GOSFORD CITY COUNCIL

WOY WOY, UMINA, ETTALONG PENINSULA DRAINAGE STRATEGY STUDY

JUNE, 1992

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CONSULTING ENGINEERS

GOSFORD CITY COUNCIL

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DRAINAGE STRATEGY STUDY

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EXECUTIVE SUMMARY

Development of the Woy Woy, Umina, Ettalong Peninsula over the past 50 years has resulted in a stormwater drainage system which is inadequate by today's standards. It does not meet the expectations of the local community and it does not satisfy Council's current design criteria for stormwater drainage.

This study was commissioned by Council to assist it in planning possible future trunk drainage works and in the preparation of a Development Control Plan (DCP). As part of the study, proposed works were costed to enable Council to estimate Section 94 drainage contributions for areas zoned Residential 2(b) (medium density).

The study determined that the existing pipe drainage system had capacities ranging from zero (where no drainage lines were in place) to the 1 in 100 Annual Exceedance Probability (AEP) flood. The range reflects the fact that much of the existing system has probably been installed on a needs basis as development progressed. The increased development, including extension of existing dwellings and an increased housing density, would have contributed to increased flows and reduced the effectiveness of the existing system. Coupled with the increasing problems, community expectations in this regard are higher than they were 20 to 30 years ago when the area was first developed. Council's resources to keep up with these changes have been limited in real dollars over the same time period.

The study determined the catchments of the existing drainage system for existing levels of development, as well as future drainage catchments with drainage reserves and easements. The future conditions allowed for the increase in runoff and higher drainage standards applicable for redevelopment of large portions of the peninsular to medium density - residential zoning 2(b).

The pipes and culverts required to augment the existing drainage system to meet contemporary design standards were estimated for different scenarios and these were costed to provide an estimate for setting Section 94 contributions.

Costs were calculated for pipe and channel works, culverts and bridges, services relocation and minor drainage works. Excluded from the estimates were land acquisition costs for drainage reserves and compensation payments for easements.

The cost to upgrade all the current trunk drainage schemes for existing development conditions is $14.2 million. The cost to upgrade and modify all existing schemes to suit proposed future drainage systems catering for ultimate future development is $29.7 million.

The difference in cost of the two schemes (existing and future) was used in estimating Section 94 contributions for trunk drainage. The rate was calculated to be $17 720/ha. It should be noted that this rate does not take into account costs for drainage reserves and compensation for easements which can only be estimated at the detailed design stage.

The cost to provide minor drainage works for Residential 2(a) is $17 000/ha. The cost to provide minor drainage works for Residential 2(b) is $30 000. The difference in the two zonings was used to estimate Section 94 contributions for minor drainage works. The rate is $13 000/ha.

The estimated Section 94 drainage contribution for both trunk and minor drainage works is thus $30 720/ha.

1. INTRODUCTION

In March, 1990 Gosford City Council commissioned Webb, McKeown & Associates to investigate trunk stormwater drainage options for the Woy, Umina, Ettalong Peninsula (Figure 1).

A number of floods in recent years have highlighted the problems of the existing drainage system. In addition current redevelopment of the Peninsula is increasing the housing density which is exacerbating the present drainage problems.

The objectives of the study were:

Data Collection

- collect survey data,
- review existing drainage studies.

Drainage Strategies and Design Criteria

- investigate the available secondary drainage strategies to reduce the load on the trunk drainage system,
- propose and justify a design standard.

Existing Drainage System

- define the boundaries of the existing catchment areas, each with its own outfall to Brisbane Water or Broken Bay,
- establish hydrologic and hydraulic models to analyse each existing stormwater drainage system under the existing (mainly low density) level of development,
- identify the sections of each drainage system that are under capacity,
- determine the augmentation works required to ensure each existing system can cater for:
  - a) the 1 in 10 AEP peak flow where secondary flow paths are available for larger floods or where nuisance flooding is minimal,

b) the 1 in 100 AEP peak flows elsewhere,

- estimate the cost of these works.

Future Drainage System

- define efficient drainage flow paths for a future stormwater drainage system and adjust the existing catchment area boundaries accordingly,
- establish hydrologic and hydraulic models to analyse the drainage system in each of the major catchments with the peninsula re-developed for (medium density) ultimate future development,
- determine the works necessary to enable each system to cater for the 1 in 100 AEP peak flows, by modifying and amplifying the existing drainage systems,
- investigate the backwater influence of high downstream water levels on the flow capacity of selected drainage systems,
- specify necessary drainage easement and reserve widths,
- estimate the cost of the future drainage works.

Section 94 Contributions

- for areas zoned 2(b), estimate the Section 94 drainage contribution rate per unit area.

2. STUDY AREA

2.1 General

The study area (Figures 1 and 2) lies within the City of Gosford and is approximately 10km south of the Gosford CBD. It is bounded to the north and east by Brisbane Water, to the south by Broken Bay and to the west by Brisbane Water National Park.

2.2 Topography

The topography of the catchment consists mainly of a series of low lying sand dunes except for that portion backing onto the National Park and Blackwall Mountain. In the sand dunes ground levels are generally between 1m and 6m above Australian Height Datum (AHD - approximately mean sea level). The developed portion of the catchment backing onto the National Park rises to approximately 80m AHD. The catchments within the National Park rise to 176m AHD.

2.3 Geology

The ground generally above 6m AHD consists mainly of Hawkesbury Sandstone. The major portion of the study area, which lies between 1m AHD and 6m AHD, is located on sand dunes. The total depth of sand is unknown, but it exceeds 3m.

2.4 Brisbane Water Levels

Water levels in Brisbane Water were examined in some detail by the Public Works Department (PWD) (1988) which found that the main factors influencing the water level were tidal range, super-elevation, ocean wave setup, winds and barometric pressure. The estimated 1 in 100 annual exceedance probability (AEP) water level was estimated to be 2m AHD.

Gosford City Council in its Specification for Design of Stormwater Drainage Works (January 1990) recommends the following levels in Brisbane Water and Broken Bay for various recurrence interval storms.

TABLE 1

BRISBANE WATER LEVELS (m) AHD

Outlet Location	Design Average Recurrence Interval					
	1,2,5,10	20		50		100
	All Discharges	Design Discharge (m^3/s)				
		<3	>3	<3	>3	<3 >3
Brisbane Water and Tributaries (upstream of the Rip)	0.35	0.35	0.70	0.70	1.00	1.00 1.50
Brisbane Water (between Half Tide Rocks and The Rip)	0.45	0.45	0.80	0.80	1.20	1.20 1.60
Pacific Ocean/Broken Bay	0.50	0.50	0.80	0.80	1.20	1.20 1.60

2.5 Development Status

The current development (land usage) of the study area consists mainly of single, free standing residential dwellings. Most of the older dwellings are built with either fibro or weatherboard cladding and have elevated floors set on brick piers. Newer residences are typically brick veneer with slab on ground construction.

