	4.989
AGG 001	0.043	0.142
AGD 013	1.402	5.162
AGH 001	0.094	0.264
AGI 001	0.042	0.117
AGH 002	0.142	0.402
AGD 014	1.541	5.559
AGD 015	1.82	6.847
AGJ 001	0.008	0.022
AGJ 002	0.08	0.454
AGJ 003	0.11	0.47
AGD 016	1.93	7.22
AGD 017	1.928	7.22
AGK 001	0.063	1
AGK 002	0.107	1.039
AGK 003	0.158	3.037
AGK 004	0.293	3.319
AGK 005	0.293	3.319
AGK 006	0.291	3.312
AGK 007	0.283	3.279
AGK 008	0.277	3.233
AGK 009	0.277	3.224
AGL 001	1.127	2.912

	Flow in Drain (m^3/s)	
Drain Name	5-year ARI	100-year ARI
AGK 010	1.133	3.978
AGK 011	1.15	11.208
AGK 012	1.142	11.2
AGK 013	1.114	11.174
AGK 014	1.114	11.174
AGK 015	1.114	11.174
AGK 016	1.114	11.174
AGK 017	1.114	11.174
AGK 018	1.114	11.174
AGK 019	1.114	11.174
AGK 020	1.114	11.174
AGK 021	1.114	11.174
AGM 001	0.083	0.232
AGM 002	0.082	0.23
AGM 003	0.115	0.32
AGM 004	0.139	0.373
AGM 005	0.143	0.385
AGM 006	0.238	0.673
AGM 007	0.287	0.814
AGM 008	0.285	0.814
AGM 009	0.288	0.873
AGN 001	0.026	0.095
AGN 002	0.054	0.2
AGN 003	0.054	0.199
AGN 004	0.054	0.198
AGO 001	0.036	0.131
AGO 002	0.072	0.263
AGN 005	0.289	1.156
AGN 006	0.288	1.156
AGP 001	0.066	0.185
AGP 002	0.066	0.184
AGN 007	0.736	2.953
AGM 010	1.336	4.784
AGM 011	1.324	4.784
AGM 012	1.419	5.161
AGM 013	1.585	5.653
AGQ 001	0.238	0.657
AGQ 002	0.237	0.655
AGQ 003	0.236	0.653
AGQ 004	0.235	0.65
AGQ 005	0.233	0.644
AGQ 006	0.23	0.637
AGQ 007	0.2	0.623
AGQ 008	0.182	0.611
AGQ 009	0.182	0.596
AGQ 010	0.18	0.576
AGQ 011	0.178	0.555
AGM 014	1.689	6.419

	Flow in Drain (m^3/s)	
Drain Name	**5-year ARI**	**100-year ARI**
AGM 015	1.725	6.653
AGR 001	0	0.529
AGR 002	0	0.527
AGR 003	0	0.521
AGR 004	0	0.515
AGR 005	0	2.234
AGR 006	0	2.234
AGS 001	0.132	0.576
AGS 002	0.131	0.576
AGR 007	0.129	2.665
AGT 001	0.074	0.209
AGT 002	0.099	0.278
AGT 003	0.119	0.329
AGU 001	0.071	0.2
AGT 004	0.199	0.55
AGV 001	0.048	0.135
AGT 005	0.249	0.69
AGT 006	0.284	0.765
AGR 008	0.328	2.89
AGR 009	0.41	3.858
AGW 001	0.187	0.554
AGW 002	0.182	0.554
AGX 001	0.231	0.852

Appendix C

MUSIC Model Output

Appendix C

Port Lincoln Existing System Pollutant Loads - MUSIC Output

6 minute Rainfall Data - Oct 2000 - Jan 2004

Catchment	Area (ha)		Flow (ML/yr)	Pollutant Concentration (kg/yr)			
	Urban	Agricultural		Total Suspended Solids	Total Phosphorus	Total Nitrogen	Gross Pollutants
Milton Avenue	12	183	79	20700	55	316	409
Kurla Street	7		6	1220	3	17	195
Bayview Road	75		38	7680	16	109	198
Smith Street	66		44	8800	19	123	949
Shaen Street	1	327	123	30934	86	555	12
Normandy Place	69		58	11750	24	168	1927
Flinders Highway	80		78	15500	31	230	3050
New West Road	101	64	111	24600	53	365	3020
Mortock Terrace	264	173	350	77700	165	1140	11400
Brougham Place	22		28	5810	12	81	1270
Stevenson Street	64		62	12700	26	181	2440
Kirton Point	32		30	6370	13	87	1150
Racecourse	199	123	285	61100	130	904	10600
Marina	83		74	15600	33	217	2660
TOTAL	**1075**	**870**	**1366.91**	**300464**	**663.12**	**4494**	**39280**

Appendix C

Port Lincoln Existing System Pollutant Loads - MUSIC Output

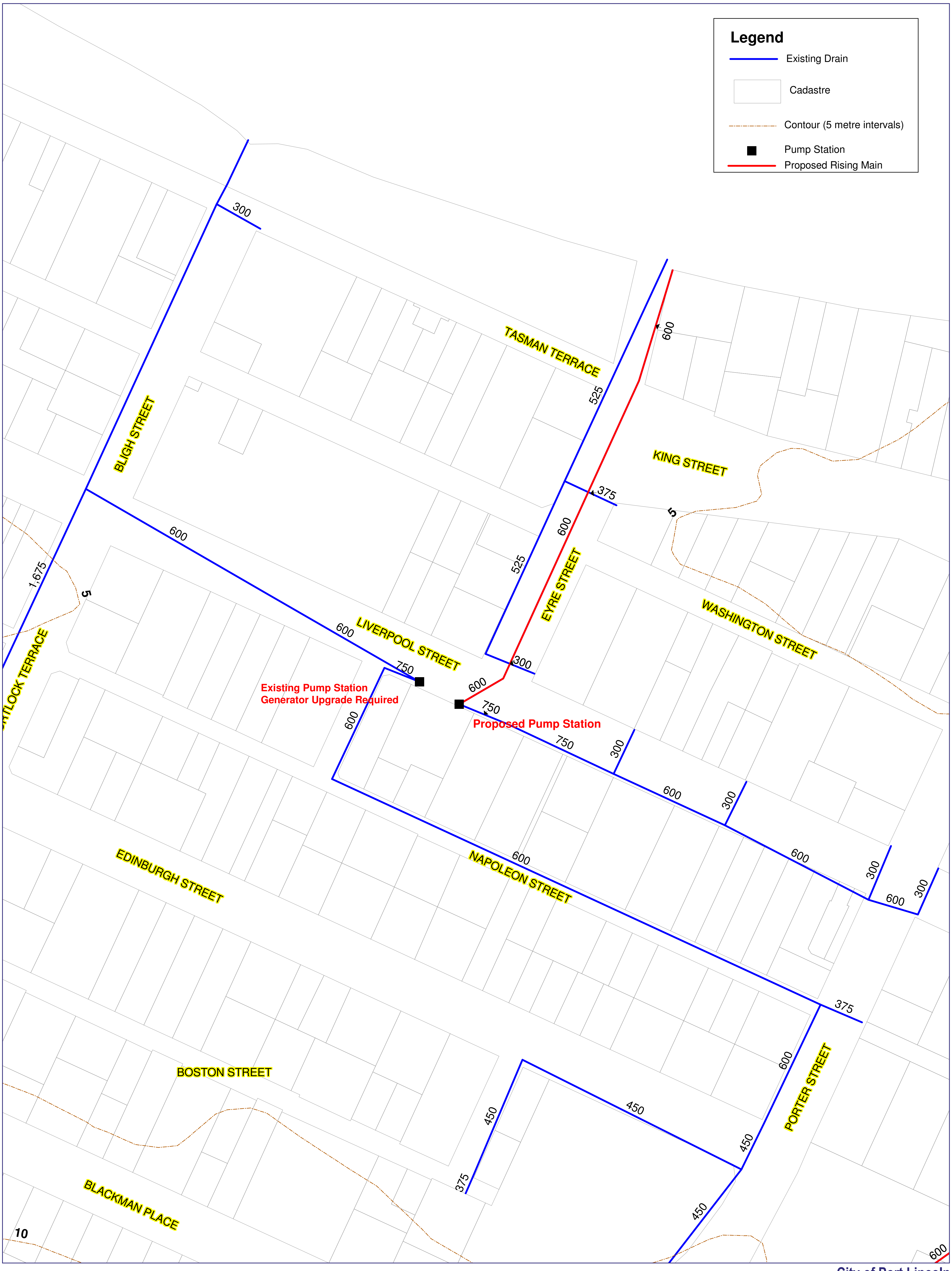
Proposed Basins total Suspended Solids Reduction

MUSIC Output

Location				Total Suspended Solids (kg/yr)		
	Basin Size (m2)	Permanent Water (m3)	Inflow (ML/yr)	In	Out	% Reduction
Hilltop Drive	5000	500	51.1	10600	2600	76
Chicken Farm	4500	500	57.1	12000	3060	75
Western Approach	5400	500	68.5	13900	3800	73

Appendix D

Concept / Design Plans



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Scale: 1:2,000 @ A3

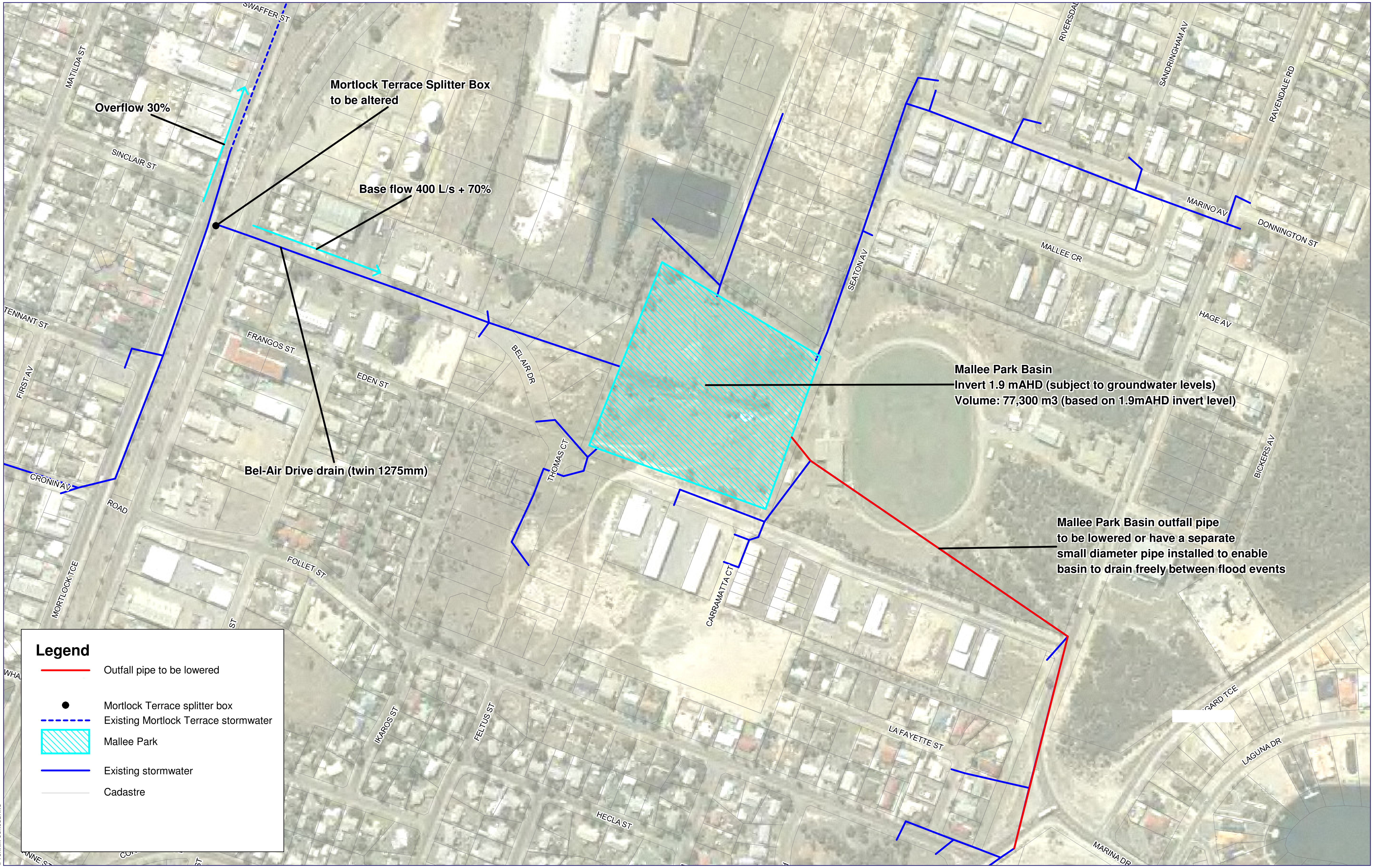
Job Number: 2007.0307
Filename: FigureD1.wor
Revision: F
Date: 11/11/2013
Drawn: TR
Technical Approval: TAK

Data Acknowledgement:
Cadastre supplied by PBBI Australia Pty Ltd

City of Port Lincoln
Stormwater Management Plan

LIVERPOOL STREET PUMP STATION PROPOSED DRAINAGE

Figure D.1



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Scale: 1:3,500 @ A3

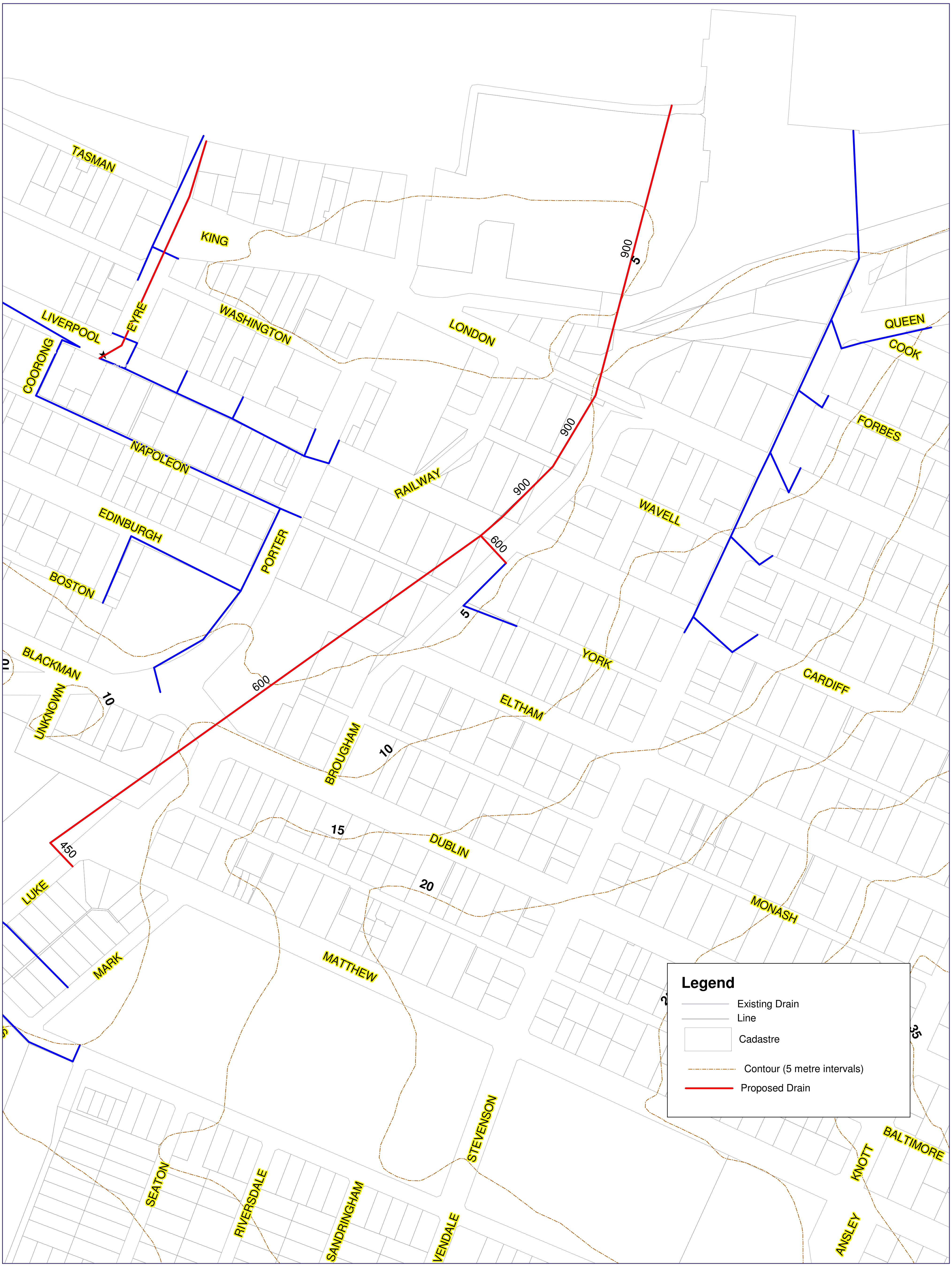
Job Number: 2008.0344
Filename: FigureD2.wor
Date: 06/12/2011
Drawn: Tim Kerby
Technical Approval: Tim Kerby

