LULU TERRACE CATCHMENT

DRAINAGE STUDY

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CONTENTS

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1. INTRODUCTION

The Lulu Terrace Catchment is situated along on land lying between Gulf St Vincent to the west and the Port River to the east. The catchment has an area of approximately 207 hectares and drains towards the Port River. The area is very flat with surface grades typically in the range of 0.1% to 0.5%. There are a number of low points within the catchment where ponding occurs during large storm events.

Three main drainage lines run east-west through the catchment. These systems are situated along Wills Street, Walton Street and Hargrave Street. The three drainage lines all converge at Victoria Road and discharges through a pipe underneath the old Lulu Terrace road reserve that is now owned by Adelaide Brighton Cement.

BC Tonkin and Associates has been commissioned by the City of Port Adelaide Enfield to investigate and refine options for upgrading the stormwater drainage system in the Lulu Terrace Catchment.

2. PREVIOUS INVESTIGATIONS

A Study by John Botting & Associates in 1997 [1] investigated the catchment hydrology using ILSAX and indicated a number of significant flooding problems within the area. The main cause of the problems was identified as being the low lying nature of the area, the very shallow grades of the existing pipes, the limited capacity of the system under Adelaide Brighton Cement and the limited capacity of the pumping station.

2.1 Wills Street System

The majority of the drains within the Wills Street system are unable to cope with a 1 in 5 year ARI event. The ILSAX model predicted overland flooding to occur throughout the catchment. Ponding at localised low spots reduces the magnitude of the peak flood flow at the catchment outlet by holding water up in the catchment. Ponding locations which were identified included the Adelaide and Wills Street T-junction and the Mary and Wills Street T-junction.

2.2 Walton Street System

The upper reaches of the Walton Street system are able to cope with a 1 in 5 year ARI event. Capacity and subsequent ponding problems occur between Trust Terrace and Victoria Road. The Alfred Street / Walton Street intersection is one of the lowest points in the catchment with flood flows from many areas draining to this point.

One of the main problems identified within the John Botting & Associates report was the limited capacity of the pipe that currently runs from Victoria Road to Elder Road. This drain has an obvert at the Victoria Road end that is above the natural surface level some 150 metres upstream. This prevents the pipe from flowing at capacity and causes significant flooding problems in the vicinity of Alfred Street and Walton Street. The pipe currently takes flows from all three of the main drainage lines (Wills Street, Walton Street and Hargrave Street) and is undersized to cope with the peak flows. Upgrading of this pipe is not feasible due to a number of buildings that are now constructed directly over the drain.

2.3 Hargrave Street

Significant areas of flooding occur behind the train line at Peterhead Street caused by a large low spot at that point. Other smaller areas of flooding occur throughout the catchment including the Hall Street and Woolnough Road T-junction. Overland flood flows occur widely throughout the catchment during a 1 in 5 year ARI event with many overland flow rates predicted to be over 0.3 m^3/s.

2.4 Pumping Station

The existing pumping station at Elder Road has a peak capacity of 2.3 m^3/s. If all the upstream pipe systems were upgraded, the existing pumping station would have sufficient capacity to carry a 1 in 1 year ARI flow. The 5 year ARI flow from the catchment was calculated to be 4.4 m^3/s.

The existing pumps are protected from debris by a system of dual screens. During high flows, these screens need to be regularly cleaned to avoid blockage and the backup of water into the upstream pipe system. This arrangement is unsatisfactory from an operational point of view.

2.5 Remedial Options

The John Botting and Associates investigation identified a number of options for the mitigation of flooding within the catchment. These were:

- Do nothing
- Total system upgrade as recommended in 1971
- Use of soakage pits
- Provision of detention basins
- Construction of an alternative outfall

Upgrading of the system as recommended in 1971 was not found to be possible. Similarly, to was found that the use of soakage pits would not be sufficient in themselves to adequately control flooding.

Given the frequency of flooding, the 'do nothing' option is considered to be socially unacceptable. Similarly, construction of detention basins, which would require acquisition of a number of residential properties was considered to have a high social impact.

As a result, the option of constructing an alternative outfall along Hargrave Street is being investigated, to determine its impact and the likely construction cost.