In recent times redevelopment has taken place by changing lots with single older dwellings into lots with villas and townhouses. The rate of redevelopment has increased with the change in dual occupancy rules introduced by the State Government. The impact on the stormwater drainage regime has been to increase surface runoff. In physical terms, redevelopment has meant extra paving and roofing which has decreased the area which allows direct infiltration into the sand beds and thereby increase the amount flowing overland as surface runoff.

3. EXISTING DRAINAGE PROBLEMS AND FUTURE STRATEGIES

3.1 Existing Drainage Problems

The subdivision of the Peninsula, which took place mainly in the early 1900's, was based on a rectangular road grid pattern. The pattern paid little or no regard to topographic contours and secondary drainage flow paths. This did not cause obvious problems at the time as most of the roof water was collected in water tanks for domestic use. Runoff from road and yard areas drained to low points in the dune system from where it either gradually seeped away into the groundwater or evaporated. Some of these low points were located in backyards, however the nuisance flooding this caused was not considered a serious problem as houses tended to be elevated above the ponding level.

The volume of ponding at low points has increased with:

- the advent of a piped water supply which has removed the need for collecting roof water,
- more intensive development,
- paving of roads, driveways and portions of backyards,
- increased dwelling size reflecting improved living standards,
- filling in of natural depressions,
- decrease in soil infiltration rate with the creation and importation of silty topsoil material.

A large proportion of the existing drainage network was designed, built, and where necessary extended, on a needs basis. Designs of the original outfalls were probably based on "rule of thumb" or empirical formulae. Even progression to more modern methods of design has not necessarily provided optimal solutions, as estimates of design rainfall intensities have tended to increase with time as more data are collected.

3.2 Possible Drainage Strategies

The existing drainage problems, the typical geology and topography of the area, and the future redevelopment potential of the Peninsula, increase the priority for planning of cost effective trunk drainage solutions.

The following options were considered in order to reduce the load on the trunk drainage system (the disadvantages are highlighted below each option):

a) Piping of roof runoff direct to groundwater via sump (absorption) pits (see Figure 6 (Reference 1)).
   - requires large numbers, regular maintenance and strict control.

b) Porous road pavements and parking areas (see Figure 7 (Ref. 2)).
   - reduced pavement strength, increased maintenance.

c) Groundwater drainage systems (see Figure 8).
   - costly and requires work in private property.

d) Surface collection facilities at local low points in yards and roads (see Figure 9).
   - costly and requires work in private property.

Consideration was given to using the deep underlying sand layer, which covers approximately 90 percent of the local catchment, to supplement the overland stormwater drainage paths. The highly pervious nature of the sand, and its significant storage capacity above the groundwater table, suggested that this could be utilised as a natural detention basin to mitigate peak discharges, and thus reduce the size and cost of surface drainage works.

However, observations during periods of continuous rainfall showed that the groundwater in low lying areas rose above ground level leading to ponding at low points for a number of days. Directing more runoff to the groundwater would exacerbate this problem.

4. DATA COLLECTION

A set of plans detailing the existing stormwater drainage layout was available from Council. Although not complete, it included over 95 percent of the existing pipes and open channels. Physical features, such as pipe diameter, were available for most of the trunk drainage part of the system. A survey of the remaining trunk drainage pipes and open channels was carried out as part of this study to complete the database.

A number of drainage studies have been carried out for limited sections of the catchment by Consultants and Gosford City Council. These studies were re-evaluated so as to take into account the present and future drainage needs of the whole Peninsula.

Ground level data were extracted from the sewer design plans prepared by the PWD in the early to mid 1980's. Levels were on average approximately 50 metres apart, and they were used in conjunction with general contours from 1:2000 scale orthophotomaps to locate drainage problem areas and estimate the general slope of the land. These maps were also used to estimate the existing, and likely future proportions of paved and unpaved area in each sub-catchment.

As part of this study Peter Bolan & Associates (Registered Surveyors), were commissioned to carry out a detailed survey of an open channel traversing Ryans Rd, Veron Rd, Dulkara Rd, Nambucca Drive to the Railway Line (see Appendix D). These survey data were used for hydraulic grade line calculations.

Areas known to be subject to flooding from local ponding of stormwater drainage were obtained from Council's records. The nature of the flooding or ponding problems at each location was clarified in discussion with Council Officers.

5. DESIGN CRITERIA

5.1 General

The drainage criteria set out in Council's Stormwater Drainage Works Specification were considered in selecting an appropriate recurrence interval, together with the recommendations of Australian Rainfall & Runoff (Reference 3). Council's criteria are set out in Table 3.

It was determined, in conjunction with Council's Officers, that the drainage criteria would need to be flexible to meet the expectations of the community and budget limitations of Council.

For areas where housing and population densities were expected to remain low, a limited amount of nuisance flooding should be acceptable, i.e., temporary storage of floodwaters in backyards, front yards and road areas.

For areas where housing densities were to be increased, nuisance flooding would affect more people and therefore would be less acceptable by the community. A higher trunk drainage standard was considered for such areas.

A trunk drainage design criteria of either 1 in 10 AEP or 1 in 100 AEP was adopted, depending on the actual situation in the field (i.e, level of development, local topography, drainage escape paths, etc.).

The large number of localised depressions meant that it was not practical to provide overland flow paths for large storm events. Retarding basins did not provide a practical alternative because of the lack of suitable land. Therefore, to keep flooding to an acceptable level, a set of design standards were proposed and these are listed in Section 5.2 below.

5.2 Proposed Design Standards

Existing Catchment Areas

a) 1 in 10 AEP trunk drainage standard where either:
   (i) housing and population densities are low,
   (ii) secondary flow paths are available, or
   (iii) nuisance flooding is low.

b) 1 in 100 AEP trunk drainage standard where either:
   (i) housing density is medium or higher, or
   (ii) no secondary flow paths are available.

c) All new development to have floor levels at least 500mm above road level. This will allow vertical realignment of local roads in the future, which would in turn progressively eliminate isolated low points. Where depressions are greater than 500mm in depth, then floor levels should be at least 300mm above the edge of the depression,

d) Where (c) is not feasible, Council to acquire land for drainage reserves in order to create secondary flow paths.

Future Catchment Areas with Medium and High Density Development

(a) 1 in 10 AEP trunk drainage standard where secondary flow paths are available.

(b) 1 in 100 AEP trunk drainage standard where no secondary flow paths are available.

c) All new development to have floor levels at least 500mm above road level. This will allow vertical realignment of local roads in the future, which would in turn progressively eliminate isolated low points. Where depressions are greater than 500mm in depth, then floor levels should be at least 300mm above the edge of the depression.

d) Where (c) is not feasible, Council to acquire land for drainage reserves in order to create secondary flow paths.