Data Acknowledgement:
Cadastre supplied by PBBI Australia Pty Ltd

City of Port Lincoln
Stormwater Management Plan

MALLEE PARK BASIN INVESTIGATION
PROPOSED WORKS

Figure D.2



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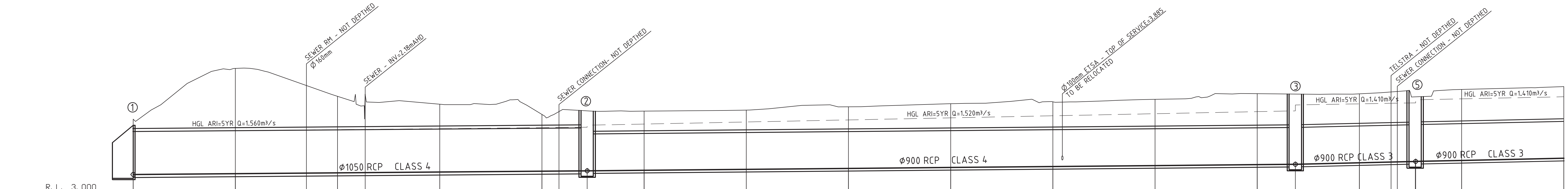
N W E S

Scale: 1:4,000 @ A3

Job Number: 2007.0307
Filename: FigureD3.wor
Revision: E
Date: 9/01/2008
Drawn: TR
Technical Approval: TAK

Data Acknowledgement:
Cadastre supplied by PBBI Australia Pty Ltd

City of Port Lincoln
Stormwater Management Plan
BROUGHAM PLACE
PROPOSED DRAINAGE
Figure D.3

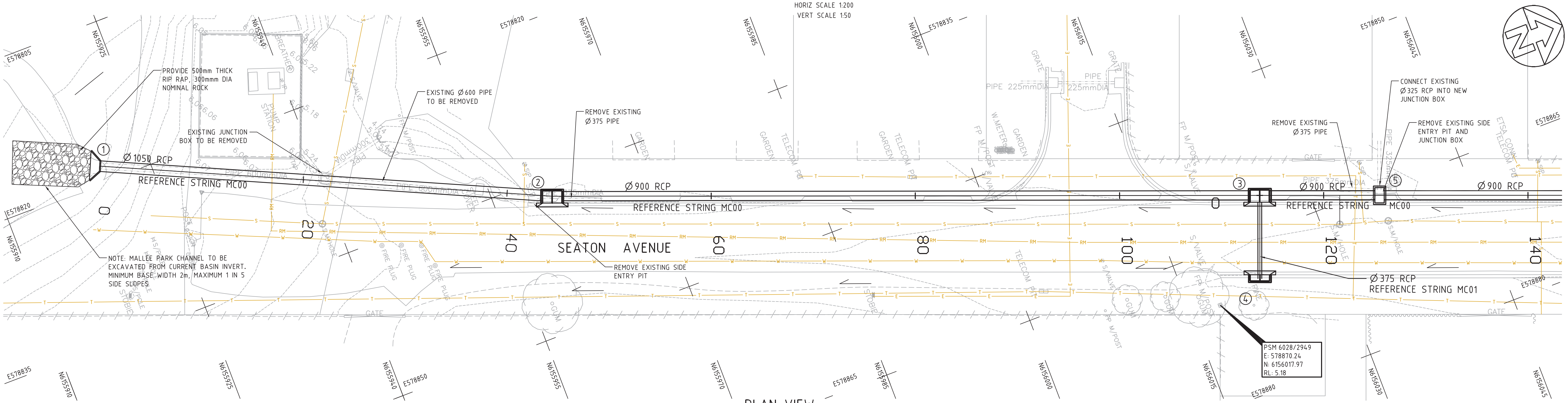


PROPOSED	3.430	3.450	3.471	3.491	3.511	3.520	3.533	3.556	3.579	3.602	3.625	3.648	3.671	3.680	3.717	3.750 3.750	3.774	3.828
CHAINAGE	0.0	10.0	20.0	30.0	40.0	44.4	50.0	60.0	70.0	80.0	90.0	100.0	110.0	113.7	120.0	125.5 125.5	130.0	140.0
EXISTING	4.78	6.03	5.34	5.15	4.90		4.98	5.01	5.09	5.16	5.21	5.27	5.41		5.40		5.51	5.58
VERT. GEOMETRY	P=0.203% L=44.431					P=0.231% L=69.302								P=0.595% L=11.767		P=0.536% L=83.894		

LONGITUDINAL SECTION

REFERENCE STRING MC00

HORIZ SCALE 1:200
VERT SCALE 1:50



PLAN VIEW

SCALE 1:200

LEGEND

Ø525 RCP -NEW STORMWATER DRAIN AS NOTED

14 -PIT NUMBER

-DOUBLE SIDE ENTRY PIT, REFER SCHEDULE

-900 SQUARE JUNCTION BOX, REFER SCHEDULE

-GUTTER FLOW ARROWS

-TREE TO BE REMOVED

EXISTING SERVICES LEGEND

RM — EXISTING RISING MAIN

S — EXISTING SEWER

T — EXISTING TELSTRA

W — EXISTING WATER

BAR SCALE 1:50

BAR SCALE 1:200

PIT SETOUT SCHEDULE

NO.	EASTING	NORTHING
1	578818.38	6155920.26
2	578836.93	6155960.63
3	578861.56	6156025.41
4	578869.19	6156022.51
5	578865.74	6156036.39

PIPE DRAIN SCHEDULE

SECTION	SIZE (mm)	CLASS	GRADE %	LENGTH
1 - 2	Ø 1050	4	0.203	44.431
2 - 3	Ø 900	4	0.231	69.302
3 - 4	Ø 375	3	6.370	8.164
3 - 5	Ø 900	3	0.595	11.767
5 - 6	Ø 900	3	0.536	83.894

DRAINAGE PIT CONNECTION SCHEDULE

NO.	DESCRIPTION	CHAINAGE & OFFSET	GUTTER EL/TOP OF PIT	DRAIN SIZE (mm)	INVERT LEVEL
1	Ø 900 HEADWALL	CHN: 0.00	4.784	Ø 1050	3.430
2	1900x1350 SIDE ENTRY PIT	CHN: 44.40	4.987	Ø 1050 Ø 1050	3.520 3.520
3	1900x1200 SIDE ENTRY PIT	CHN: 113.70	5.398	Ø 1050 Ø 1050 Ø 375	3.680 3.680 3.680
4	1900x600 SIDE ENTRY PIT	CHN: 113.70 OFFSET: 7.75	5.589	Ø 375	4.350
5	1500x900 JUNCTION BOX	CHN: 125.50	5.406	Ø 1050 Ø 1050	3.750 3.750

NOTE: ∗ REFERS TO INLET (GUTTER) LEVEL
INVERTS LISTED CLOCKWISE FROM OUTLET

REVISION	AMENDMENT / REASON FOR ISSUE	APPROVED	DATE
A	ISSUED FOR CONSTRUCTION	T.K.	28.06.10

NOTES:

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SCALE: 1:200 1:50 | SHEET SIZE A1

DESIGNED: TCR | DRAWN: CEM

PROJECT MANAGER: T.KIRBY | SENIOR DRAFTER A.MORRISON

SURVEYED: | SURVEY DATE:

APPROVED: D.JACOBI

DATE: 28.06.10

CITY OF PORT LINCOLN

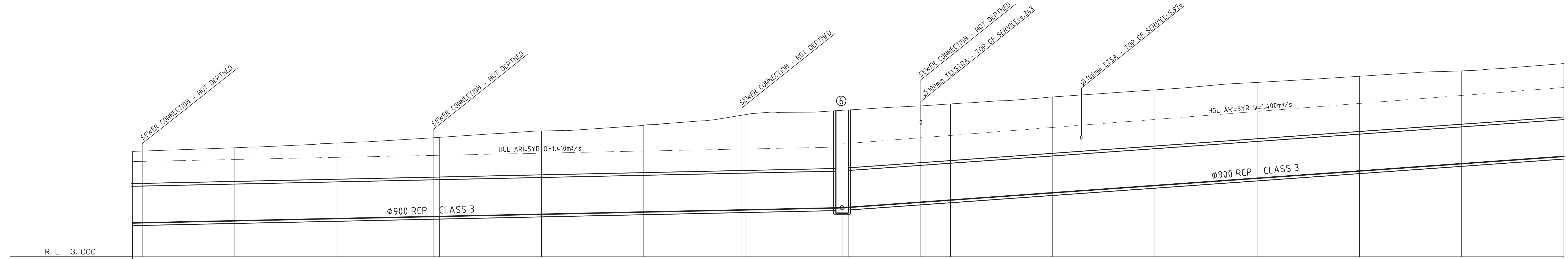
PORT LINCOLN DRAINAGE DESIGN
SEATON AVENUE AND MARINO AVENUE, PORT LINCOLN
PLAN AND LONGITUDINAL SECTION CHN 0.00 TO 140.00

FILENAME: 20080344.5_PLAN.DWG

JOB NUMBER 2008.0344.5

SHEET NUMBER 01

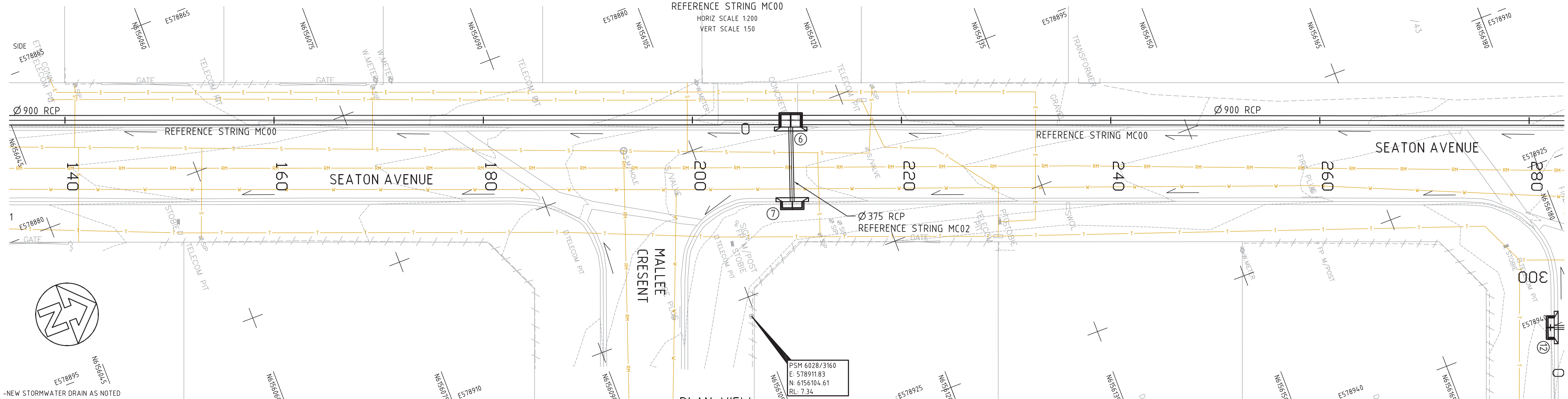
REVISION A



PROPOSED	3.828	3.881	3.935	3.989	4.042	4.096	4.150	4.200 / 4.211	4.389	4.567	4.746	4.924	5.102	5.280	5.458
CHAINAGE	140.0	150.0	160.0	170.0	180.0	190.0	200.0	209.4 / 210.0	220.0	230.0	240.0	250.0	260.0	270.0	280.0
EXISTING	5.58	5.67	5.79	5.92	6.08	6.22	6.48	6.60	6.74	6.91	7.09	7.27	7.42	7.55	7.73
VERT. GEOMETRY	P=0.536% L=83.894								P=1.782% L=76.304						

LONGITUDINAL SECTION

REFERENCE STRING MC00
HORIZ SCALE 1:200
VERT SCALE 1:50



PLAN VIEW

SCALE 1:200

LEGEND

- Ø525 RCP -NEW STORMWATER DRAIN AS NOTED
- 14 -PIT NUMBER
- -DOUBLE SIDE ENTRY PIT, REFER SCHEDULE
- -900 SQUARE JUNCTION BOX, REFER SCHEDULE
- -GUTTER FLOW ARROWS
- -TREE TO BE REMOVED

EXISTING SERVICES LEGEND

- RM — EXISTING RISING MAIN
- S — EXISTING SEWER
- T — EXISTING TELSTRA
- W — EXISTING WATER

BAR SCALE 1:50

BAR SCALE 1:200

PIT SETOUT SCHEDULE

NO.	EASTING	NORTHING
6	578895.62	6156114.80
7	578903.32	6156112.03

PIPE DRAIN SCHEDULE

SECTION	SIZE (mm)	CLASS	GRADE %	LENGTH
6 - 8	Ø900	3	1.782	76.304
6 - 7	Ø375	3	6.719	8.186

DRAINAGE PIT CONNECTION SCHEDULE

NO.	DESCRIPTION	CHAINAGE & OFFSET	GUTTER EL/TOP OF PIT	DRAIN SIZE (mm)	INVERT LEVEL
6	1800x1200 SIDE ENTRY PIT	CHN: 209.40	6.587	Ø900 Ø900 Ø375	4.200 4.200 4.200
7	1900x600 SIDE ENTRY PIT	CHN: 209.45 OFFSET: 8.19	6.786	Ø375	5.310