3. HYDROLOGICAL MODELLING

3.1 Introduction

ILSAX modelling of the existing drainage network has indicated that the 1350mm diameter pipe that passes under the Adelaide Brighton Cement site is unable to cope with the combined flows from the three main contributing drainage lines (Wills Street, Walton Street and Hargrave Street). The flow that currently reaches the drain in a 1 in 5 ARI event is estimated to be 2.35 m^3/s. The Hargrave Street system makes up approximately 39% of this flow while 37% comes from the Wills Street system and the remaining 24% from the Walton Street system. The pipe capacity is estimated to only be in the vicinity of 1.4 cumecs.

The ILSAX model developed by John Botting & Associates was a lumped catchment model. This model has been refined to include a greater level of detail in the Hargrave Street catchment to enable assessment of the proposed Hargrave Street drain. The parameters used in the modelling are described below.

3.2 Rainfall Data

Rainfall data has been derived from Australian Rainfall and Runoff (IEAust, 1987). Rainfall depths and temporal patterns were determined for average recurrence intervals between 2 and 100 years and storm durations ranging from 10 minutes to 3 hours.

3.3 Rainfall Loss Model

ILSAX provides the option of modelling rainfall losses on each subarea using either an initial loss / continuing loss model or a runoff coefficient model.

The initial loss / continuing loss model has been used for the pervious areas in the catchment. An initial loss of 30 mm and a continuing loss at 2 mm/hr, was adopted for the previous modelling. Given the sandy nature of soils in the area, it is considered that higher losses may be appropriate. An initial loss of 50 mm and a continuing loss of 3 mm/hr is considered to be more appropriate. It is unlikely that the adoption of these higher losses will significantly affect the flows previously calculated for the 1, 2 and 5 year ARI events as there would have been limited runoff from the pervious areas for these events.

Impervious parts of the catchment have been modelled using a runoff coefficient approach. The percentage impervious area for each subarea have been taken from the John Botting & Associates report and are based on housing density. The majority of the subcatchments have a coefficient of runoff of between 0.15 to 0.25.

3.4 Physical Data

The model was set up in sufficient detail such that all major drain branches have been included. Only a few side entry pits and the associated lateral pipe systems have been omitted.

Subcatchments draining to each inlet within the system were identified from a 1:4000 scale map. Times of concentration were calculated by determining the longest length

of travel within the subcatchment to the inlet and the slope of the travel path. A flow time of five minutes from residential roofs to the street gutter was used. The time of concentration for the pervious areas was taken to be 30 minutes for all subcatchments.

Pipes grades have been modelled to be at 75% of the surface grade to allow for hydraulic losses that occur within the pipe system. Surface grades have been taken directly from the John Botting & Associate's report.

4. INVESTIGATION OF HARGRAVE STREET OUTFALL

4.1 Description of Proposed Scheme

The proposed Hargrave Street outfall scheme involves the following works:

- Construction of a new drain along Hargrave Street between Military Road and Victoria Road to intercept flows from the contributing catchment up to a 5 year Ari event.
- Construction of a new stormwater pumping station within land currently owned by Adelaide Brighton Cement on the corner of Hargrave Street and Victoria Road.
- Construction of a rising main from the pumping station north along Victoria Road and then east through the Adelaide Brighton Cement site to the Port River.
- Upgrade of lateral pipe systems feeding the Hargrave Street drain to a 5 year ARI standard.

The layout of the proposed scheme is shown in Figure 1.

4.2 Assessment of Hargrave Street system using ILSAX

The ILSAX model of the catchment was modified to include the above works. The revised model layout is shown in Figure 2. The drain numbering for the Wills and Walton Street catchments has remained unaltered from the model used in the previous investigation of the catchment.

The modelling showed that interception of flows from Hargrave Street will reduce the flow reaching the existing drain under the Adelaide Brighton Cement site by 39% during the 1 in 5 ARI event. Interception of these flows would allow the 1 in 5 ARI flows from the existing Wills and Walton Street catchments to pass through the Lulu Terrace drain (that is the peak 5 year ARI flow from the catchment would be less than 1.4 m^3/s.)

As much of the Hargrave Street system is undersized for the 1 in 5 ARI event, a number of improvements to the capacity of the feeder drain system will be required. This includes the area directly upstream of the railway line at Peterhead Street where large ponding currently occurs. The upgrading of the system would reduce water being held up in the system which will therefore increase the peak flow at the downstream end of the system. Modelling indicates that the peak flow at the downstream end of the Hargrave Street system for the 1 in 5 ARI event will increase from 1.25 cumecs to 2.56 cumecs. The pump would therefore need to be sized to cope with flows of this size. The rising main from this point would head north along Victoria Road and then cut eastwards through a gap within the building of the Adelaide Brighton Cement property.