5.3 Proposed Design Philosophy for Future Works

- pipe drainage to be used only when velocities would be greater than 0.6m/s for self cleansing purposes,
- open drains to be used where velocities are lower as they normally would have lower hydraulic losses and are easier to maintain. Option of:
  - i) grass lined channels to increase infiltration and for aesthetic purposes, or
  - ii) concrete lined channels to reduce land take and reduce maintenance requirements,
- drainage lines to be as short and direct as possible to Brisbane Water/Broken Bay,
- existing and/or future culverts and bridges to be sized to provide a flow area of at least the same as the upstream pipe or channel.

TABLE 3

GOSFORD COUNCIL CRITERIA FOR SELECTING RECURRENCE INTERVALS

	Drainage Situation	Design Flood Average Recurrence Interval
1	Residential streets with overflow or bypass along the street.	10 years
2	Residential streets at low points with overflow along public reserves and pathways.	10 years
3	Residential streets at low points with drainage lines traversing building allotments or other locations where surface flow may cause property damage.	20 years
4	Major system traversing developed areas (residential, commercial or industrial). (Major systems are defined as those having catchment areas in excess of 15ha or having 1 in 50 AEP runoff in excess of $3m^3/sec$.	50 years
5	Industrial and neighbourhood business areas.	20 years
6	Larger business areas.	50 years
7	In any specific case where damage to property or unusual inconvenience is likely to result from surcharging of the drainage system, the City Engineer may require a longer average recurrence interval to be used than those given above.	

6. ILSAX MODEL

6.1 Choice of Model

To properly simulate the rainfall-runoff process on an urban catchment, an urban drainage model must be capable of developing runoff hydrographs at each entry point to a pipe or open channel system, and then route and combine the hydrographs through the drainage network.

The computer based model ILSAX meets these requirements. It contains a comprehensive hydrologic model for calculating flows, and an approximate procedure for pipe sizing. It can be used to analyse an existing drainage system, upgrade an existing system, or design and cost a new system.

6.2 Hydraulic Calculations

Hydraulic calculations in ILSAX are simplified. The model assumes that the pipes flow full but not under pressure. It therefore cannot do hydraulic grade line calculations, and can only estimate the correct pipe size to match the peak calculated flow at pipe capacity. Pipe capacity is calculated in the model using the Colebrook-White friction relationship assuming that the energy line slope is the same as the pipe slope. Upstream or downstream controls cannot be simulated.

In this study ILSAX was used in design mode, in which it estimates the peak flow and required pipe size for each pipe reach. These data were used to determine which sections of existing pipe or open channel were under capacity, and what augmentation works were required.

The following upgrade options were considered in analysing both the existing and future systems:

(i) Additional Pipes - calculated by determining the pipe diameter required to produce a combined flow area at least the same as the pipe size recommended by ILSAX.

(ii) New Pipes - as recommended by ILSAX.

(iii) New Open Channel - calculated by using Manning's equation to determine the open channel size required to take the flow rate calculated in ILSAX.

ILSAX results were checked for three selected catchments using the Hydraulic Grade Line method (see Section 9.4).

6.3 Pipe System Definition

The ILSAX pipe system is made up of:

- overland flow entry points representing pits, called *nodes*,
- pipe lengths between nodes, called *reaches*.

A number of consecutive reaches is called a branch. A pipe system is made up of one or more pipes, and is defined by nominating the nodes where two or more branches join to form one branch.

6.4 Catchment Definition

Each sub-catchment boundary has to be defined so that the contributing catchment area can be measured. In ILSAX, each pipe reach has a sub-catchment which contributes surface water inflow to the upstream node on the reach. The amount of flow from each sub-catchment is influenced by area, extent of development, soil type, and overland flow travel time.

6.5 Rainfall Data

ILSAX uses standard design rainfall intensities and temporal patterns. These are taken from Australian Rainfall and Runoff (AR&R) (Reference 3).

6.6 Rainfall Losses

Losses need to be subtracted from rainfall to determine surface runoff.

In ILSAX, losses from paved areas consist of an initial loss only. Ongoing losses are considered to be zero. Losses from grassed areas employ an infiltration equation (Horton's equation), where the infiltration capacity of the soil decreases with time. The form of the equation and the values of the parameters adopted at Woy Woy are given in Table 2.

TABLE 2

Soil Infiltration Parameters

Horton's Equation: $f = f_c + (f_o - f_c).e^{-kt}$

Initial Rate	f_o	=	250 mm/h
Final Rate	f_c	=	25 mm/h
Shape Factor	k	=	2

7. UNIT RATES

7.1 Inclusions and Exclusions

The costings include all pipe and channel works required as well as culvert and bridge works and services relocation. Excluded items include land acquisition for drainage reserves and compensation payments for easements.

7.2 Pipework Unit Rates

The unit rates used for pipework were obtained from Council and reviewed against "Contractor Rates" for recent contracts. The Council rates were found to be consistent and realistic and were therefore adopted. The unit rates included all components of material, labour and plant required to install the pipes and complete the drainage system.

Table 4 lists the unit rates adopted for pipework as used in ILSAX.

TABLE 4

Pipework Unit Rates ($ Dec 1990)

Pipe Size (mm)	Excavation & Backfill ($/m)	Supply RCP ($/m)	Lay & Joint ($/m)	Pits & Fittings ($/m)	TOTAL COST ($/m)
375	66	31	37	8.5	143
450	75	44	40	9.0	167
525	85	57	45	9.5	196
600	96	70	51	10.0	227
675	104	89	53	11.0	257
750	112	109	57	12.0	289
825	119	134	60	13.0	326
900	125	164	62	15.0	367
1050	144	213	68	17.5	443
1200	163	268	76	20.0	527
1350	179	327	84	22.0	612
1500	194	398	92	24.0	708
1650	215	471	97	26.0	809
1800	235	550	105	28.0	918
1950	255	645	114	31.0	1045
2100	274	748	126	34.0	1181

7.3 Open Channel Unit Rates

The unit rates for open channels depend on the type and size of channel. Council will need to use different types of open channels to suit different situations. In this study the channel was assumed to have a concrete base and concrete block sides, as shown in Figure 5. This configuration was adopted throughout for the purpose of estimating costs and easement widths. It should not necessarily be used for design.

Table 5 lists the unit rates adopted for the assumed open channel configuration of variable width (w). These rates were used in the ILSAX analysis.