NOTE: * REFERS TO INLET (GUTTER) LEVEL
INVERTS LISTED CLOCKWISE FROM OUTLET

REVISION	AMENDMENT / REASON FOR ISSUE	APPROVED	DATE
A	ISSUED FOR CONSTRUCTION	T.K.	28.06.10

NOTES:

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SCALE: 1:200 / 1:50
SHEET SIZE: A1
DESIGNED: TCR
DRAWN: CM
PROJECT MANAGER: T.KIRBY
SENIOR DRAFTER: A. MORRISON
SURVEYED:
SURVEY DATE:
APPROVED: D.JACOBI
DATE: 28.06.10

CITY OF PORT LINCOLN

PORT LINCOLN DRAINAGE DESIGN
SEATON AVENUE AND MARINO AVENUE, PORT LINCOLN
PLAN AND LONGITUDINAL SECTION CHN 140.00 TO 280.00

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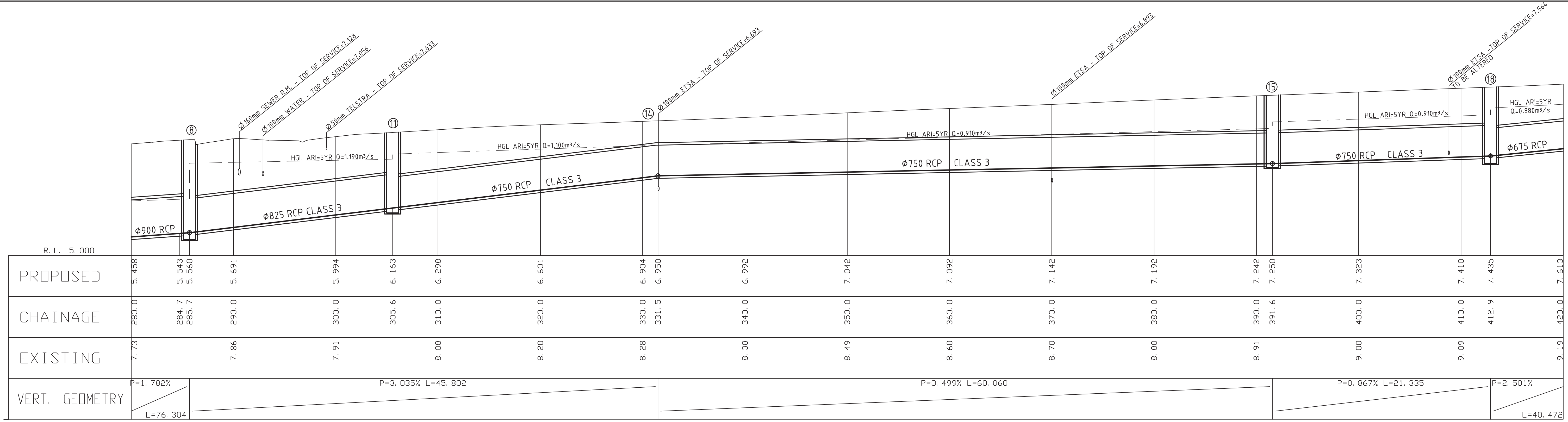
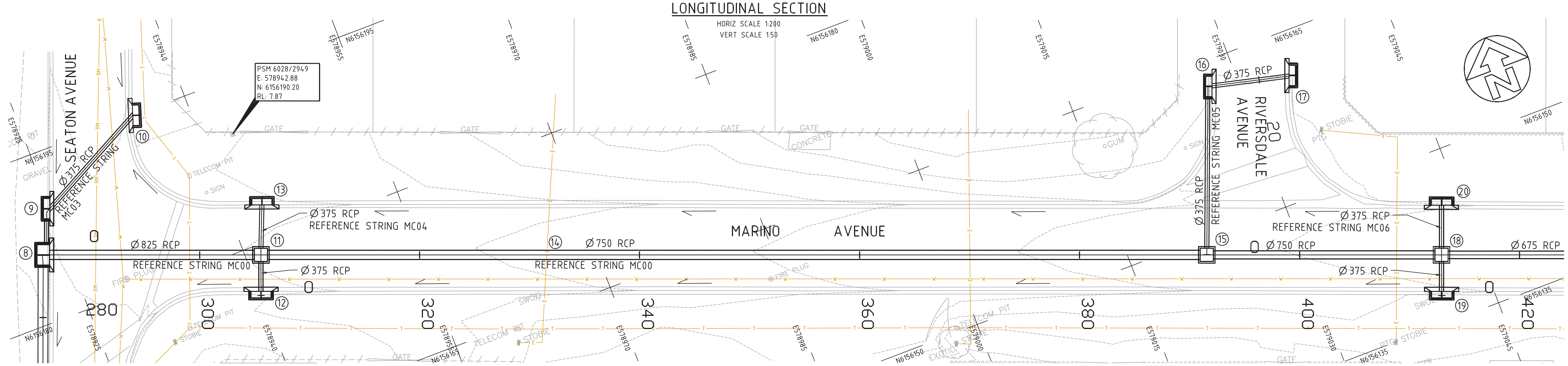
JOB NUMBER: 2008.0344.5
SHEET NUMBER: 02
REVISION: A



LONGITUDINAL SECTION

HORIZ SCALE 1:200
VERT SCALE 1:50



PLAN

SCALE 1:200

LEGEND

Ø525 RCP -NEW STORMWATER DRAIN AS NOTED

14 -PIT NUMBER

-DOUBLE SIDE ENTRY PIT, REFER SCHEDULE

-900 SQUARE JUNCTION BOX, REFER SCHEDULE

-GUTTER FLOW ARROWS

-TREE TO BE REMOVED

BAR SCALE 1:50 (1 0 1 2 3 4 5 Metres)

BAR SCALE 1:200 (10 8 6 4 2 0 10 20 Metres)

EXISTING SERVICES LEGEND

RM — EXISTING RISING MAIN

S — EXISTING SEWER

T — EXISTING TELSTRA

W — EXISTING WATER

PIT SETOUT SCHEDULE

NO.	EASTING	NORTHING
8	578922.80	6156186.10
9	578924.57	6156189.92
10	578935.33	6156194.90
11	578941.37	6156179.04
12	578940.07	6156175.58
13	578943.20	6156183.60
14	578965.61	6156169.82
15	579021.75	6156148.48
16	579027.28	6156162.76
17	579034.88	6156160.92
18	579041.69	6156140.90
19	579040.40	6156137.44
20	579043.43	6156145.46

PIPE DRAIN SCHEDULE

SECTION	SIZE (mm)	CLASS	GRADE %	LENGTH
8 - 9	Ø375	3	20.345	3.251
8 - 11	Ø825	3	3.035	19.867
9 - 10	Ø375	3	2.545	11.790
11 - 12	Ø375	3	1.351	3.688
11 - 13	Ø375	3	1.020	4.914
11 - 14	Ø750	3	3.035	25.935
14 - 15	Ø750	3	0.499	60.060
15 - 16	Ø375	3	0.523	15.307
15 - 18	Ø750	3	0.867	21.335
16 - 17	Ø375	3	2.557	7.822
18 - 19	Ø375	3	1.216	3.695
18 - 20	Ø375	3	10.612	4.879
18 - 21	Ø675	4	2.501	40.472

DRAINAGE PIT CONNECTION SCHEDULE

NO.	DESCRIPTION	CHAINAGE & OFFSET	GUTTER EL/TOP OF PIT	DRAIN SIZE (mm)	INVERT LEVEL
15	1200Sq JUNCTION BOX	CHN: 391.60	8.922	Ø750 Ø375 Ø750	7.250 7.750 7.250
16	1900x600 SIDE ENTRY PIT	CHN: 391.66 OFFSET: 15.31	9.040	Ø375 Ø375	7.830 7.830
17	1900x600 SIDE ENTRY PIT	CHN: 399.42 OFFSET: 16.30	9.077	Ø375	8.030
18	900Sq JUNCTION BOX	CHN: 412.89	9.118	Ø750 Ø375 Ø675 Ø375	7.435 7.435 7.435 7.435
19	1900x600 SIDE ENTRY PIT	CHN: 412.89 OFFSET: 3.70	9.032	Ø375	7.480
20	1900x600 SIDE ENTRY PIT	CHN: 412.89 OFFSET: 4.88	9.053	Ø375	7.955

NOTE: * REFERS TO INLET (GUTTER) LEVEL
INVERTS LISTED CLOCKWISE FROM OUTLET

DRAINAGE PIT CONNECTION SCHEDULE

NO.	DESCRIPTION	CHAINAGE & OFFSET	GUTTER EL/TOP OF PIT	DRAIN SIZE (mm)	INVERT LEVEL
8	1900x1200 SIDE ENTRY PIT	CHN: 285.70	7.835	Ø900 Ø375 Ø825	5.560 5.560 5.560
9	1900x600 SIDE ENTRY PIT	CHN: 286.70 OFFSET: 4.20	7.910	Ø375 Ø375	6.150 6.150
10	1900x600 SIDE ENTRY PIT	CHN: 294.29 OFFSET: 12.69	8.039	Ø375	6.450
11	Ø1200Sq JUNCTION BOX	CHN: 305.60	8.010	Ø825 Ø375 Ø750 Ø375	6.163 6.163 6.163 6.163
12	1900x600 SIDE ENTRY PIT	CHN: 305.56 OFFSET: 3.69	7.989	Ø375	6.400
13	1900x600 SIDE ENTRY PIT	CHN: 305.56 OFFSET: 14.86	7.978	Ø375	6.915
14	VERTICAL SPLAY	CHN: 331.50	8.296	Ø750 Ø750	6.950 6.950

REVISION	AMENDMENT / REASON FOR ISSUE	APPROVED	DATE
A	ISSUED FOR CONSTRUCTION	T.K.	28.06.10

NOTES:

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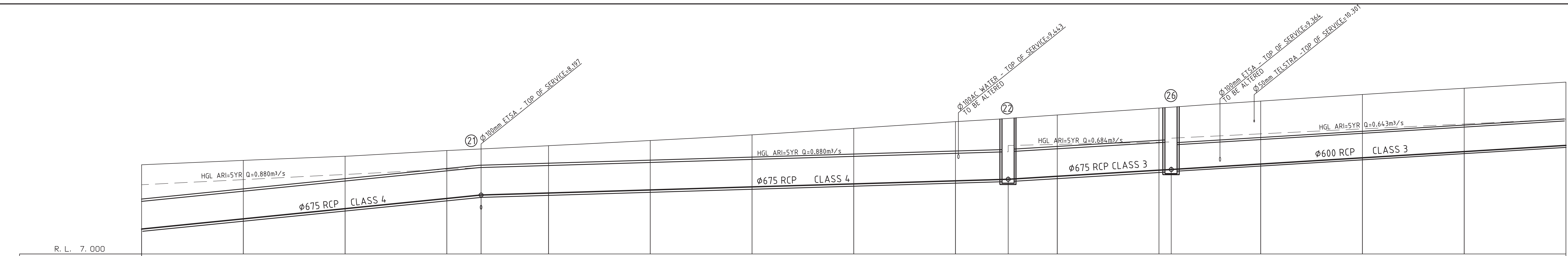
SCALE: 1:200 1:50
SHEET SIZE A1
DESIGNED: TCR
DRAWN: CM
PROJECT MANAGER: T.KIRBY
SENIOR DRAFTER: A.MORRISON
SURVEYED:
SURVEY DATE:
APPROVED: D.JACOBI
DATE: 28.06.10

CITY OF PORT LINCOLN

PORT LINCOLN DRAINAGE DESIGN
SEATON AVENUE AND MARINO AVENUE, PORT LINCOLN
PLAN AND LONGITUDINAL SECTION CHN 280.00 TO 420.00

FILENAME: 20080344.5_PLAN.DWG
JOB NUMBER: 2008.0344.5
SHEET NUMBER: 03
REVISION: A

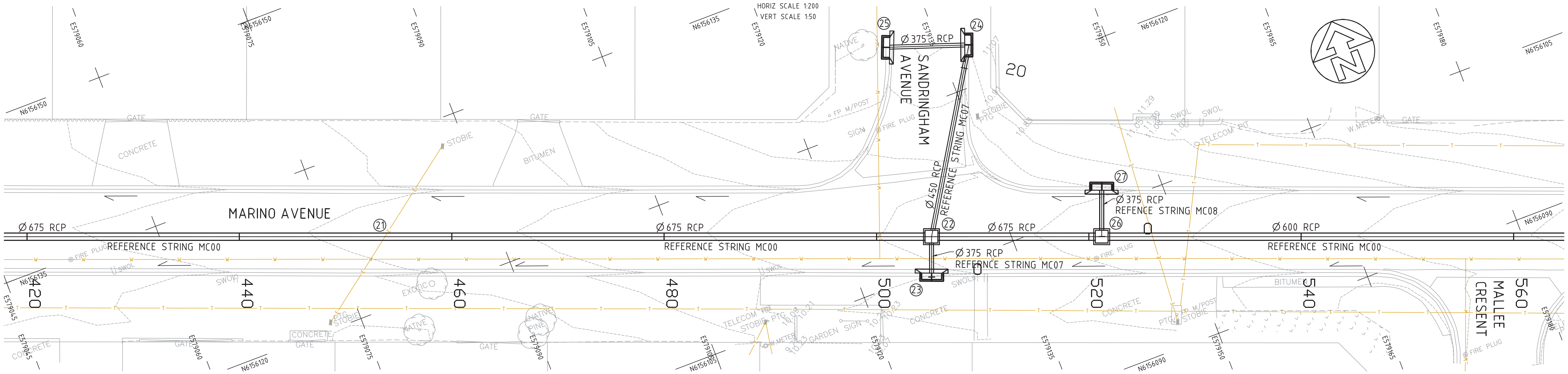


PROPOSED	7.613	7.863	8.113	8.363	8.447	8.497	8.572	8.646	8.721	8.796	8.835	8.907	9.057	9.075	9.209	9.362	9.514	9.667
CHAINAGE	420.0	430.0	440.0	450.0	453.4	460.0	470.0	480.0	490.0	500.0	505.2	510.0	520.0	521.2	530.0	540.0	550.0	560.0
EXISTING	9.19	9.30	9.40	9.54		9.66	9.79	9.92	10.08	10.25		10.41	10.58		10.75	10.92	11.07	11.22

VERT. GEOMETRY: P=2.501% L=40.472 | P=0.749% L=51.811 | P=1.497% L=16.027 | P=1.525% L=53.777

LONGITUDINAL SECTION

HORIZ SCALE 1:200
VERT SCALE 1:50



PLAN

SCALE 1:200

BAR SCALE 1:50

BAR SCALE 1:200

LEGEND

Ø525 RCP -NEW STORMWATER DRAIN AS NOTED

(14) -PIT NUMBER

-DOUBLE SIDE ENTRY PIT, REFER SCHEDULE

-900 SQUARE JUNCTION BOX, REFER SCHEDULE

-GUTTER FLOW ARROWS

-TREE TO BE REMOVED

EXISTING SERVICES LEGEND

RM — EXISTING RISING MAIN

S — EXISTING SEWER

T — EXISTING TELSTRA

W — EXISTING WATER

PIT SETOUT SCHEDULE

NO.	EASTING	NORTHING
21	579079.84	6156126.40
22	579127.95	6156108.11
23	579126.61	6156104.55
24	579137.65	6156123.77
25	579130.26	6156126.33
26	579142.94	6156102.42
27	579144.62	6156106.86