A number of the drains higher up in the catchment (above the railway crossing at Peterhead Street) will be made into duel systems where the existing network will be maintained such that the size of the newly installed pipes can be reduced, which will reduce material and construction costs.

4.3 Wills Street System

Localised ponding within the Wills Street system currently reduces the levels of overland flood flows. Ultimately the likelihood of ponding at these locations should be reduced by improving the capacity of pipes in the area. Reduction of ponding volumes will increase the flow rates and cause problems further downstream and is therefore not an adequate solution unless the entire network is upgraded (as if proposed for the Hargrave Street system).

The only major drainage pipe within the system that is able to take the 1 in 5 year ARI flows is the section along Wills Street between Fletcher Road and Mary Street. A possible improvement for the catchment would be to extend this pipe until Victoria Road and then along Victoria Road and join into the Lulu Terrace road reserve pipe. Any overflows at this junction could be directed via a small pipe to the proposed pump station for the Hargrave Street system. This would prevent any overland flood flows for the 1 in 5 year ARI event for this part of the system and reduce the large amounts of overland flow that is causing large problems at Walton Street. It is estimated that the peak overflow to the pump station from this part of the catchment would be 160 litres per second. This peak occurs 60 minutes after the start of the storm, while the peak inflow to the pump station from the Hargrave system, of 2.56 cumecs, occurs at 25 minutes. At 25 minutes the overflow from the Lulu Terrace road reserve pipe is estimated to only be 60 litres a second which only increases the pump size required marginally.

4.4 Walton Street

The significant flooding problem in the vicinity of Alfred and Walton Street will largely be alleviated following the upgrade of the Hargrave Street system with the alternative outfall. Further improvements would be if the downstream section of the Wills Street system was upgraded to prevent flood flows from reaching this point.

Additional capacity within this system is unlikely to improve the flooding problem due to the capacity limitation of the Lulu Terrace road reserve drain. Increasing the capacity of the network is likely to reduce the amount of storage in the catchment and therefore worsen the problem at Walton Street.

5. SUMMARY OF COSTS

Table 5.1 shows a summary of the costs associated with the upgrade of the Hargrave Street system. Figure 5.1 shows the location of the pipes shown in the table. The costs include dewatering of the trenches due to the shallow water table at a rate of $42/metre and shoring at $15/metre. The pipe costs have been taken from recent tender figures received by BC Tonkin and Associates and include installation and reinstatement. The pipe diameters used for the calculation are in the upgraded Drain Size column of the table except for when a figure is shown in the Parallel Pipe Size column. The cost includes a construction cost factor of 27% for stages 2 to 4 and 17% for stage 1. The reduction for stage one is due to the service alteration costs which have been explicitly estimated.

The total cost of upgrading the pipe system is estimated to be $3.46 million. As some pipe sections within the network already have a 1 in 5 ARI rating or above they will not require replacing. The sections of pipe not requiring replacement are:

- the 375mm diameter pipe along Woolnough Road to Hargrave Street (D4 to D6),
- the 375mm diameter pipe along Clarence Street to Hargrave Street (AC1 and AC2),
- the 375mm diameter pipe along Ruby Street and Whyte Street (AE1 and AE2),
- the 450mm diameter pipe along Workman Street (G1 and G2),
- the 600 by 450mm box culvert, 450mm and 600mm diameter pipe that run along Victoria Road south of the Charles Street (I3, I4, IA1 and IB1),
- the 600 by 150 box culvert that runs from Parr Street to Osborne Street.

Reach letter	Reach number	Existing Drain Size	Parallel Pipe Size	Upgraded Drain Size	Reach Length	Cost Per Metre	Total Cost*[1]
A	1	N/a	-	450	60	$ 362*[4]	$ 25,137
A	2	N/a	-	525	60	$ 419*[4]	$ 28,566
A	3	N/a	-	600	80	$ 457*[4]	$ 41,136
A	4	450	600	675	130	$ 457*[4]	$ 66,846
B	1	N/a	-	300	70	$ 165	$ 15,547
B	2	N/a	-	375	100	$ 203	$ 26,020
BA	1	N/a	-	300	10	$ 248*[4]	$ 3,047
B	3	450	375	600	140	$ 305*[4]	$ 50,652
A	5	450	600	675	150	$ 241	$ 44,745
AB	1	No info.	-	300	10	$ 165	$ 2,221
A	6	450	675	750	100	$ 356	$ 41,260
D	1	N/a	-	300	10	$ 165	$ 2,221
D	2	N/a	-	300	10	$ 165	$ 2,221
D	3	N/a	-	375	70	$ 203	$ 18,214
D	4	375	-	375	160	$ 203	-
D	5	375	-	375	100	$ 203	-
D	6	375	-	375	100	$ 203	-
D	7	375	300	450	10	$ 165	$ 2,221
C	1	N/a	-	300	160	$ 165	$ 35,536
CA	1	N/a	-	450	120	$ 241	$ 35,796
C	2	N/a	-	525	60	$ 279	$ 20,184
C	3	600 by 450 BC	450	525	15	$ 241	$ 4,475
C	4	600 by 450 BC	525	675	110	$ 279	$ 37,004
C	5	600 by 450 BC	525	750	180	$ 279	$ 60,552
A	7	600 by 450 BC	1050	1050	160	$ 648	$ 112,752