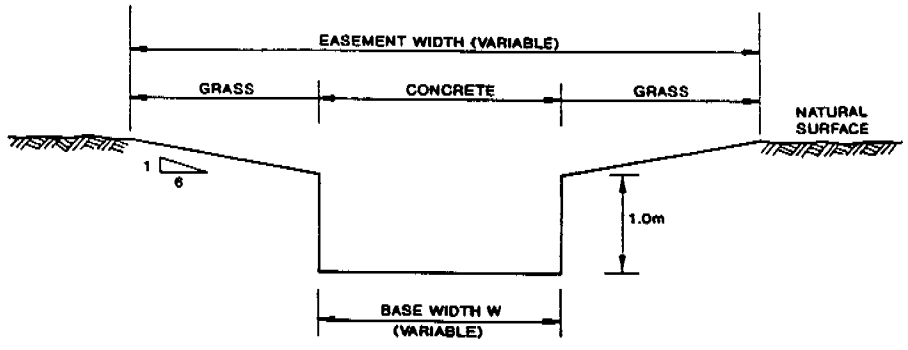
TABLE 5

Open Channel Unit Rates, ($ Dec 1990)

Item	Rate	Quantity/m	$/m
mass concrete	$15/m²	w + 0.8	15w + 12.00
slab, with mesh	$55/m²	w + 0.4	55w + 22.00
reinforced blockwork	$75/m²	2.0	150.00
excavation & dewatering	$26/m³	2.2w + 1.2² x 6	57w + 225.00
trim embankment	$1/m²	1.2 x 6 x 2	14.40
supply & place topsoil	$6.25/m²	1.2 x 6 x 2	90.00
supply and place turfing	$3.50/m²	1.2 x 6 x 2	50.40
		total	**$ (127w + 564)/m**

Notes i) Refer to Figure 5 for assumed channel configuration

ii) Rates refer to a 1m length of channel, width = w metres.



7.4 Culvert Unit Rates

Rates for the estimation of culvert costs were based on manufacturer's cost for supply of pipes or box culverts and Council's rates for labour and plant. Road reinstatement costs were included in the estimated cost for each culvert. Culverts were assumed to be on average 18m long.

8. EXISTING DRAINAGE SYSTEM ANALYSIS

8.1 Definition of Existing Catchment Boundaries and Pipe Systems

The Peninsula has a number of stormwater outfalls into Woy Woy Channel, Brisbane Water and Broken Bay. Each outfall was labelled alphanumerically from A to AW (see Figures 3a & 3b). The extent of the catchment for each outfall was determined from the existing drainage layout and surface level data.

Pipe lengths were measured from Council's existing stormwater layout plan. Pipe slopes were not available, and had to be calculated assuming a reasonable pipe cover to the ground surface level, starting at the outlet and continuing up each of the branches.

These calculations and all ILSAX pipe and catchment data are tabulated in a spreadsheet (see Appendix A).

8.2 Augmentation Works for Sections which are Under Capacity

ILSAX was used to analyse each of the existing drainage systems relating to each of the catchment areas, A to AW, shown on Figures 3a & 3b. Details of each of the three augmentation options for each reach (refer to Section 6.2) are listed in a spreadsheet (see Appendix A).

8.3 Costings

The cost of the works for each of the three augmentation options was calculated using the unit rates. In most cases the more cost effective option was considered to be the preferred option. The costs of the preferred options were totalled for each catchment, and for the whole Peninsula. These results are listed in a spreadsheet (see Appendix A).

Costs were calculated for pipe and channel works to upgrade the system to the standards described in Section 5.2. Excluded items consisted of land acquisition for drainage reserves and compensation payments for easements.

9. FUTURE DRAINAGE SYSTEM ANALYSIS

9.1 Proposed Flow Paths and Catchment Boundaries

The lack of topographic relief over most of the Peninsula meant that the location of catchment boundaries under existing conditions tended to be somewhat arbitrary.

Future flow paths and catchment boundaries were determined taking the following factors into account:

- drainage lines should be as short and direct as possible,
- catchment areas should be of similar size to reduce the load on any one drainage system,
- existing drainage easements should be used if possible to reduce the need to resume land and create new easements,
- existing pipes and open channels that have adequate capacity (as calculated in the hydraulic analysis of the existing drainage) should be incorporated into the future drainage system wherever possible,
- potential increases in housing density should be allowed for,
- additional outfalls should be introduced where appropriate,
- existing open space at the rear of residential lots (laneways) should be utilised where possible,
- more open drains should be provided to improve hydraulic efficiency and to partially overcome the lack of grade.

Many of the small catchments that cannot properly be classified as forming part of the trunk drainage system, were not reviewed. The new catchments defined using the above factors, and their outfalls labelled A to P, are shown on Figures 4a and 4b.

9.2 Drainage Works Required

ILSAX was used to analyse the drainage systems for each of the future catchment areas A to P shown on Figures 4a & 4b. Details of the three upgrade options for each reach (refer to Section 6.2) are listed in a spreadsheet (see Appendix B).

9.3 Costings

The cost of the works for each of the three upgrade options was calculated using the unit rates. In most cases the more cost effective option was considered to be the preferred option. The costs of the preferred options were totalled for each catchment and for the whole Peninsula. These results are listed in a spreadsheet (see Appendix A). Costs were calculated for the trunk drainage works required to upgrade to the standards set in Section 5.2. As already noted, land acquisition for drainage reserves and compensation payments for easements were not included in the estimates.

The cost to upgrade all existing systems to cater for ultimate future development is $30.8 million.

9.4 Hydraulic Grade Line Backwater Analyses

Design open channel widths for existing and future catchments (see Appendices A & B) were calculated using Manning's formula assuming normal depth along the channel. This assumption is only valid for long reaches where there are no upstream or downstream hydraulic controls. Three catchments were modelled using a full backwater analysis under future conditions in order to verify whether the channel widths calculated using the normal depth assumption were valid. The analyses are described in the following sub-sections.

9.4.1 Ryans Rd, Veron Rd, Dulkara Rd, Nambucca Drive to the Railway Line

A survey of the existing open channel was carried out in March 1991 (see Appendix D). Profiles were analysed with HEC-2 (Reference 8), a one-dimensional backwater model that uses the energy equation. 1 in 100 AEP flows calculated by ILSAX for the future development were used in the calculations. Profiles were calculated using:

i) various Brisbane Water levels,
ii) either the existing channel or the proposed future channel,
iii) various combinations of existing culverts and upgraded culverts.

The results are given on Figure 10. They show that the existing culverts are the main contributor towards high flood levels. High Brisbane Water levels have only a small impact on flood levels, affecting the downstream reach.

If the culverts alone were upgraded to have at least the same flow area as the adjoining channel, then flood levels along some sections could be reduced by up to 0.8m. Upgrading the channel without upgrading the culverts would produce no significant reduction in flood levels. Upgrading the channel and all the culverts would reduce flood levels along some sections by up to 1.4m.

9.4.2 Ross St, Rowan Rd to Brisbane Water

The backwater analysis in this case was performed using a number of methods. Sections of open channel were modelled using HEC-2 (Reference 8). Pipe sections were modelled using hydraulic grade line calculations by hand (see AR&R Section 14.5.8). Culverts were modelled using Boyd's culvert program (Reference 9).