PIPE DRAIN SCHEDULE

SECTION	SIZE (mm)	CLASS	GRADE %	LENGTH
21 - 22	Ø675	4	0.749	51.811
22 - 23	Ø375	3	3.947	3.813
22 - 24	Ø450	3	3.881	18.423
22 - 26	Ø675	3	1.497	16.027
24 - 25	Ø375	3	0.959	7.818
26 - 27	Ø375	3	7.708	4.754
26 - 28	Ø600	3	1.525	53.777

DRAINAGE PIT CONNECTION SCHEDULE

NO.	DESCRIPTION	CHAINAGE & OFFSET	GUTTER EL/TOP OF PIT	DRAIN SIZE (mm)	INVERT LEVEL
25	1900x600 SIDE ENTRY PIT	CHN: 500.86 OFFSET: 17.85	10.694	Ø375	9.625
26	1200Sq JUNCTION BOX	CHN: 521.20	10.605	Ø675 Ø375 Ø600	9.075 9.075 9.075
27	1900x600 SIDE ENTRY PIT	CHN: 521.20 OFFSET: 4.75	10.518	Ø375	9.445

NOTE: * REFERS TO INLET (GUTTER) LEVEL
INVERTS LISTED CLOCKWISE FROM OUTLET

DRAINAGE PIT CONNECTION SCHEDULE

NO.	DESCRIPTION	CHAINAGE & OFFSET	GUTTER EL/TOP OF PIT	DRAIN SIZE (mm)	INVERT LEVEL
21	VERTICAL SPLAY	CHN: 453.40	9.579	Ø675 Ø675	8.447 8.447
22	1200Sq JUNCTION BOX	CHN: 505.20	10.332	Ø675 Ø450 Ø675 Ø375	8.835 8.835 8.835 8.835
23	1900x600 SIDE ENTRY PIT	CHN: 505.18 OFFSET: 3.81	10.261	Ø375	8.850
24	1900x600 SIDE ENTRY PIT	CHN: 508.67 OFFSET: 18.08	10.771	Ø450 Ø375	9.550 9.550

REVISION	AMENDMENT / REASON FOR ISSUE	APPROVED	DATE
A	ISSUED FOR CONSTRUCTION	T.K.	28.06.10

NOTES:

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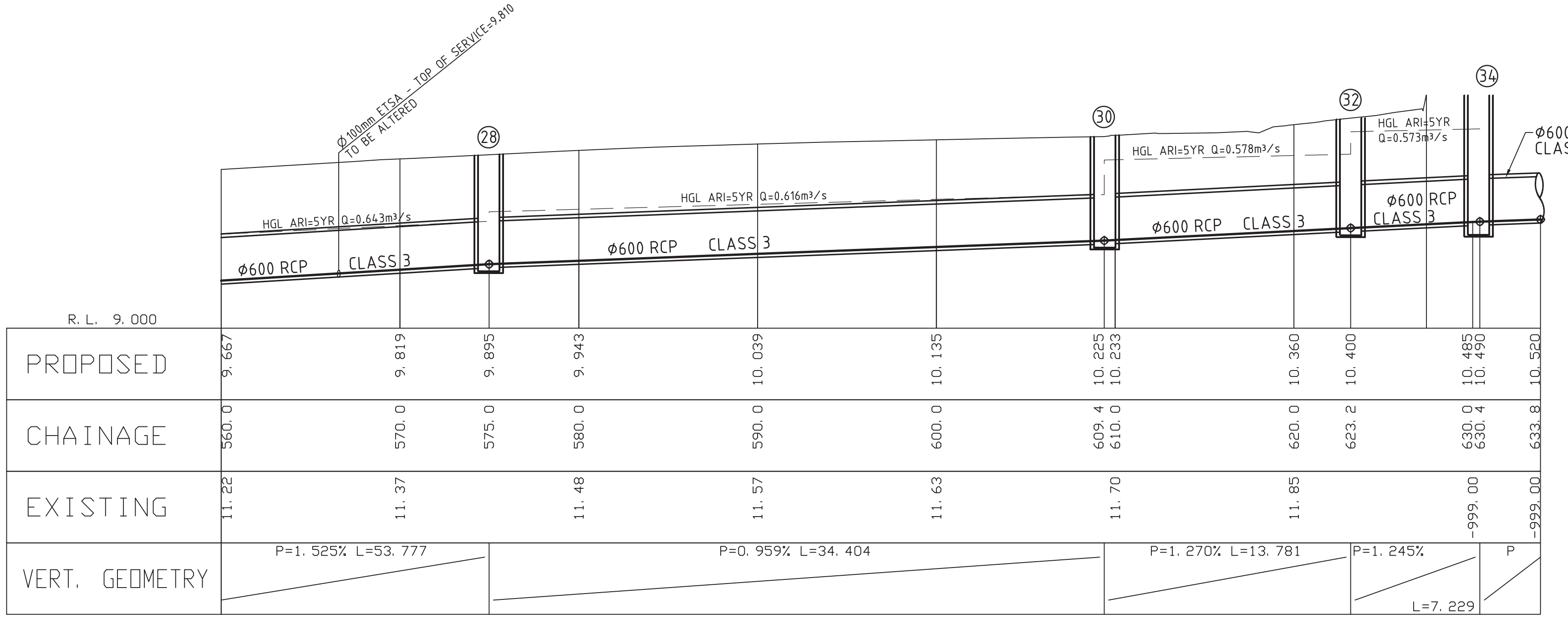
- BUILDING SURVEYING
- SPATIAL INFORMATION
- ELECTRICAL, MECHANICAL AND AUTOMOTIVE

SCALE: 1:200 / 1:50
SHEET SIZE A1
DESIGNED: TCR
DRAWN: CM
PROJECT MANAGER: T.KIRBY
SENIOR DRAFTER: A.MORRISON
SURVEYED:
SURVEY DATE:
APPROVED: D.JACOBI
DATE: 28.06.10

CITY OF PORT LINCOLN

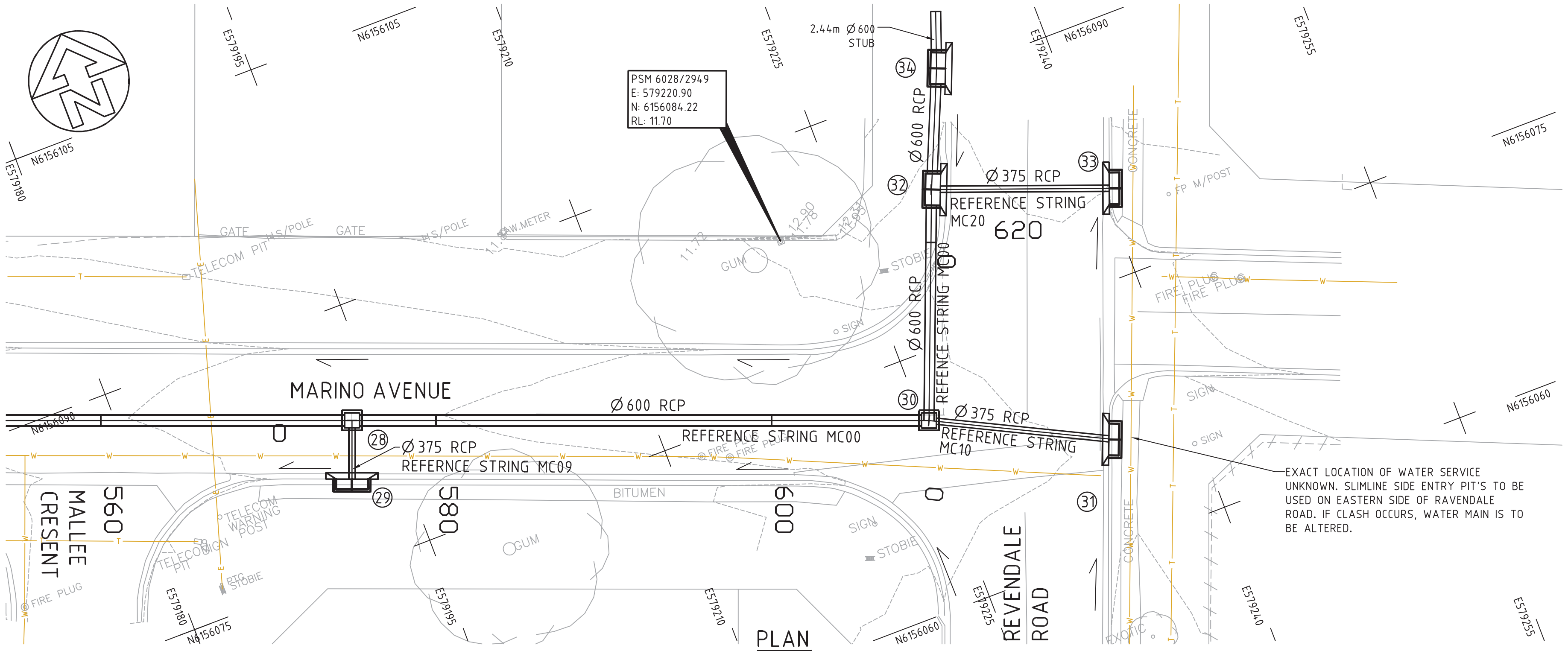
PORT LINCOLN DRAINAGE DESIGN
SEATON AVENUE AND MARINO AVENUE, PORT LINCOLN
PLAN AND LONGITUDINAL SECTION CHN 420.00 TO 560.00

FILENAME: 20080344.5_PLAN.DWG
JOB NUMBER: 2008.0344.5
SHEET NUMBER: 04
REVISION: A



LONGITUDINAL SECTION

HORIZ SCALE 1:200
VERT SCALE 1:50



PLAN

SCALE 1:200

LEGEND

Ø525 RCP -NEW STORMWATER DRAIN AS NOTED
14 -PIT NUMBER
-DOUBLE SIDE ENTRY PIT, REFER SCHEDULE
-900 SQUARE JUNCTION BOX, REFER SCHEDULE
-GUTTER FLOW ARROWS
-TREE TO BE REMOVED

EXISTING SERVICES LEGEND

RM — EXISTING RISING MAIN
S — EXISTING SEWER
T — EXISTING TELSTRA
W — EXISTING WATER

BAR SCALE 1:50
BAR SCALE 1:200

PIT SETOUT SCHEDULE

NO.	EASTING	NORTHING
28	579193.20	6156083.31
29	579191.84	6156079.73
30	579225.36	6156071.09
31	579234.35	6156063.54
32	579230.26	6156083.96
33	579240.68	6156080.07
34	579233.11	6156090.61

PIPE DRAIN SCHEDULE

SECTION	SIZE (mm)	CLASS	GRADE %	LENGTH
28 - 29	Ø375	3	0.385	3.869
28 - 30	Ø600	3	0.959	34.404
30 - 31	Ø375	3	5.736	11.157
30 - 32	Ø600	3	1.270	13.781
32 - 33	Ø375	3	5.797	11.126
32 - 34	Ø600	3	1.245	7.229

DRAINAGE PIT CONNECTION SCHEDULE

NO.	DESCRIPTION	CHAINAGE & OFFSET	GUTTER EL/TOP OF PIT	DRAIN SIZE (mm)	INVERT LEVEL
28	900Sq JUNCTION BOX	CHN: 575.00	11.425	Ø600 Ø600 Ø375	9.895 9.895 9.895
29	1900x450 SIDE ENTRY PIT	CHN: 575.00 OFFSET:	11.359	Ø375	9.810
30	900Sq JUNCTION BOX	CHN: 610.00	11.681	Ø600 Ø600 Ø375	10.225 10.225 10.225
31	1900x450 SIDE ENTRY PIT	CHN: 609.39 OFFSET: 11.16	11.939	Ø375	10.865
32	1900x900 SIDE ENTRY PIT	CHN: 623.20	11.938	Ø600 Ø600 Ø375	10.400 10.400 10.400
33	1900x600 SIDE ENTRY PIT	CHN: 623.70 OFFSET: 11.11	12.120	Ø375	10.045
34	1900x600 SIDE ENTRY PIT	CHN: 630.40	-	Ø600 Ø600	10.490 10.490

NOTE: * REFERS TO INLET (GUTTER) LEVEL
INVERTS LISTED CLOCKWISE FROM OUTLET

REVISION	AMENDMENT / REASON FOR ISSUE	APPROVED	DATE
A	ISSUED FOR CONSTRUCTION	T.K.	28.06.10

NOTES:

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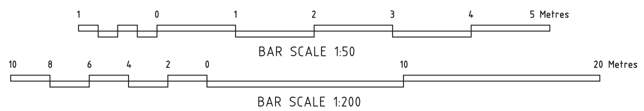
- SPATIAL INFORMATION
- ELECTRICAL MECHANICAL AND AUTOMOTIVE

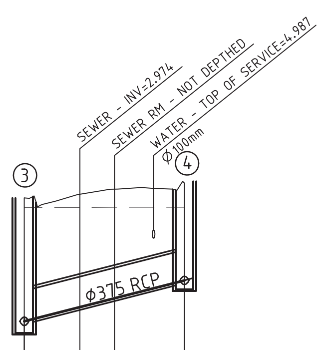
SCALE: 1:200 / 1:50 — SHEET SIZE A1
DESIGNED: AVV/CM — DRAWN: CM
PROJECT MANAGER: T.KIRBY — SENIOR DRAFTER: A.MORRISON
SURVEYED: — SURVEY DATE:
APPROVED: D.JACOBI
DATE: 28.06.10

CITY OF PORT LINCOLN

PORT LINCOLN DRAINAGE DESIGN
SEATON AVENUE AND MARINO AVENUE, PORT LINCOLN
CPLAN AND LONGITUDINAL SETION CHN 560.00 TO END

FILENAME: 20080344.5_PLAN.DWG — JOB NUMBER: 2008.0344.5 — SHEET NUMBER: 05 — REVISION: A

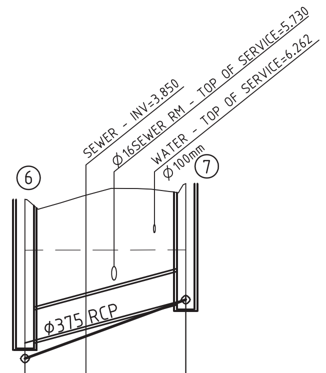




R.L. 3.000 HGL ARI=5YR Q=0.040m³/s

PROPOSED	3.830	4.350
CHAINAGE	0.0	8.2
EXISTING	5.40	5.59
VERT. GEOMETRY	P=6.370% L=8.164	

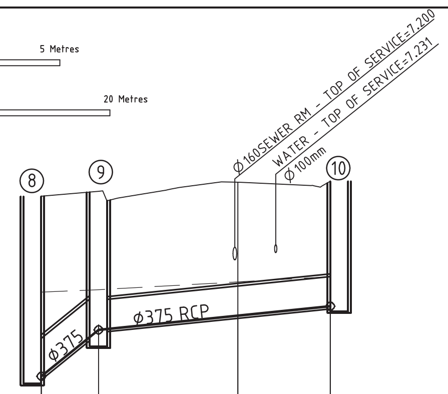
LONGITUDINAL SECTION
REFERENCE STRING MC01
HORIZ SCALE 1:200
VERT SCALE 1:50



R.L. 4.000 HGL ARI=5YR Q=0.040m³/s

PROPOSED	4.560	5.310
CHAINAGE	0.0	8.2
EXISTING	6.59	6.79
VERT. GEOMETRY	P=9.162% L=8.186	

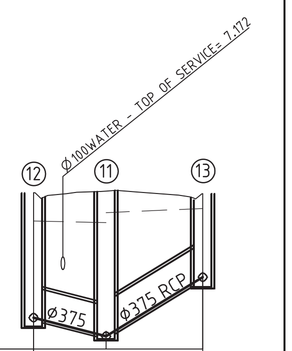
LONGITUDINAL SECTION
REFERENCE STRING MC02
HORIZ SCALE 1:200
VERT SCALE 1:50



R.L. 5.000 HGL ARI=5YR Q=0.168m³/s HGL ARI=5YR Q=0.088m³/s

PROPOSED	5.560	6.150	6.330	6.450
CHAINAGE	0.0	2.9	10.0	14.7
EXISTING	7.85		8.03	8.04
VERT. GEOMETRY	P	P=2.545% L=11.790		

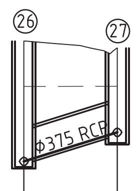
LONGITUDINAL SECTION
REFERENCE STRING MC03
HORIZ SCALE 1:200
VERT SCALE 1:50



R.L. 6.000

PROPOSED	6.400	6.163	6.915
	ARI=5YR Q=0.035m³/s		ARI=5YR Q=0.047m³/s
CHAINAGE	0.0	3.7	8.6
EXISTING	7.99		7.98
VERT. GEOMETRY	P	P	