AC	1	375	-	375	50	$ 203	-
AC	2	375	-	375	100	$ 203	-
AC	3	375	300	450	100	$ 165	$ 22,210
A	8	1200 by 450 BC	1050	1050	150	$ 165	$ 79,035
ABA	1	N/a	-	300	10	$ 241	$ 2,221
ABB	2	N/a	-	300	110	$ 470	$ 32,813
E	1	600 by 150 BC	-	600 by 150 BC	150	$ 165	-
EA	1	N/a	-	300	90	$ 165	$ 19,989
E	2	600 by 225 BC	375	450	100	$ 203	$ 26,020
E	3	600 by 225 BC	375	525	50	$ 203	$ 13,010
EB	1	No info.	-	300	10	$ 165	$ 2,221
E	4	600 by 225 BC	450	525	90	$ 241	$ 26,847
E	5	600 by 225 BC	525	600	10	$ 279	$ 3,364
F	1	300	375	450	100	$ 203	$ 26,020
A	9	1350 by 450 BC	-	1350	120	$ 725	$ 93,888
AD	1	N/a	-	375	10	$ 203	$ 2,602
A	10	1350 by 450 BC	-	1350	80	$ 725	$ 62,592
A	11	1350 by 450 BC	-	1350	50	$ 725	$ 39,120
A	12	1350 by 450 BC	-	1350	20	$ 725	$ 15,648
A	13	1350 by 450 BC	-	1350	50	$ 725	$ 39,120
AE	1	375	-	375	180	$ 165	-
AE	2	375	-	375	10	$ 203	-
G	1	450	-	450	70	$ 165	-
G	2	450	-	450	200	$ 241	-
A	14	1350 by 450 BC	-	1350	60	$ 725	$ 46,944
AF	1	No info.	-	300	10	$ 165	$ 2,221
A	15	1350 by 450 BC	-	1350	15	$ 725	$ 11,736
A	16	1350 by 450 BC	-	1350	60	$ 725	$ 46,944
A	17	1350 by 450 BC	-	1350	15	$ 725	$ 11,736
A	18	1350 by 450 BC	-	1350	60	$ 725	$ 46,944
AG	1	No info.	-	300	120	$ 165	$ 26,652
A	19	1170 *[2]	-	1500	180	$ 831	$ 159,786
AH	1	N/a	-	375	80	$ 203	$ 20,816
A	20	1170 *[2]	-	1500	120	$ 831	$ 106,524
H	1	N/a	-	375	10	$ 203	$ 2,602
HA	1	N/a	-	300	10	$ 165	$ 2,221
H	2	N/a	-	375	150	$ 203	$ 39,030
HB	1	N/a	-	300	10	$ 165	$ 2,221
H	3	N/a	-	525	15	$ 279	$ 5,046
A	21	1170 *[2]	-	1500	70	$ 831	$ 62,139
A	22	1170 *[2]	-	1500	110	$ 831	$ 97,647
I	1	N/a	-	375	180	$ 203	$ 46,836
I	2	N/a	-	450	40	$ 241	$ 11,932
I	3	600 by 450 BC	-	600 by 450 BC	30	$ 279	-
IA	1	450	-	450	100	$ 165	-
I	4	600	-	600	200	$ 305	-
IB	1	600	-	600	30	$ 279	-
I	5	600	-	750	80	$ 610*[4]	$ 53,328
A	23	N/a	-	1050	610	$ 648	$ 444,516
W	1	1200 by 450 BC	-	1050	180	$ 648	$ 126,846
W	2	1350 by 450 BC	-	1200	340	$711	$ 261,188
Sub-TOTAL				**$2,929,000**			
Side Entry Pits		65 (11)*[3]		$1400 ($2100)		$98,700	
Junction Boxes		85 (14)*[3]		$1200 ($1800)		$127,000	
Pump Station		4 pumps		$61 000		$244 000	
Pump Controllers		1		$60 000		$60 000	
Pump Station Sump		1		$20 000		$20 000	
TOTAL				**$3,462,400**			

*[1] includes cost of dewatering and shoring the trench of $57/metre.