The existing channel, pipe and culvert details were taken from Centia's Report (Reference 5).

Flows calculated by ILSAX for the future development 1 in 100 AEP flood were used in the calculation of the surface water profiles. Various Brisbane Water levels were used. ILSAX demonstrated that the existing pipe system is inadequate because of the poor pipework geometry and this has therefore not been plotted. The profile calculated and shown on Figures 11a & 11b, demonstrates the performance of the channel and pipe system as calculated by the normal depth procedure. (Figure 11a considers existing flows and Figure 11b considers future flows.) The lower reaches of the system were sized for both existing catchment and future catchment areas (see Figure 3a - existing catchment Q, Figure 4a - future catchment I).

The results show that the system as proposed will function adequately with a reasonable freeboard. High Brisbane Water levels have a significant impact on levels in the lower catchment, but only a very small impact in the middle and upper catchment.

9.4.3 Bourke Road to Broken Bay

The backwater analysis in this case was performed using HEC-2 (Reference 8).

Flows calculated by ILSAX for the future development 1 in 100 AEP flood were used in the calculation of the Hydraulic Grade Line (HGL). The level in Broken Bay was taken to be 1.6m AHD. The profile calculated (see Figure 12) shows the performance of the channel widths as recommended by the normal depth procedure.

The results show that the system as designed will function adequately with reasonable freeboard. High Broken Bay water levels have no impact in the upper catchment.

9.5 Width of Drainage Reserves

The width of open channel drainage reserves required can be estimated from the open channel width calculated in the spreadsheets (Appendices A & B) by allowing for a suitable batter and an access way along one side.

In the spreadsheets, the batter width recommended on each side of the channel is the length required for a 1 in 6 batter slope to reach natural surface level from the level of the top of the channel. See Figure 5 for the assumed channel details.

9.6 Minimum Floor Levels

Minimum floor levels for all future development should be determined by providing a freeboard to allow for design uncertainties and larger floods (> 1 in 100 AEP).

In most cases an acceptable standard would be 0.5m above road level. However, some properties may be land-locked in local depressions. In such cases either the minimum floor level should be raised even further to provide adequate freeboard (at least 0.3m) above the escape level out of the depression, or the vertical road alignment should be altered to provide a flowpath for overflows.

In order to specify such levels over the whole area a detailed survey of road levels would be required. Alternatively, this matter should be considered at the time of determining new development applications.

9.7 Staging of the Works

9.7.1 General

In order to stage the works, appropriate priorities should be assigned to each problem area. It is recommended that the works providing maximum benefit be carried out first. This is sometimes determined by calculating and comparing benefit-cost ratios for each section of upgrade works. Other considerations may dictate that greater emphasis be given to social factors in ordering the priority of the works. It is also desirable as a general principle to carry out works from the downstream end up, thus ensuring no properties will be worse off in the time prior to completion of the whole system.

Within each existing catchment area there are often specific locations that act as hydraulic controls on flow capacity, typically at culverts. Solutions to these problems should be addressed first, because major improvements can often be achieved at relatively low cost.

Annual Council budget allowances have also been considered in determining works for the short to medium term upgrading of the existing system with no allowance for any increase in building density. These works are presented in Appendix C.

Council have indicated a particular interest in one of the catchments, and staging of the works for this area has been examined further in the following section. This also serves as an example of the application of the principles just discussed.

9.7.2 Ryans Rd, Veron Rd, Dulkara Rd, Nambucca Drive to the Railway Line

This catchment is referred to as catchment A. Hydraulic Grade Lines for this drainage system are discussed in Section 9.4.1 and plotted on Figure 10. The suggested priority order for the works in this catchment is set out below:

i) if only the four upstream culverts are upgraded, then the flood level in the 1 in 100 AEP event will be reduced by up to 0.7m,

ii) upgrading of these four culverts and the channel will produce a combined reduction in flood levels of up to 1.1m,

iii) upgrading of all culverts, including the three downstream culverts at the railway line, and upgrading the channel, will produce a combined reduction in flood levels of up to 1.4m.

If the channel works or downstream culvert works are undertaken before the four upstream culverts are upgraded, then there will be no upstream benefit. Therefore, the four upstream culverts should be given the highest priority and undertaken first. Upgrading of the railway culvert produces a relatively small benefit and should be regarded as having low priority.

10. MINOR DRAINAGE WORKS

Minor drainage works are that part of the works necessary in each sub-catchment to collect overland runoff and transfer the flow to the trunk drains. Minor drainage works consist mainly of inlet pits and side lines.

To determine Section 94 drainage contributions for areas zoned future 2(b) a typical catchment within the study area was selected for further analyses.

Council had previously engaged a consultant to study the residential area adjacent to the Everglades Golf Course. The consultant determined the minor drainage works for all the sub-catchments within the Everglades Catchment for the existing level of development and to Council's current design standard.

A 3 hectare sub-catchment was selected for further analyses. Minor trunk drainage was determined for the catchment for residential 2(b) conditions.

The cost for existing level of development and residential 2(b) level of development are $17 000 per hectare and $30 000 per hectare respectively. The difference in the cost is $13 000 per hectare and this is the estimated Section 94 contribution for minor drainage for residential 2(b) zoned land.

11. SECTION 94 DRAINAGE CONTRIBUTIONS

Section 94 drainage contributions have been estimated for areas zoned 2(b). These contributions have been calculated on the basis of the pipe and channel works, culvert and bridge works and services relocation costs. The costs of land acquisition for drainage reserves and compensation payments for easements have not been included.

The costs of drainage works within the 2(b) areas alone were calculated for each of the two schemes (existing and future). The difference in cost of the two schemes, proportioned over the total area zoned 2(b), was used in setting Section 94 contributions.

The rate was calculated to be $17 720/ha for Trunk Drainage and $13 000/ha for Minor Drainage. (A full set of calculations is given in Appendix D.) Total Section 94 contributions for drainage is thus $30 720/ha excluding cost of land acquisition and easements.

12. CONCLUSIONS AND RECOMMENDATIONS

The purpose of this study was to develop a trunk drainage strategy for the whole of the Woy Woy, Umina, Ettalong Peninsula area. In developing the strategy, the works required to mitigate existing drainage problems and those required to allow for further development were considered separately, to enable calculation of Section 94 drainage contributions.

Costs were calculated for pipe and channel works including culverts and bridges, and services relocation, to upgrade to the proposed standards (refer to Section 5.2). The cost to upgrade all existing trunk systems to the proposed standard for existing development is $14.2 million. The cost to upgrade to cater for ultimate future development is $29.7 million.

The difference in cost was used in estimating appropriate Section 94 trunk drainage contributions. The rate was calculated to be $17 720/ha, which includes only pipe and channel works, culverts and bridges, and services relocation. Land acquisition and compensation payments for easements have been excluded.