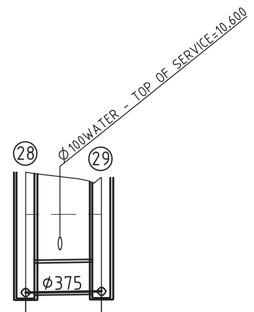
LONGITUDINAL SECTION
REFERENCE STRING MC04
HORIZ SCALE 1:200
VERT SCALE 1:50



R.L. 8.000 HGL ARI=5YR Q=0.038m³/s

PROPOSED	9.075	9.445
CHAINAGE	0.0	4.8
EXISTING	10.60	10.52
VERT. GEOMETRY	P	

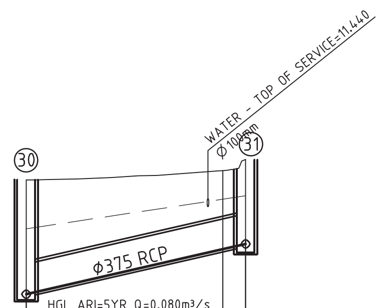
LONGITUDINAL SECTION
REFERENCE STRING MC08
HORIZ SCALE 1:200 VERT SCALE 1:50



R.L. 9.000 HGL ARI=5YR Q=0.082m³/s

PROPOSED	9.895	9.910
CHAINAGE	0.0	3.9
EXISTING	11.43	11.36
VERT. GEOMETRY	P	

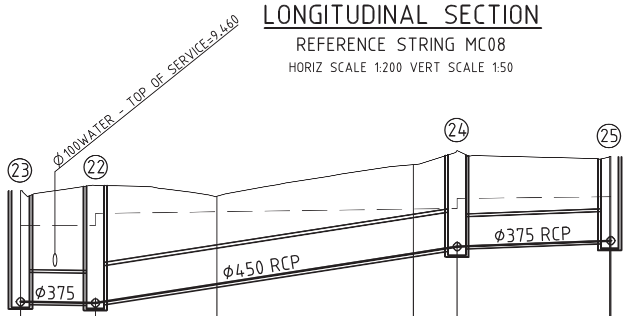
LONGITUDINAL SECTION
REFERENCE STRING MC09
HORIZ SCALE 1:200 VERT SCALE 1:50



R.L. 10.000 HGL ARI=5YR Q=0.080m³/s

PROPOSED	10.225	10.799	10.865
CHAINAGE	0.0	10.0	11.2
EXISTING	11.68	11.80	11.94
VERT. GEOMETRY	P=5.736% L=11.157		

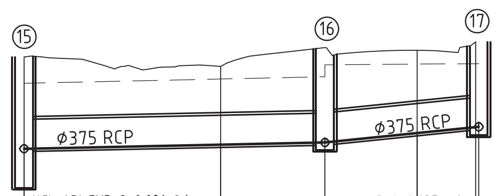
LONGITUDINAL SECTION
REFERENCE STRING MC10
HORIZ SCALE 1:200 VERT SCALE 1:50



R.L. 8.000 HGL ARI=5YR Q=0.205m³/s HGL ARI=5YR Q=0.116m³/s HGL ARI=5YR Q=0.051m³/s

PROPOSED	8.850	8.835	9.075	9.463	9.550	9.625
CHAINAGE	0.0	3.8	10.0	20.0	22.2	30.0
EXISTING	10.26		10.19	10.59		10.70
VERT. GEOMETRY	P	P=3.881% L=18.422			P=0.959% L=7.818	

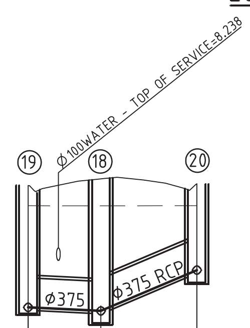
LONGITUDINAL SECTION
REFERENCE STRING MC07
HORIZ SCALE 1:200 VERT SCALE 1:50



R.L. 7.000 HGL ARI=5YR Q=0.086m³/s ARI=5YR Q=0.035m³/s

PROPOSED	7.750	7.802	7.830	7.950	8.030
CHAINAGE	0.0	10.0	15.3	20.0	23.1
EXISTING	8.92	8.80		9.00	-999.00
VERT. GEOMETRY	P=0.523% L=15.307			P=2.557% L=7.822	

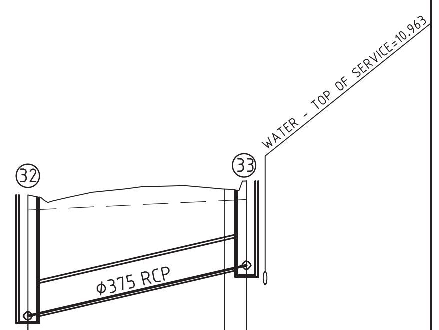
LONGITUDINAL SECTION
REFERENCE STRING MC05
HORIZ SCALE 1:200 VERT SCALE 1:50



R.L. 7.000 ARI=5YR Q=0.035m³/s HGL ARI=5YR Q=0.047m³/s

PROPOSED	7.480	7.435	7.955
CHAINAGE	0.0	3.7	8.6
EXISTING	9.03		9.05
VERT. GEOMETRY	P	P	

LONGITUDINAL SECTION
REFERENCE STRING MC06
HORIZ SCALE 1:200 VERT SCALE 1:50



R.L. 10.000 HGL ARI=5YR Q=0.080m³/s

PROPOSED	10.400	10.980	11.045
CHAINAGE	0.0	10.1	11.1
EXISTING	11.94	12.01	12.12
VERT. GEOMETRY	P=5.797% L=11.126		

LONGITUDINAL SECTION
REFERENCE STRING MC20
HORIZ SCALE 1:200 VERT SCALE 1:50

REVISION	AMENDMENT / REASON FOR ISSUE	APPROVED	DATE
A	ISSUED FOR CONSTRUCTION	T.K.	28.06.10

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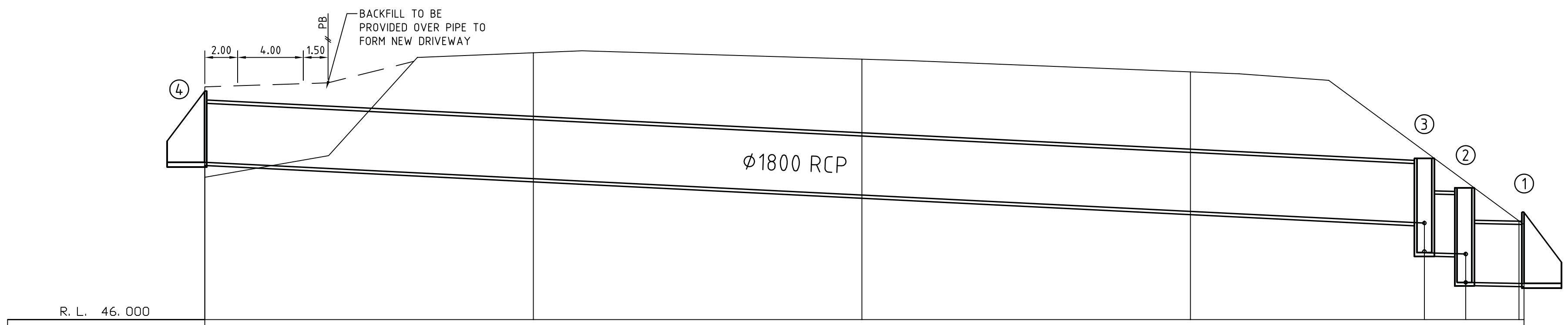
SCALE: 1:200 1:50
SHEET SIZE A1
DESIGNED: TCR
DRAWN: CM
PROJECT MANAGER: T.KIRBY
SENIOR DRAFTER: A.MORRISON
SURVEYED:
SURVEY DATE:
APPROVED: D.JACOBI
DATE: 28.06.10

CITY OF PORT LINCOLN

PORT LINCOLN DRAINAGE DESIGN
SEATON AVENUE AND MARINO AVENUE, PORT LINCOLN
LONGITUDINAL SECTIONS

FILENAME: 20080344.5_PLAN.DWG
JOB NUMBER 06
SHEET NUMBER 2008.0344.5
REVISION A



PROPOSED	50.80	50.30	49.80	49.30	48.94	48.04	48.00	47.14	47.11	47.10
CHAINAGE	0.0	20.0	40.0	60.0	74.24	74.24	76.75	76.75	80.0	80.3
EXISTING	50.34	54.14	53.94	53.56	51.14	51.14	50.21	50.21	49.01	48.90
VERT. GEOMETRY	P=2.5% L=74.24				P=1.5% L=2.51		P=1.0% L=3.55			

LONGITUDINAL SECTION

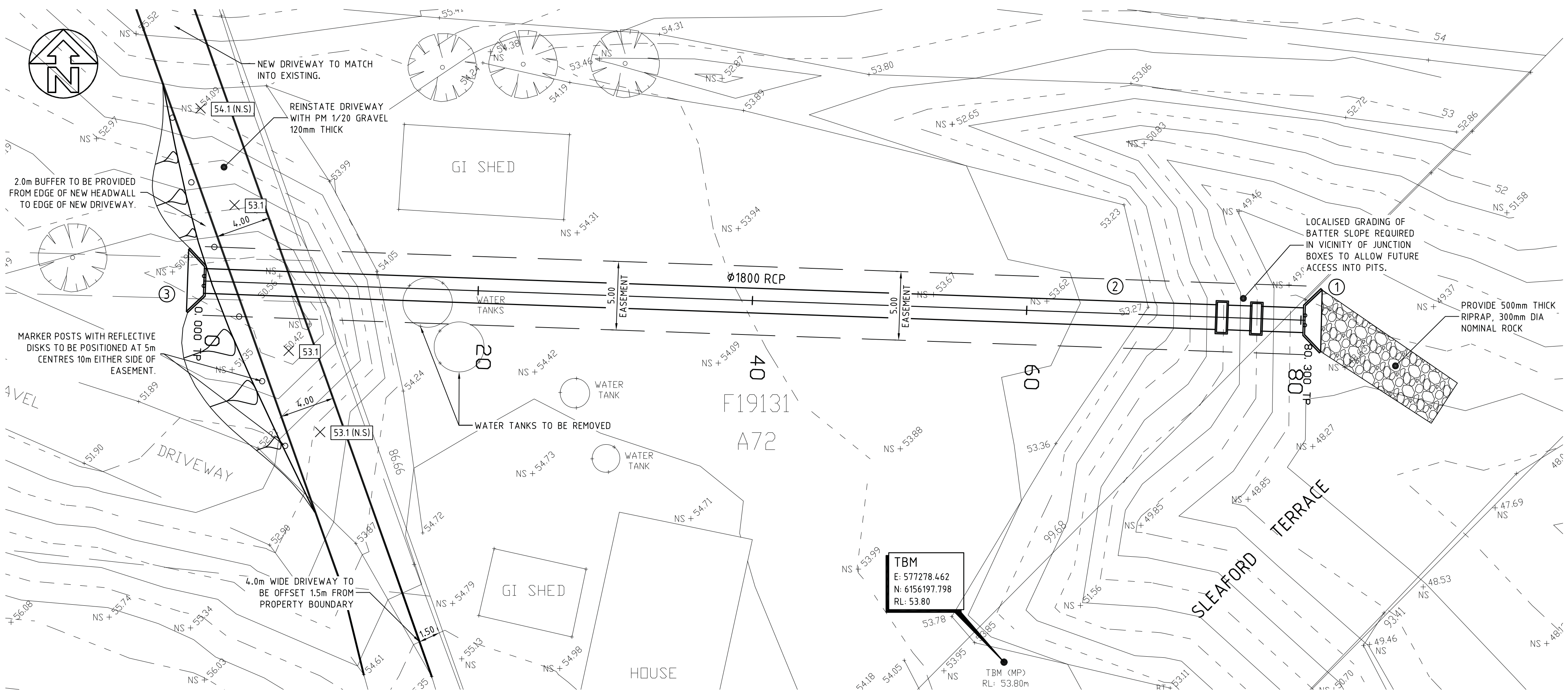
SCALE: 1:200 HORIZONTAL
1:100 VERTICAL

DRAINAGE PIT CONNECTION SCHEDULE

NO.	DESCRIPTION	EASTING: NORTHING:	GUTTER EL/TOP OF PIT	DRAIN SIZE (mm)	INVERT LEVEL
1	Ø1800 HEADWALL	E: 577300.397 N: 6156222.697	-	Ø1800	47.10
2	2400x900 JUNCTION BOX	E: 577296.895 N: 6156222.822	50.21	Ø1800 Ø1800	47.14 48.00
3	2400x900 JUNCTION BOX	E: 577294.332 N: 6156222.914	51.18	Ø1800 Ø1800	48.08 48.95
4	Ø1800 HEADWALL	E: 577220.150 N: 6156225.567	-	Ø1800	50.80

PIPE DRAIN SCHEDULE

SECTION	SIZE (mm)	CLASS	GRADE %	LENGTH
1 - 2	Ø1800	2	1.00	3.55
2 - 3	Ø1800	2	1.50	2.51
3 - 4	Ø1800	2	2.50	74.13

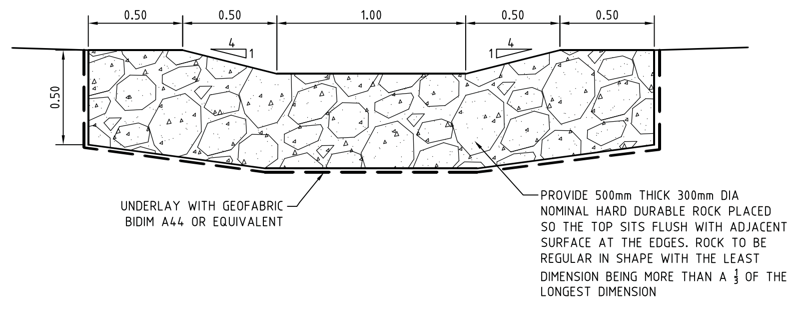


PLAN

SCALE 1:200

BAR SCALE HORIZ 1:200

BAR SCALE VERT 1:100



ROCK SCOUR PROTECTION DETAIL

SCALE: 1:20

REVISION	AMENDMENT / REASON FOR ISSUE	APPROVED	DATE
A	ISSUED FOR CONSTRUCTION	D.K.	02/07/10

NOTES:

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APPROVED COMPANY ISO 9001 Quality Management Systems QMS

SCALE: H=1:200 V=1:100 — SHEET SIZE A1

DESIGNED: C.D./D.B.B. — DRAWN: C.D./D.B.B.