*[2] equivalent diameter of a 750mm pipe and 1350 by 450mm box culvert.

*[3] Cost of SEPs and JBs in brackets increased by 50% to allow for construction being within a Transport SA road which requires higher levels of reinstatement.

*[4] Price increased 50% to allow for construction being within a Transport SA road which requires higher levels of reinstatement.

Table 5.1: Cost Summary

(insert figure here)

Figure 5.1: Proposed Drainage Network

5.1 Advised Work Schedule

It is understood that the current budget allocation for the upgrading of the Lulu Terrace drainage system is in the vicinity of $900 000 per annum. This is less than the total cost of all works and so it is recommended that the system be built in stages. As the total cost of the upgrade is estimated to be close to $3.35 million dollars it is advised that the task be carried out in a number of stages, with each stage costing approximately $900 000 to complete.

5.1.1 Stage 1 1999/2000

The first stage of works should be the replacement of the main drainage line running along Hargrave Street from the proposed pumping station adjacent Victoria Road up to the railway line at Peterhead Street. Excluding any of the proposed lateral pipes the estimated cost of this stage is approximately $840,000. This price excludes any service alterations. Generally it is estimated that service alterations add approximately 10% to the total cost. Following is a summary of service alteration costs for this stage:

- Boral Energy indicate that gas alterations of gas services for this section will cost just under $60 000.
- Information from United Water indicate the water alterations to cost approximately $XXXX. A large component of this is the alteration of the 750mm main that runs along Mead Street which is estimated to cost $60 000 to alter. Approximately 150 metres of sewer will also require moving near Trust Terrace. The cost of this relocation is estimated to be $25 000.
- Telstra services are estimated to cost $XXXX to alter.
- All ETSA services are above ground and so alteration costs are not anticipated.

5.1.2 Stage 2 2000/2001

The second stage would involved the construction of the rising main and the pump station on the corner of Hargrave Street and Victoria Road. Once this is completed and connected with stage one, there will be a large reduction of flows entering the drain underneath the Lulu Terrace road reserve and will therefore reduce flooding problems at Walton Street. The rising main is likely to cost in the order of $480 000 while the pump station will cost approximately $320 000. This is comprised of four identical pumps at $60 000 (each able to pump 600l/s at 10 metres head), the controller at $60 000 and the sump at $20 000. Service relocation for this stage is likely to be less costly than stage 1 due to their only being one section of pipe that requires installation. Once this stage is complete the system will be partially operational.

5.1.3 Stage 3 2001/2002

Stage three would involve construction of the network upstream of the railway crossing at Peterhead Street. This would reduce large amounts of flooding behind the railway line and increase flows further down the system. The upgrade at the eastern end of Wills Street could also be incorporated into this stage. This would also involve connecting overflow from the Lulu Terrace road reserve drain to the new pumping station. Service alterations for this stage is likely to be less that stage one as there are less road crossings involved and the services are smaller and not as congested.

The Will Street upgrade is estimated to cost $385 000 while the main drainage line above Peterhead Street will cost $440 000 giving a total cost for this stage of $825 000.

5.1.4 Stage 4 2002/2003

The final stage would involve construction of the minor lateral pipes within the system. This will prevent large surface flows along roadways and ensure full utilisation of the main drain. Service alterations for this stage will make up only a minor component of the total cost. The total cost of this stage is estimated to cost $710 000.

5.2 Summary of Work Schedule

Stage	Timing	Description	Cost
1	1999/2000	Main drain down Hargrave Street from Victoria Road to Peterhead Street	$1 025 000
2	2000/2001	Pump station and rising main	$800 000
3	2001/2002	Main drain above Peterhead Street along Hargrave Street and south along Military Road to Swan Street and Wills Street upgrade	$825 000
4	2002/2003	Minor lateral throughout the Hargrave Street system	$710 000
TOTAL COST			$3 360 000

Table 5.2: Summary of Costs for each Stage

6. CONCLUSION

7. REFERENCES

[1] Bottting J. (1997) “Lulu Terrace Drainage Study” John Botting & Associates.