The estimated Section 94 minor drainage contribution is $13 000/ha. Thus the Section 94 contribution for both trunk and minor drainage works is $30 720/ha.

For the upgrading of the existing drainage system to cater for the existing level of development, funding of the works would be limited (refer to Gosford City Council's letter dated 20 December 1991) and a medium term timeframe is envisaged before all the works recommended in Appendix C could be implemented. The various sub-catchments should be ranked in order of priority to develop a program of works taking into account works which have the greatest hydraulic and social benefits. Implementation of minimum floor levels for new buildings or existing building extensions should be immediate.

For areas to be zoned 2(b) - medium density development - the collection of Section 94 funds sufficient to construct the works would only be collected over a long period. Therefore, minimum floor levels should be incorporated in all new development to ensure flood freedom in the meantime.

13. REFERENCES

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HEC-2 Water Surface Profiles, 1982.

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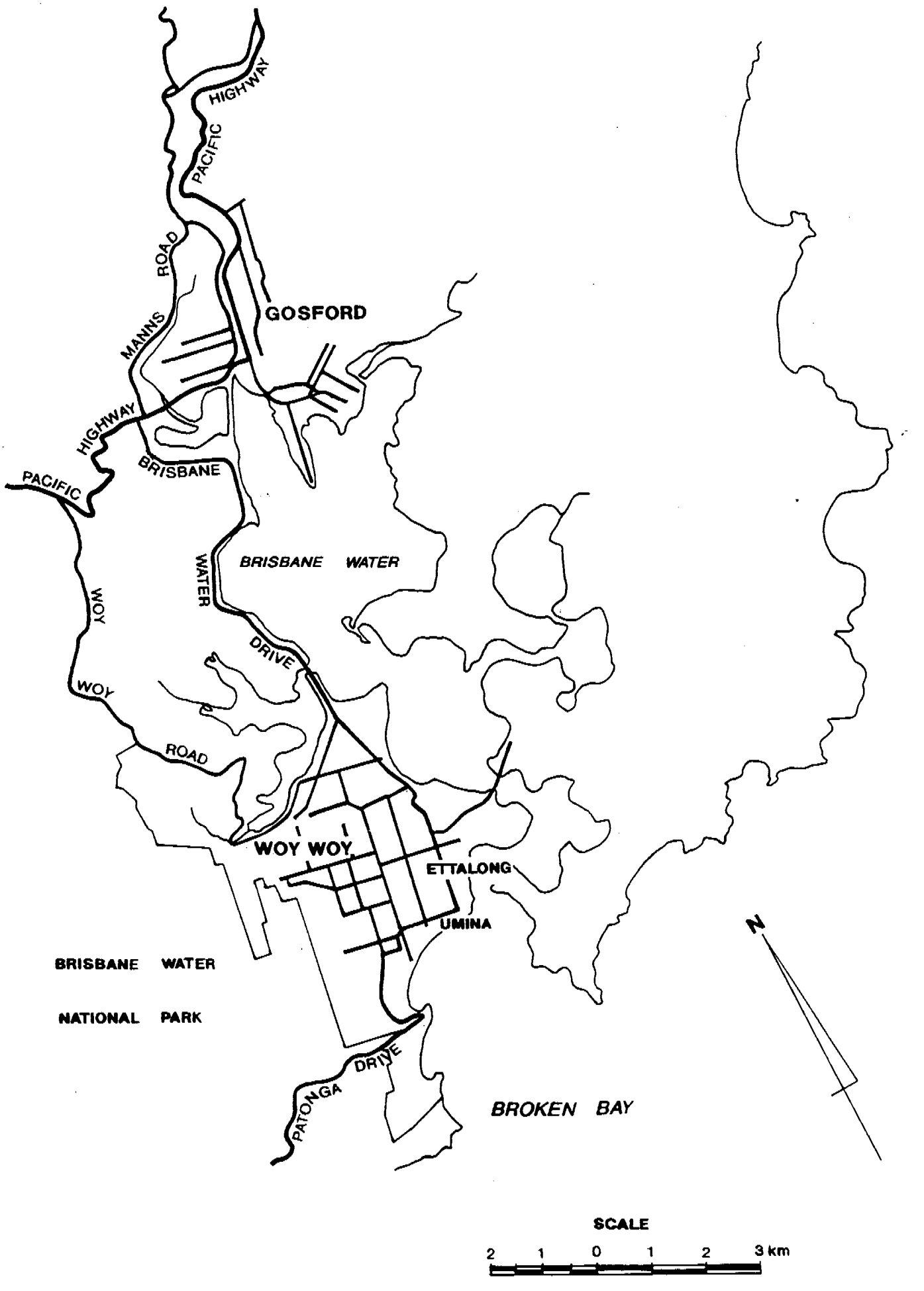
FIGURES