PROJECT MANAGER: D.K. — SENIOR DRAFTER: A.M.

SURVEYED: — SURVEY DATE:

APPROVED: D.J. — DATE: 07/07/2010

CITY OF PORT LINCOLN

STORMWATER DRAINAGE DESIGN
GRANTALA GULLY, PORT LINCOLN
PLAN AND LONGITUDINAL SECTION

FILENAME: 20080344.1_PLAN.DWG — JOB NUMBER: 2008.0344 — SHEET NUMBER: 01 — REVISION: A

T:\2008\20080344 PORT LINCOLN DEVELOPMENTS STORMWATER DESIGN\ACAD\FINAL\2008.0344.1\20080344.1_PLAN.DWG [SHEET 1 PLAN AND LSECT] 07-Jul-2010 - 4:26pm

SWALE SETOUT SCHEDULE

NO.	EASTING	NORTHING	INVERT LEVEL
1	577552.933	6156118.604	39.90
2	577560.036	6156109.289	39.55
3	577569.097	6156100.141	39.17
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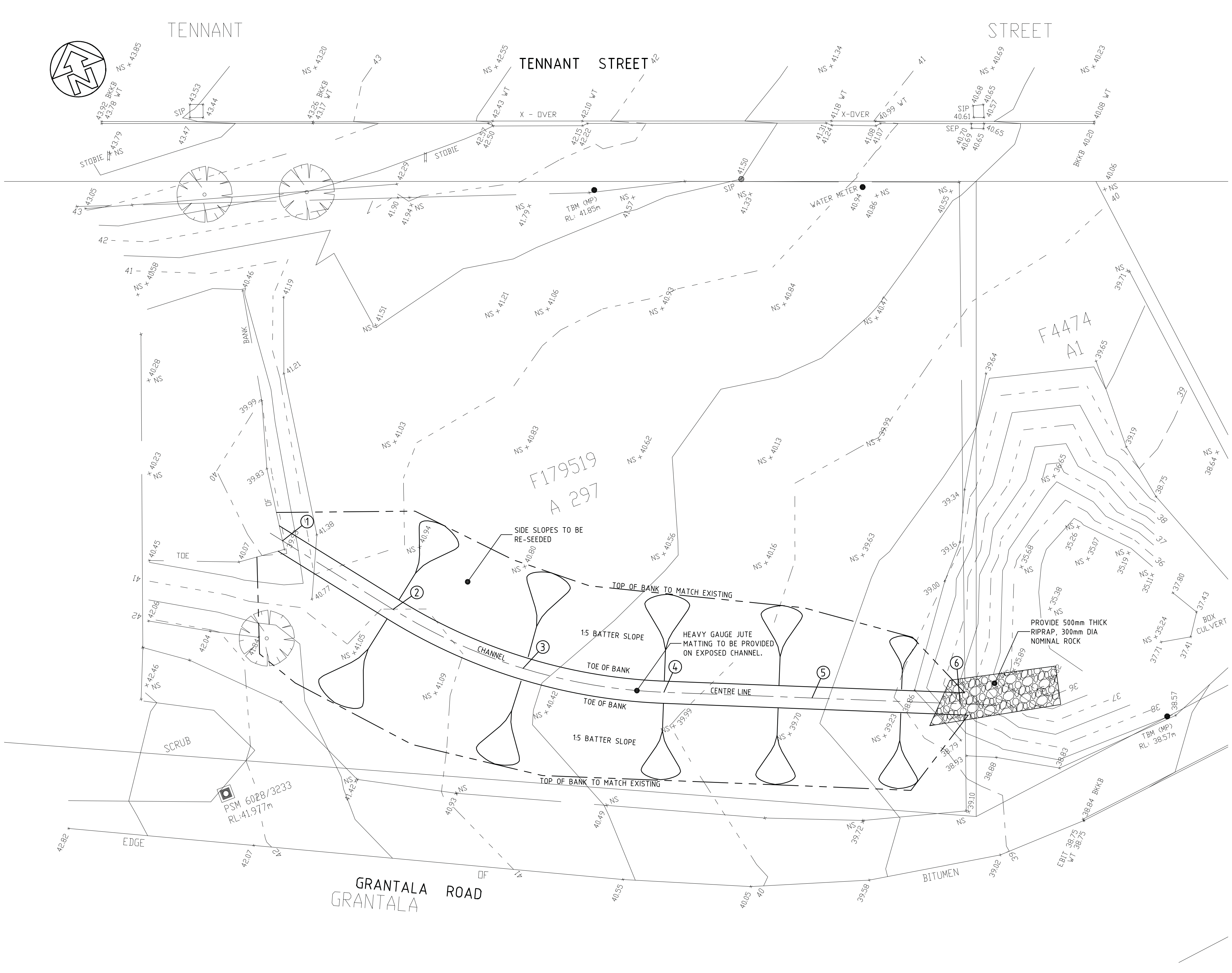
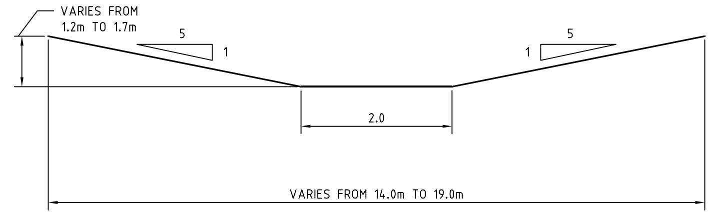


PLAN

SCALE 1:200

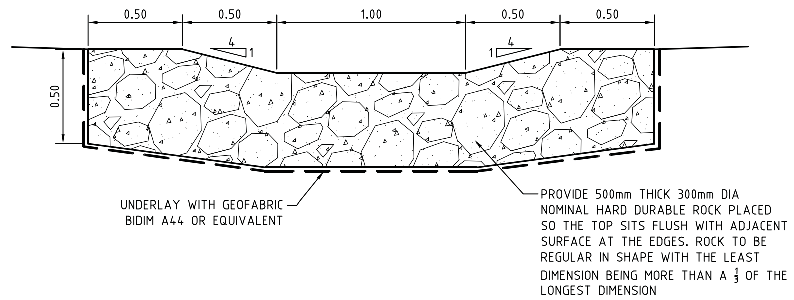
BAR SCALE HORIZ 1:200 (10 8 6 4 2 0 10 20 Metres)

BAR SCALE VERT 1:100 (5 4 3 2 1 0 5 10 Metres)



TYPICAL SWALE CROSS SECTION

SCALE: 1 : 100



ROCK SCOUR PROTECTION DETAIL

SCALE: 1 : 20

REVISION	AMENDMENT / REASON FOR ISSUE	APPROVED	DATE
A	ISSUED FOR CONSTRUCTION	D.K.	07/07/10

NOTES:

ALL LEVELS TO A.H.D.

100mm ON ORIGINAL DRAWING — DO NOT SCALE

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APPROVED COMPANY ISO 9001 Quality Management Systems QMS

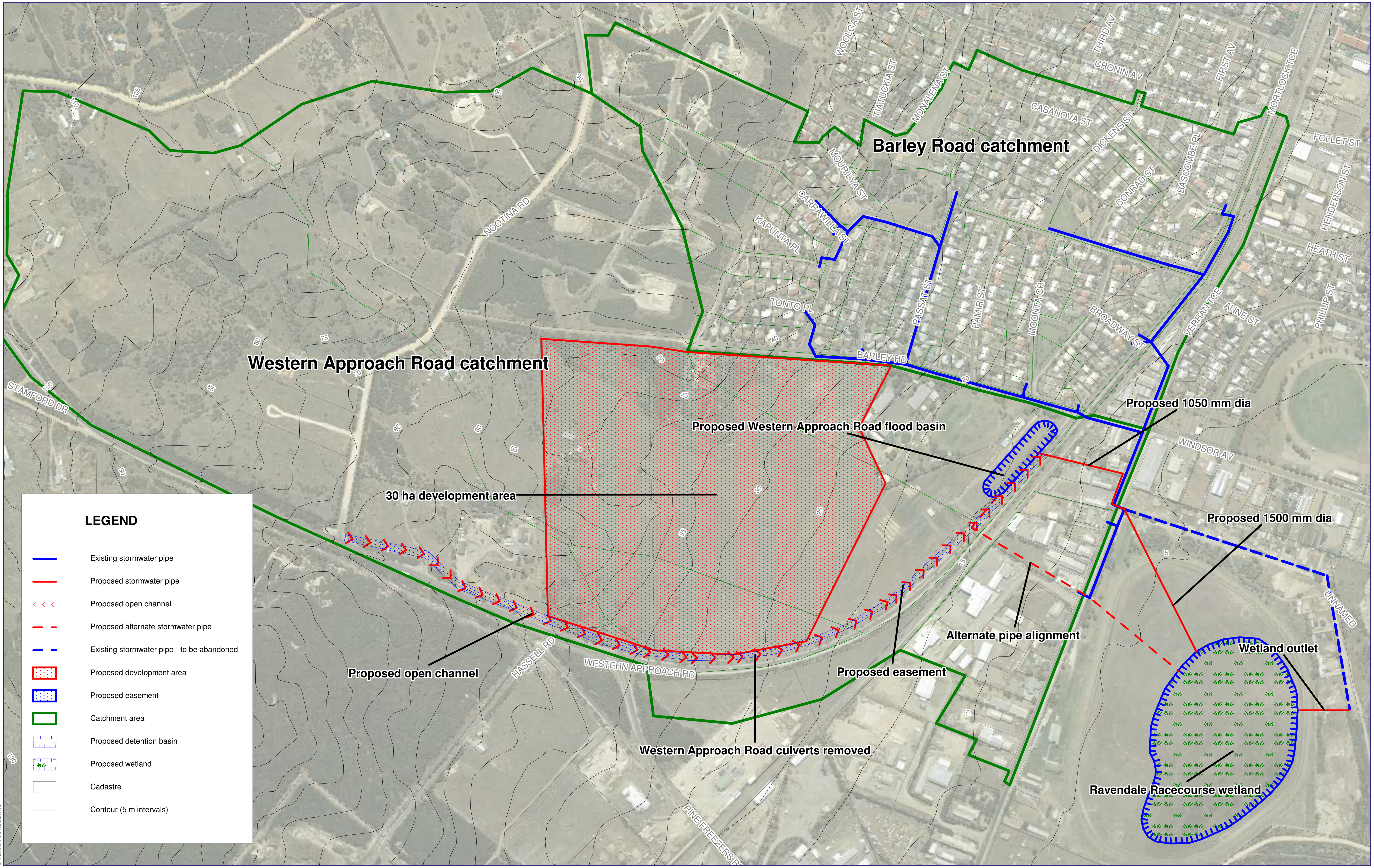
SCALE: H=1:200 V=1:100	SHEET SIZE A1
DESIGNED: C.D./D.B.B.	DRAWN: C.D./D.B.B.
PROJECT MANAGER: D.K.	SENIOR DRAFTER: A.M.
SURVEYED:	SURVEY DATE:
APPROVED: D.J.	DATE: 07/07/2010

CITY OF PORT LINCOLN

STORMWATER DRAINAGE DESIGN
GRANTALA GULLY, PORT LINCOLN
PLAN AND TYPICAL CROSS SECTION

FILENAME:	JOB NUMBER	SHEET NUMBER	REVISION
20080344.1_PLAN.DWG	2008.0344		A

T:\2008\20080344 PORT LINCOLN DEVELOPMENTS STORMWATER DESIGN\ACAD\FINAL\2008.0344.1\20080344.1_PLAN.DWG [SHEET 2 PLAN AND CROSS SECT] 07-Jul-2010 - 4:27pm



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N W E S

Scale: 1:6,500 @3

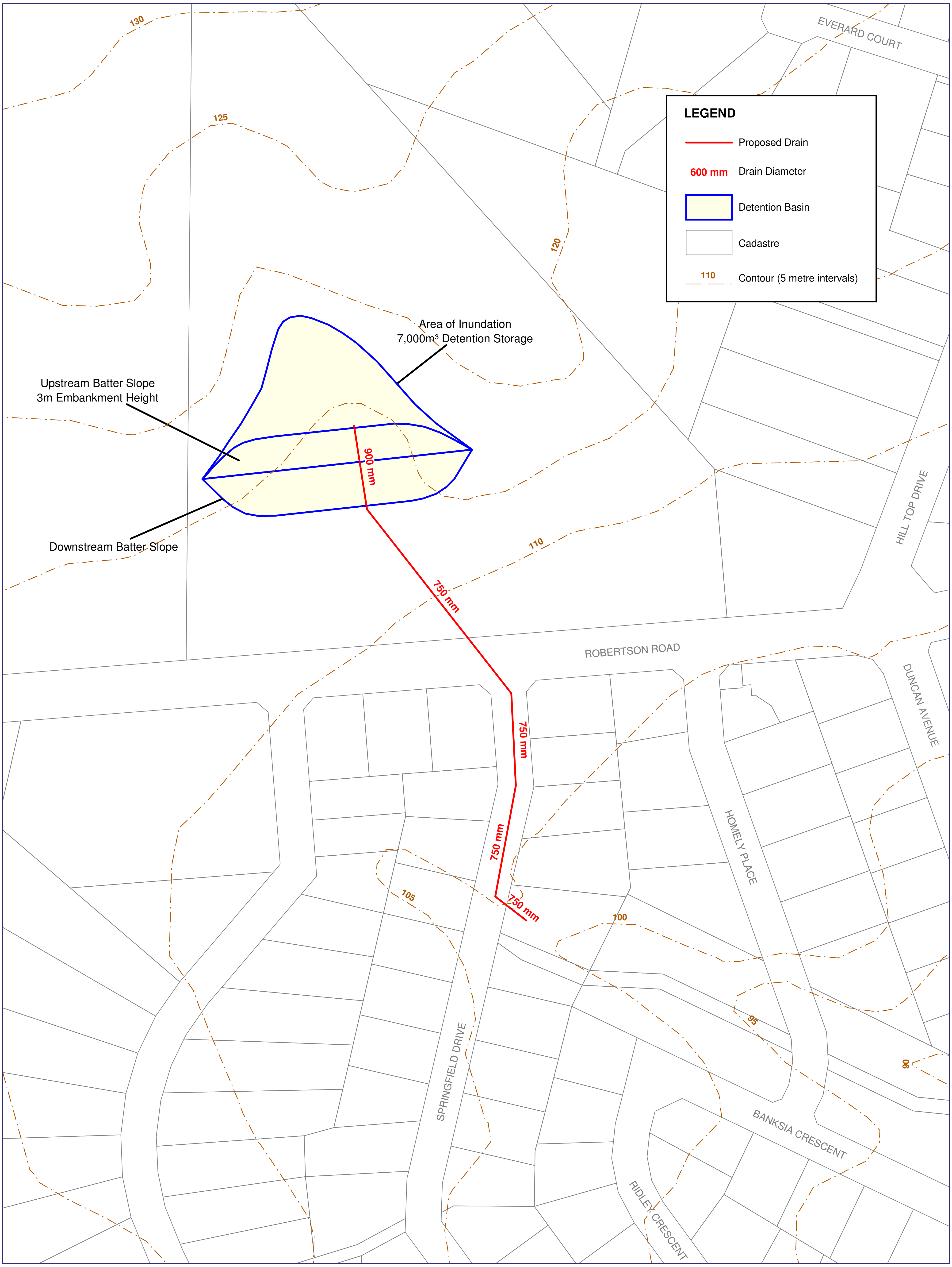
Job Number:	2007.0307
Filename:	FigureD5.wor
Revision:	E
Date:	06/03/2009
Drawn:	TR
Technical Approval:	TAK