FIGURE 1

LOCALITY MAP



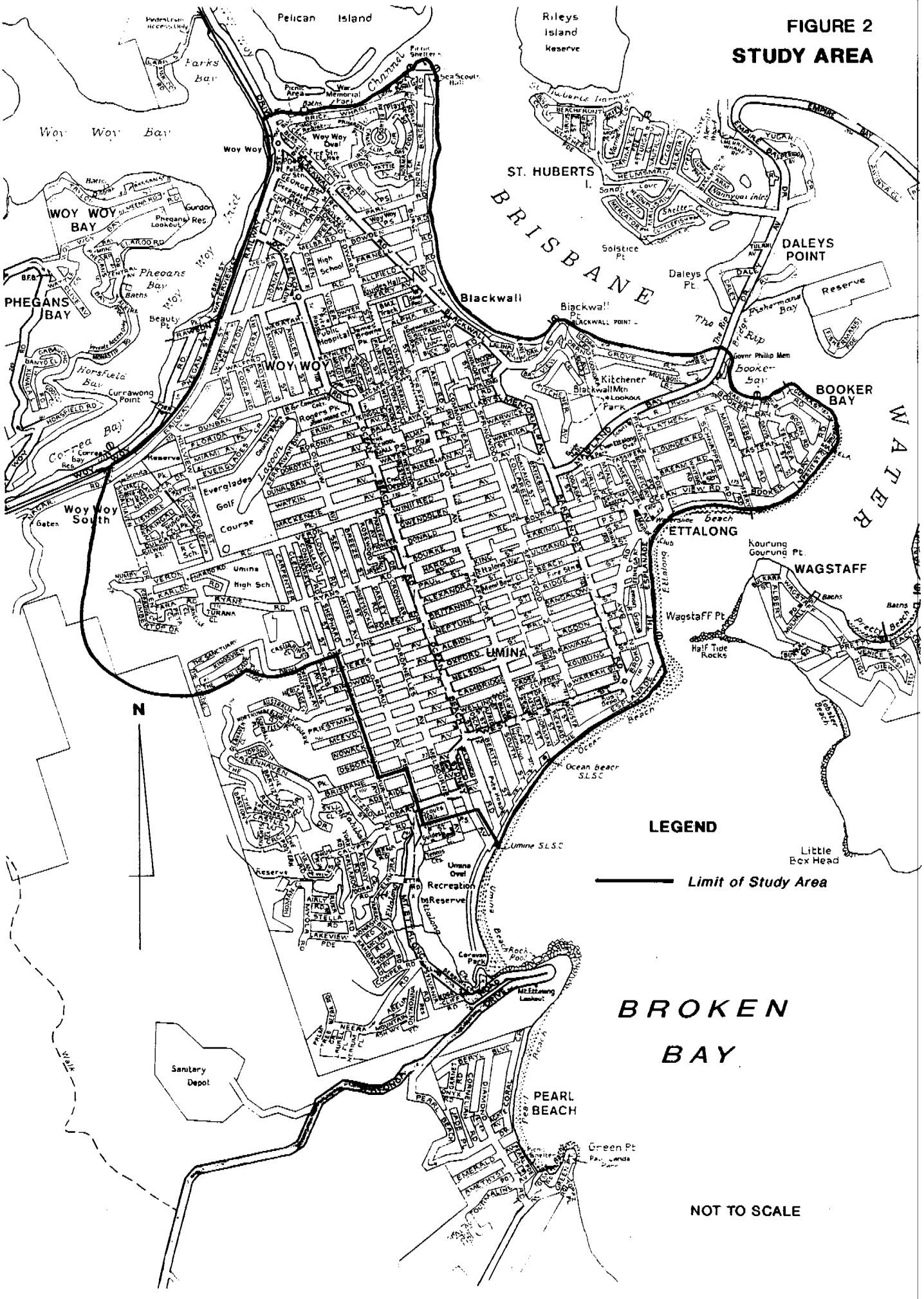


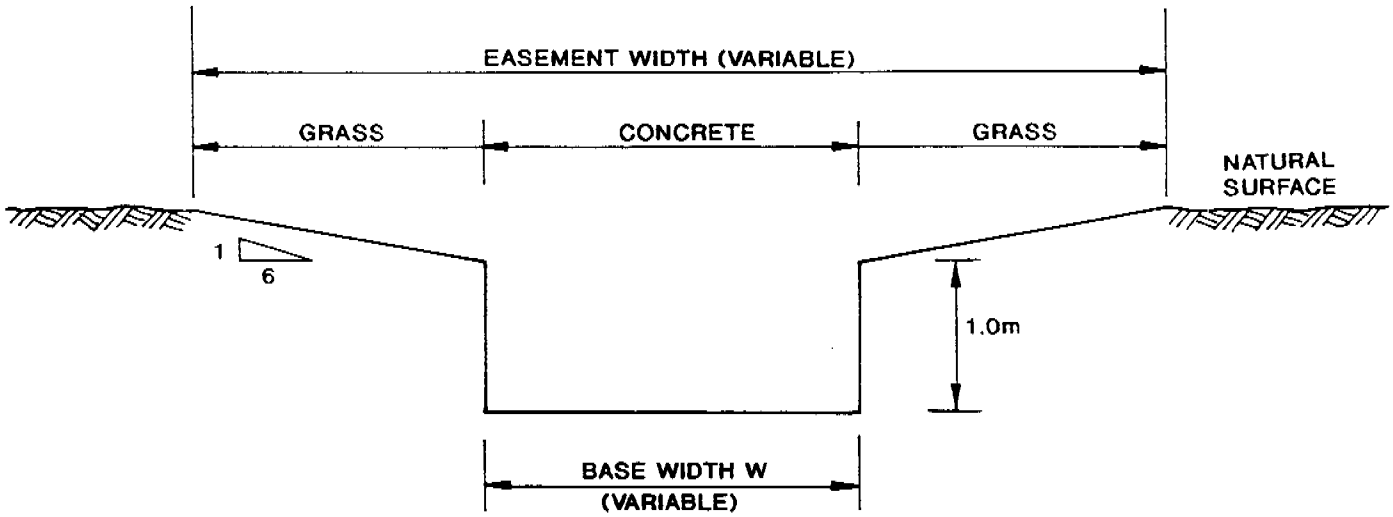
FIGURE 2
STUDY AREA
Pelican Island
Riley's Island Reserve
Parks Bay
Woy Woy Bay
Woy Woy
ST. HUBERTS I.
BRISBANE WATER
DALEYS POINT
Daleys Pt
Solstice Pt
WOY WOY BAY
PHEGANS BAY
Pheoans Bay
Beauty Pt
Blackwall
Blackwall Pt
WOY WOY
Kitchener Park
BOOKER BAY
Bridge Rip
Fishermans Bay
Reserve
Currawong Point
Horsfield Bay
Correa Bay
Woy Woy South
Gates
Everglades Golf Course
Lagoon
ETTALONG
Ettalong Beach
Kourung
Gourung Pt
WAGSTAFF
Wagstaff Pt
Half Tide Rocks
Pretty Beach
Tuggerah Beach
UMINA
Ocean Beach SLSC
Umina SLSC
Umina Oval
Recreation Reserve
Little Box Head
N
LEGEND
Limit of Study Area
BROKEN BAY
Sanitary Depot
PEARL BEACH
Green Pt
NOT TO SCALE