Data Acknowledgement:
Cadastre supplied by PBBI Australia Pty Ltd
Road data supplied by PBBI Australia Pty Ltd

City of Port Lincoln
Stormwater Management Plan

WESTERN APPROACH ROAD PROPOSED DRAINAGE WORKS

Figure D.5



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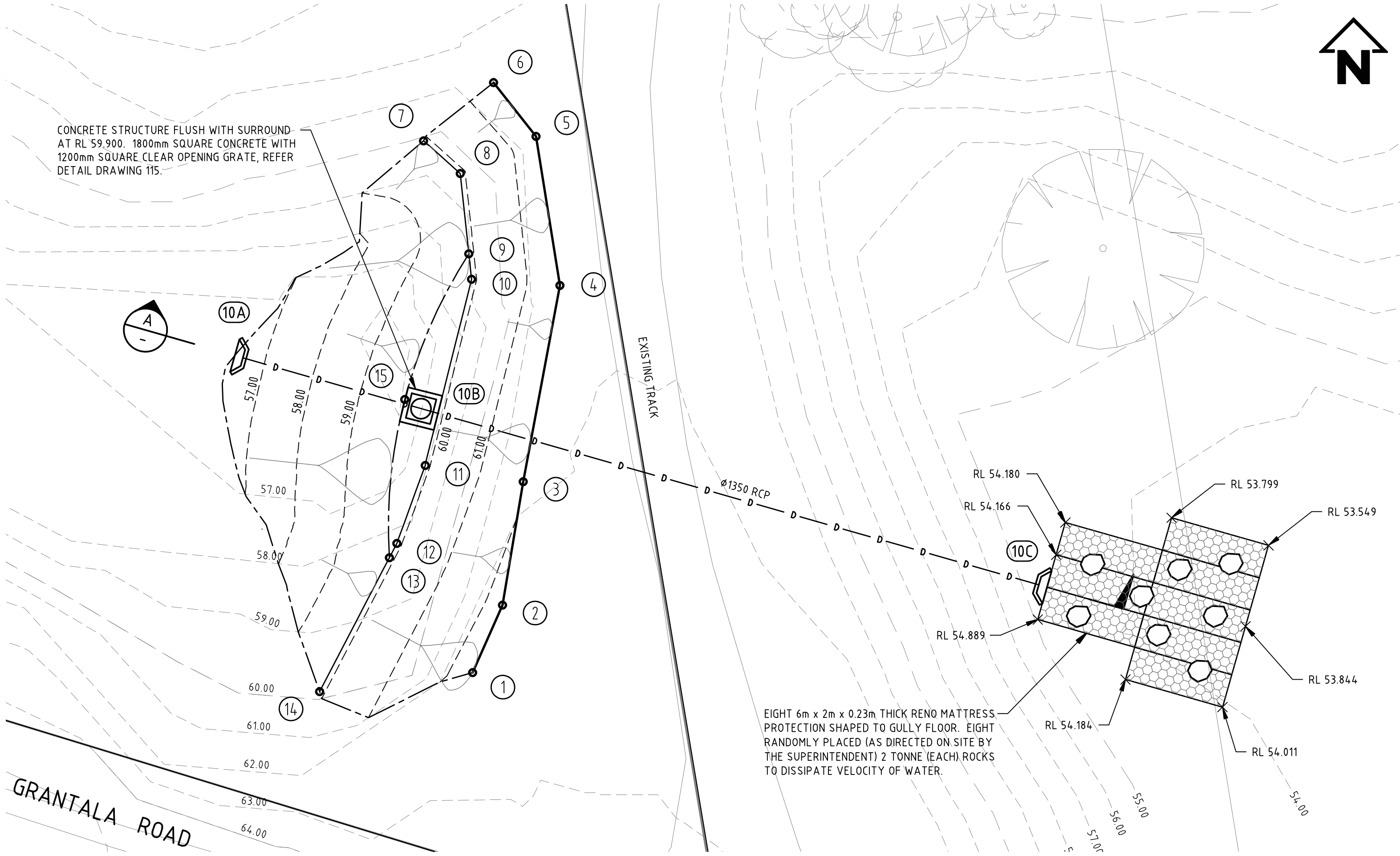
N W E S

Scale: 1:1,500 @ A3

Job Number: 2007.0307
Filename: FigureD6.wor
Revision: E
Date: 9/01/2008
Drawn: TR
Technical Approval: TAK

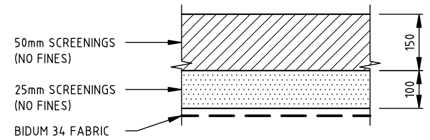
Data Acknowledgement:
Cadastre supplied by PBBI Australia Pty Ltd

City of Port Lincoln
Stormwater Management Plan
PROPOSED DETENTION BASIN
HILLTOP DRIVE
Figure D.6



PLAN

SCALE 1:200



RIP-RAP DETAIL

SETOUT DATA				
POINT	EASTING	NORTHING	LEVEL	COMMENTS
1	577087.494	6156211.277	62.420	
2	577089.279	6156215.279	62.331	
3	577090.503	6156222.620	61.871	
4	577092.697	6156234.292	61.635	
5	577091.265	6156243.158	61.472	
6	577088.746	6156246.349	61.855	
7	577084.583	6156242.893	59.900	
8	577086.765	6156240.949	59.900	
9	577087.273	6156236.168	59.900	
10	577087.433	6156234.655	59.900	
11	577084.674	6156223.591	59.900	
12	577082.988	6156218.957	59.900	
13	577082.540	6156218.097	59.900	
14	577078.397	6156210.146	59.900	
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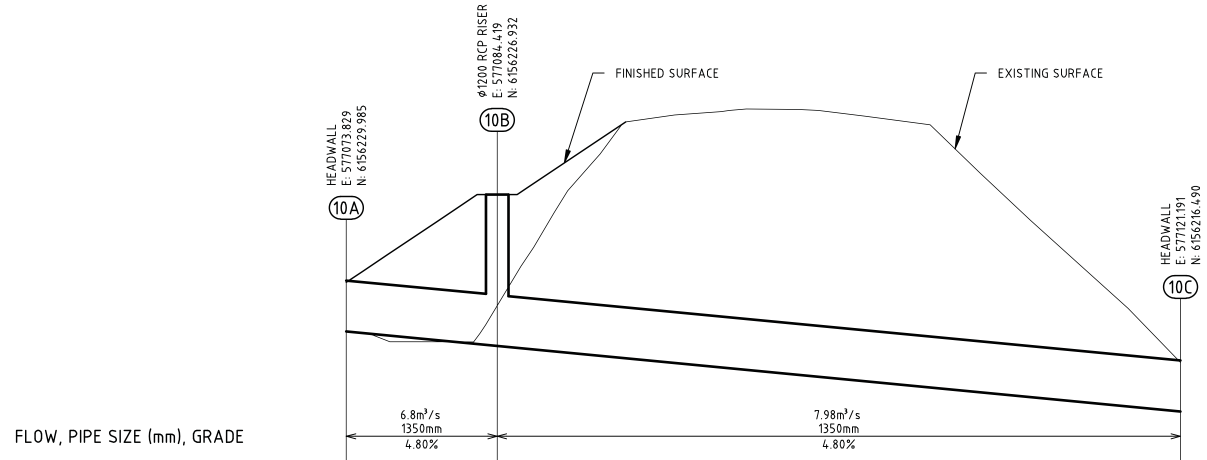
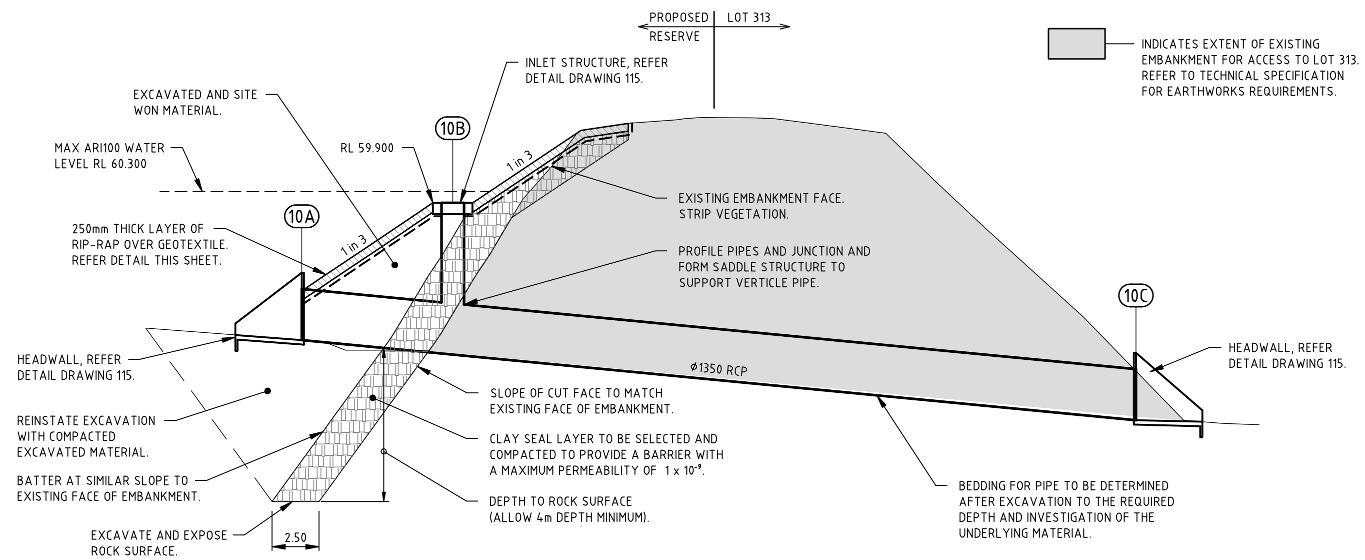


FLOW, PIPE SIZE (mm), GRADE		$6.8 m^3/s$ 1350mm 4.80%	$7.98 m^3/s$ 1350mm 4.80%
DATUM	Datum El. 52		

	10A	10B	10C
DEPTH TO INVERT	1.300	4.010	1.300
INVERT LEVEL	56.274	55.890	54.153
SURFACE LEVEL	57.574	59.900	55.453
CHAINAGE	0.00	8.00	44.20

STORMWATER LONGITUDINAL SECTION

SCALE 1:200 HOR
1:100 VERT



SECTION A

SCALE 1:200 HOR
1:100 VERT

NOT FOR CONSTRUCTION

A1	XREF FILES		
DESIGN JDB	AUG 09	SCALES	AS SHOWN
DESIGN CHECK BJS	SEP 09	CAD FILE	08-328-114
DRAWN JDB	AUG 09	PLOT SCALE / PROJECT APPROVAL	DATE
DRAFTING CHECK BJS	SEP 09	CLIENT APPROVAL	

100 MILLIMETRES ON ORIGINAL DRAWING

SCALE OF METRES 1:200 AT A1 (0 2 4 6 8 10)

SCALE OF METRES 1:100 AT A1 (0 1 2 3 4 5)

CODE	DATE	DESCRIPTION	DRAFT	DES
A	18.09.09	ISSUED FOR APPROVAL	JDB	JDB

REVISIONS AND ISSUES

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Adelaide SA 5000
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ABN 39 061 222 984

LINCOLN HEIGHTS PTY LTD
NEW WEST ROAD SUBDIVISION
PORT LINCOLN STAGE 1

DETENTION BASIN LAYOUT PLAN

DRAWING NUMBER 08-328-114

REVISION CODE A

Appendix E

Costings

INDICATIVE CONSTRUCTION COST ESTIMATE FOR
MALLEE PARK DETENTION BASIN & STAMFORD TCE DRAIN

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Project: **Port lincoln Drainage Review**

Job No: 2007.0307
Date: 5-Jun-13 Sheet No 1 of 1

Estimated by: T. Rundle
Review by: T. Kerby

Note: Cost estimates provided by Tonkin Consulting are based upon historic cost information and experience, and do not allow for latent conditions, changes in scope and market conditions (ie competition, escalation, changes to public and private utility policies in regards to relocation and augmentation of services).

Tonkin Consulting recommend that a professional Quantity Surveyor be engaged if assurance of cost is required and project budget estimates allowing for these factors are required.

Item No	Description	Unit	Qty	Rate	Cost
1	**Preliminaries**				
	Establishment	item	1	$30,000	$30,000
	Setting Out	item	1	$10,000	$10,000
2	**Stormwater Drainage**				
	900 dia RCP Class 2	m	550	$900	$495,000
	900 dia headwall	ea	1	$1,500	$1,500
	Connection to existing drain	item	1	$2,000	$2,000
	Modification of Splitter Box	item	1	$5,000	$5,000
3	**Earthworks**				
	Cut to disposal*	m^3	60,000	$8	$480,000
	Wetland Excavation*	m^3	20,000	$8	$160,000
	Landscaping	m^2	35,000	$3	$105,000
4	**Miscellaneous** #				
	CCTV Survey	item	1	$4,000	$4,000
	Testing	item	1	$10,000	$10,000
	Cleaning Up	item	1	$10,000	$10,000

Total (+20% loading) **$1,575,000**

* Price assumes for the excavation of soil. Higher cost are expected if rock is encountered during the excavation of the Wetland
# No allowance for aquifer storage and recovery works

INDICATIVE CONSTRUCTION COST ESTIMATE FOR
RAVENDALE RACECOURSE BASIN & PIPEWORK

Project: **Port lincoln Drainage Review**

Job No: 2007.0307
Date: 6-Jun-13 Sheet No 1 of 1

Estimated by: T. Kerby
Review by: J. O'Brien

Note: Cost estimates provided by Tonkin Consulting are based upon historic cost information and experience, and do not allow for latent conditions, changes in scope and market conditions (ie competition, escalation, changes to public and private utility policies in regards to relocation and augmentation of services).

Tonkin Consulting recommend that a professional Quantity Surveyor be engaged if assurance of cost is required and project budget estimates allowing for these factors are required.

Item No	Description	Unit	Qty	Rate	Cost
1	**Preliminaries**				
	Establishment	item	1	$30,000	$30,000
	Setting Out	item	1	$10,000	$10,000
2	**Stormwater Drainage**				
	900 dia RCP Class 2	m	90	$800	$72,000
	Connection to existing drain	item	1	$5,000	$5,000
3	**Earthworks**				
	Wetland Excavation*	m^3	116,100	$8	$928,800
	Landscaping	m^2	77,000	$3	$231,000
4	**Miscellaneous** #				
	CCTV Survey	item	1	$4,000	$4,000
	Testing	item	1	$10,000	$10,000
	Cleaning Up	item	1	$10,000	$10,000

Total (+20% loading) **$1,560,960**

* Price assumes for the excavation of soil. Higher cost are expected if rock is encountered during the excavation of the Wetland
# No allowance for aquifer storage and recovery works

INDICATIVE CONSTRUCTION COST ESTIMATE
WESTERN APPROACH ROAD DETENTION BASIN AND OUTLET PIPES

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Project: **Port Lincoln Drainage Review**

Job No: 2007.0307
Date: 11-Dec-07 Sheet No 1 of 1

Estimated by: T. Rundle
Review by: T. Kerby

Note: Cost estimates provided by Tonkin Consulting are based upon historic cost information and experience, and do not allow for latent conditions, changes in scope and market conditions (ie competition, escalation, changes to public and private utility policies in regards to relocation and augmentation of services).

Tonkin Consulting recommend that a professional Quantity Surveyor be engaged if assurance of cost is required and project budget estimates allowing for these factors are required.

Item No	Description	Unit	Qty	Rate	Cost
1	**Preliminaries**				
	Establishment	item	1	$5,000	$5,000
	Setting Out	item	1	$5,000	$5,000
2	**Stormwater Drainage**				
	750 dia Class 2 RCP	m	100	$700	$70,000
	750 dia Precast headwall	ea	1	$2,000	$2,000
	1050 dia RCP Class 2	m	160	$900	$144,000
	1500 dia RCP Class 2	m	370	$1,600	$592,000
	1500 dia Precast headwall	ea	1	$1,500	$1,500
	1800 sq Junction Box	ea	5	$8,000	$40,000
	Connection to existing drain	item	4	$500	$2,000
3	**Earthworks**				
	Interception swale	m	1280	$20	$25,600
	Cut to disposal	m^3	9200	$8	$73,600
	Grassing	m^2	7000	$2	$14,000
4	**Miscellaneous**				
	Testing	item	1	$2,000	$2,000
	Cleaning Up	item	1	$5,000	$5,000

Total (+20% loading)* **$1,178,040**

*No allowance has been made for service alterations

LIVERPOOL STREET PUMP STATION & DRAINAGE DESIGN INDICATIVE CONSTRUCTION COST ESTIMATE

Project: **Port Lincoln Drainage Review**
Job No: 2007.0307
Date: 11-Dec-07 Sheet No 1 of 1

Estimated by: T. Rundle
Review by: T. Kerby

Note: Cost estimates provided by Tonkin Consulting are based upon historic cost information and experience, and do not allow for latent conditions, changes in scope and market conditions (ie competition, escalation, changes to public and private utility policies in regards to relocation and augmentation of services).

Tonkin Consulting recommend that a professional Quantity Surveyor be engaged if assurance of cost is required and project budget estimates allowing for these factors are required.

Item No	Description	Unit	Qty	Rate	Cost
1	**Preliminaries**				
	Establishment	item	1	$30,000	$30,000
	Setting Out	item	1	$10,000	$10,000
2	**Stormwater Drainage**				
	750 L/s pump, installed	item	1	$60,000	$60,000
	Power Supply	item	1	$30,000	$30,000
	Inlet Modifications	item	1	$15,000	$15,000
	600 dia Class 2 RCP Rising Main	m	280	$650	$182,000
	Junction Box	ea	3	$4,000	$12,000
	Headwall	ea	1	$3,000	$3,000
	Generator Upgrade	item	1	$110,000	$110,000
3	**Miscellaneous**				
	CCTV Survey	item	1	$4,000	$4,000
	Testing	item	1	$4,000	$4,000
	Cleaning Up	item	1	$5,000	$5,000

Total (+20% loading)* **$558,000**

*No allowance has been made for service alterations

BROUGHAM PLACE DRAINAGE DESIGN INDICATIVE CONSTRUCTION COST ESTIMATE

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Project: **Port Lincoln Drainage Review**
Job No: 2007.0307
Date: 11-Dec-07

Sheet No 1 of 1

Estimated by: T. Rundle
Review by: T. Kerby

Note: Cost estimates provided by Tonkin Consulting are based upon historic cost information and experience, and do not allow for latent conditions, changes in scope and market conditions (ie competition, escalation, changes to public and private utility policies in regards to relocation and augmentation of services).

Tonkin Consulting recommend that a professional Quantity Surveyor be engaged if assurance of cost is required and project budget estimates allowing for these factors are required.

Item No	Description	Unit	Qty	Rate	Cost
1	**Preliminaries**				
	Establishment	item	1	$10,000	$10,000
	Setting Out	item	1	$5,000	$5,000
2	**Stormwater Drainage**				
	450 dia Class 2 RCP	m	40	$400	$16,000
	600 dia Class 2 RCP	m	600	$650	$390,000
	900 dia Class 2 RCP	m	550	$800	$440,000
	Junction Box	ea	12	$4,000	$48,000
	Headwall	ea	1	$3,000	$3,000
3	**Miscellaneous**				
	CCTV Survey	item	1	$4,000	$4,000
	Testing	item	1	$2,000	$2,000
	Cleaning Up	item	1	$5,000	$5,000

Total (+20% loading)* **$1,107,600**

*No allowance has been made for service alterations

SEATON AVENUE DRAINAGE DESIGN INDICATIVE CONSTRUCTION COST ESTIMATE (STAGE 1)

Project: **Port Lincoln Drainage Review**
Job No: 2008.0344
Date: 1-Apr-11 Sheet No 1 of 1

Estimated by: T. Rundle
Review by: T. Kerby

Note: Cost estimates provided by Tonkin Consulting are based upon historic cost information and experience, and do not allow for latent conditions, changes in scope and market conditions (ie competition, escalation, changes to public and private utility policies in regards to relocation and augmentation of services).

Tonkin Consulting recommend that a professional Quantity Surveyor be engaged if assurance of cost is required and project budget estimates allowing for these factors are required.

Item No	Description	Unit	Qty	Rate	Cost
1	**Preliminaries**				
	Establishment	item	1	$25,000	$25,000
	Setting Out	item	1	$12,000	$12,000
2	**Stormwater Drainage**				
	375 dia RCP	m	29	$320	$9,280
	825 dia RCP	m	20	$750	$15,000
	900 dia RCP	m	241	$810	$195,210
	1050 dia RCP	m	44	$900	$39,600
	Double 1900 x 600 SEP	ea	6	$3,500	$21,000
	Double 1900 x 1350 SEP	ea	1	$6,500	$6,500
	Double 1900 x 1200 SEP	ea	3	$8,000	$24,000
	1200 SQ Junction Box	ea	1	$5,000	$5,000
	1500x900 Junction Box	ea	1	$5,000	$5,000
	1050 dia Headwall	ea	1	$3,000	$3,000
3	**Miscellaneous**				
	CCTV Survey	item	1	$5,000	$5,000
	Testing	item	1	$5,000	$5,000
	Cleaning Up	item	1	$10,000	$10,000
		GST			$38,059
		Total (+20% loading)*			**$502,379**

*No allowance has been made for service alterations

MARINO AVENUE DRAINAGE DESIGN INDICATIVE CONSTRUCTION COST ESTIMATE (STAGE 2)

Project: **Port Lincoln Drainage Review**
Job No: 2008.0344
Date: 1-Apr-11

Sheet No 1 of 1

Estimated by: T. Rundle
Review by: T. Kerby

Note: Cost estimates provided by Tonkin Consulting are based upon historic cost information and experience, and do not allow for latent conditions, changes in scope and market conditions (ie competition, escalation, changes to public and private utility policies in regards to relocation and augmentation of services).

Tonkin Consulting recommend that a professional Quantity Surveyor be engaged if assurance of cost is required and project budget estimates allowing for these factors are required.

Item No	Description	Unit	Qty	Rate	Cost
1	**Preliminaries**				
	Establishment	item	1	$25,000	$25,000
	Setting Out	item	1	$12,000	$12,000
2	**Stormwater Drainage**				
	375 dia RCP	m	75	$320	$24,000
	450 dia RCP	m	19	$420	$7,980
	600 dia RCP	m	111	$520	$57,720
	675 dia RCP	m	108	$620	$66,960
	750 dia RCP	m	107	$700	$74,900
	Double 1900 x 450 SEP	ea	2	$3,300	$6,600
	Double 1900 x 600 SEP	ea	9	$3,500	$31,500
	Double 1900 x 900 SEP	ea	2	$5,000	$10,000
	1200 SQ Junction Box	ea	5	$5,000	$25,000
	900 SQ Junction Box	ea	1	$3,000	$3,000
3	**Miscellaneous**				
	CCTV Survey	item	1	$5,000	$5,000
	Testing	item	1	$5,000	$5,000
	Cleaning Up	item	1	$10,000	$10,000
		GST			$36,466
		Total (+20% loading)*			**$481,351**

*No allowance has been made for service alterations

HALLETT PLACE DRAINAGE DESIGN INDICATIVE CONSTRUCTION COST ESTIMATE

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Project: **Port Lincoln Drainage Review**
Job No: 2007.0307
Date: 6-Jun-13

Sheet No 1 of 1

Estimated by: T. Kerby
Review by: J. O'Brien

Note: Cost estimates provided by Tonkin Consulting are based upon historic cost information and experience, and do not allow for latent conditions, changes in scope and market conditions (ie competition, escalation, changes to public and private utility policies in regards to relocation and augmentation of services).

Tonkin Consulting recommend that a professional Quantity Surveyor be engaged if assurance of cost is required and project budget estimates allowing for these factors are required.

Item No	Description	Unit	Qty	Rate	Cost
1	**Preliminaries**				
	Establishment	item	1	$5,000	$5,000
	Setting Out	item	1	$10,000	$10,000
2	**Stormwater Drainage**				
	375 dia RCP Class 3	m	10	$320	$3,200
	450mm RCP Class 3	m	180	$420	$75,600
	525mm RCP Class 3	m	40	$500	$20,000
	300x300 Box Culvert	m	10	$500	$5,000
	Double 1900 x 900 SEP	ea	9	$4,500	$40,500
	900 SQ Junction Box	ea	4	$3,000	$12,000
3	**Miscellaneous**				
	CCTV Survey	item	1	$5,000	$5,000
	Testing	item	1	$2,000	$2,000
	Cleaning Up	item	1	$5,000	$5,000

Total (+20% loading)* **$219,960**

*No allowance has been made for service alterations

INDICATIVE CONSTRUCTION COST ESTIMATE
GRANTALA ROAD GULLY

Project: **Port Lincoln Drainage Review**
Job No: 2007.0307
Date: 6-Jun-13

Sheet No 1 of 1

Estimated by: T. Kerby
Review by: J. O'Brien

Note: Cost estimates provided by Tonkin Consulting are based upon historic cost information and experience, and do not allow for latent conditions, changes in scope and market conditions (ie competition, escalation, changes to public and private utility policies in regards to relocation and augmentation of services).

Tonkin Consulting recommend that a professional Quantity Surveyor be engaged if assurance of cost is required and project budget estimates allowing for these factors are required.

Item No	Description	Unit	Qty	Rate	Cost
1	**Preliminaries**				
	Establishment & setting out	item	1	$10,000	$10,000
2	**Stormwater Drainage**				
	1800mm RCP Class 2	m	80	$2,200	$176,000
	2400 x 900 Junction Box	ea	2	$5,000	$10,000
	1800 headwall	ea	2	$6,000	$12,000
	Swale trenching	m^3	1200	$30	$36,000
	Heavy Gauge Jute Matting	m^2	1050	$25	$26,250
	Erosion protection	item	1	$10,000	$10,000
3	**Miscellaneous**				
	Match in and Make Good with Existing D	item	2	$3,000	$6,000
	Testing	item	1	$3,000	$3,000
	Cleaning up	item	1	$3,000	$3,000

Total (+20% loading) **$350,700**

INDICATIVE CONSTRUCTION COST ESTIMATE
FOR THE KURARA ROAD DETENTION BASIN

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Project: **Port Lincoln Drainage Review**

Job No: 2007.0307
Date: 11-Dec-07

Sheet No 1 of 1

Estimated by: T. Rundle
Review by: T. Kerby

Note: Cost estimates provided by Tonkin Consulting are based upon historic cost information and experience, and do not allow for latent conditions, changes in scope and market conditions (ie competition, escalation, changes to public and private utility policies in regards to relocation and augmentation of services).

Tonkin Consulting recommend that a professional Quantity Surveyor be engaged if assurance of cost is required and project budget estimates allowing for these factors are required.

Item No	Description	Unit	Qty	Rate	Cost
1	**Preliminaries**				
	Establishment	item	1	$5,000	$5,000
	Setting Out	item	1	$2,000	$2,000
2	**Stormwater Drainage**				
	450 dia Class 2 RCP	m	100	$400	$40,000
	450 dia Precast headwall	ea	1	$1,000	$1,000
	Connection to existing drain	item	1	$500	$500
3	**Earthworks**				
	Cut to disposal	m^3	3500	$8	$28,000
	Grassing	m^2	3000	$2	$6,000
4	**Miscellaneous**				
	Testing	item	1	$2,000	$2,000
	Cleaning Up	item	1	$5,000	$5,000

Total (+20% loading) **$107,400**

INDICATIVE CONSTRUCTION COST ESTIMATE
FOR THE HILLTOP DRIVE DETENTION BASIN

Tonkin CONSULTING
a better approach

Project: **Port Lincoln Drainage Review**

Job No: 2007.0307
Date: 11-Dec-07 Sheet No 1 of 1

Estimated by: T. Rundle
Review by: T. Kerby

Note: Cost estimates provided by Tonkin Consulting are based upon historic cost information and experience, and do not allow for latent conditions, changes in scope and market conditions (ie competition, escalation, changes to public and private utility policies in regards to relocation and augmentation of services).

Tonkin Consulting recommend that a professional Quantity Surveyor be engaged if assurance of cost is required and project budget estimates allowing for these factors are required.

Item No	Description	Unit	Qty	Rate	Cost
1	**Preliminaries**				
	Establishment	item	1	$5,000	$5,000
	Setting Out	item	1	$2,000	$2,000
2	**Stormwater Drainage**				
	750 dia Class 2 RCP	m	300	$750	$225,000
	900 dia Class 2 RCP	m	50	$800	$40,000
	900 dia Precast headwall	ea	1	$2,000	$2,000
3	**Earthworks**				
	Cut to disposal	m^3	7100	$8	$56,800
	Grassing	m^2	4000	$2	$8,000
4	**Miscellaneous**				
	Testing	item	1	$2,000	$2,000
	Cleaning Up	item	1	$5,000	$5,000

Total (+20% loading) **$414,960**

INDICATIVE CONSTRUCTION COST ESTIMATE FOR THE
GROSS POLLUTANT TRAPS ON MORTLOCK TCE AND BARLEY ROAD

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Estimated by: T. Rundle
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Item No	Description	Unit	Qty	Rate	Cost
1	**Preliminaries**				
	Establishment	item	1	$5,000	$5,000
	Setting Out	item	1	$2,000	$2,000
2	**Pollutant Traps**				
	Mortlock Terrace/Bligh Street GPT	item	1	$150,000	$150,000
	Barley Road Trash Rack	item	1	$60,000	$60,000
3	**Miscellaneous**				
	Testing	item	1	$2,000	$2,000
	Cleaning Up	item	1	$5,000	$5,000

Total (+20% loading) **$268,800**