FIGURES 3a,3b & 4a,4b

REFER ATTACHMENT A

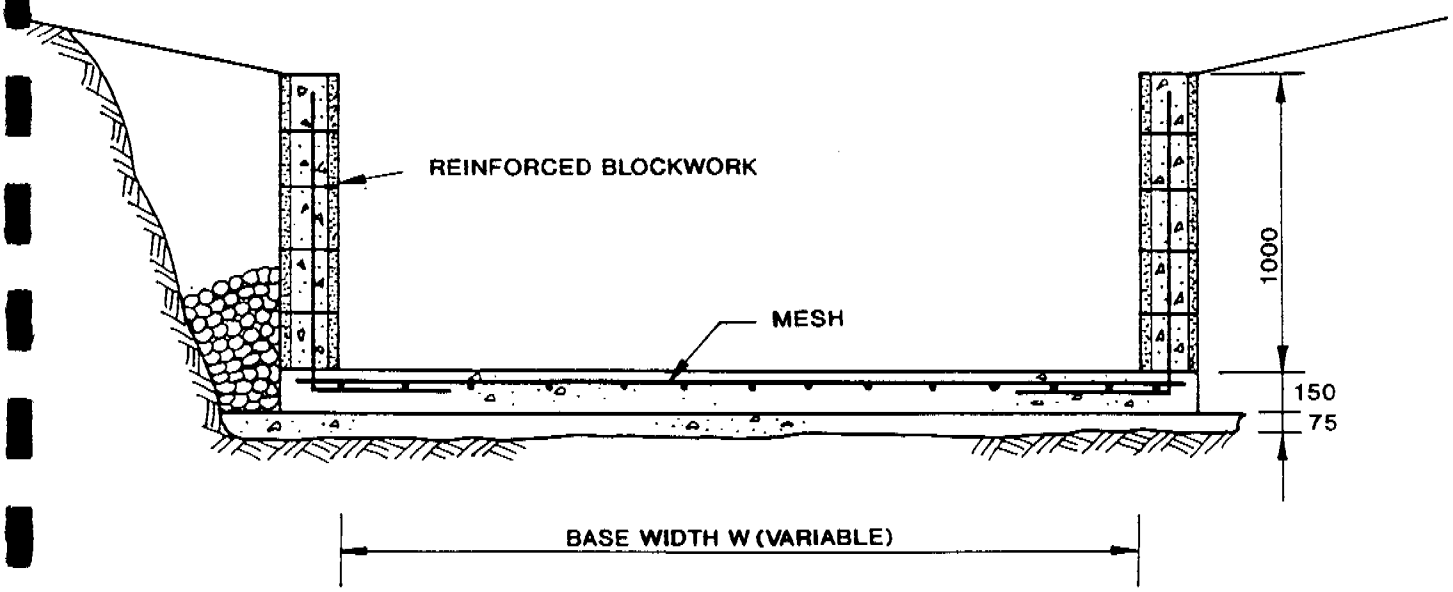
FIGURE 5

DESIGN CHANNEL DIMENSIONS



DESIGN CHANNEL ADOPTED

1:50



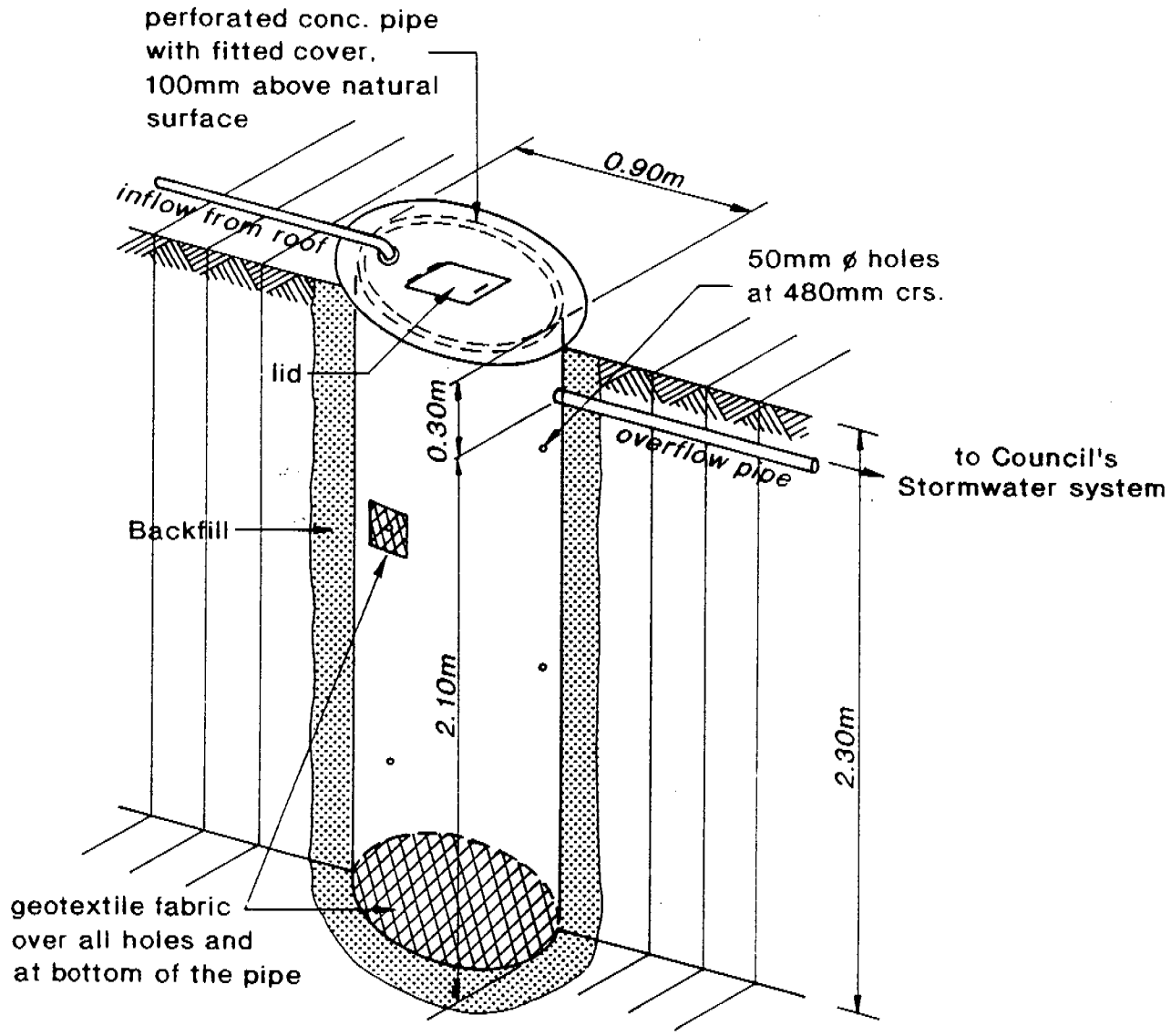
TYPICAL SECTION OF CONCRETE CHANNEL

NOTE: This section was adopted to estimate cost and easement width. Refer Section 7.3

N.T.S.

FIGURE 6

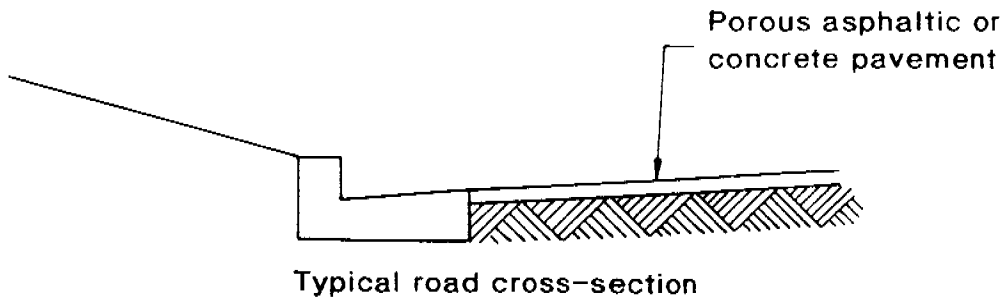
ROOF RUNOFF TO GROUND-WATER VIA SUMP PITS



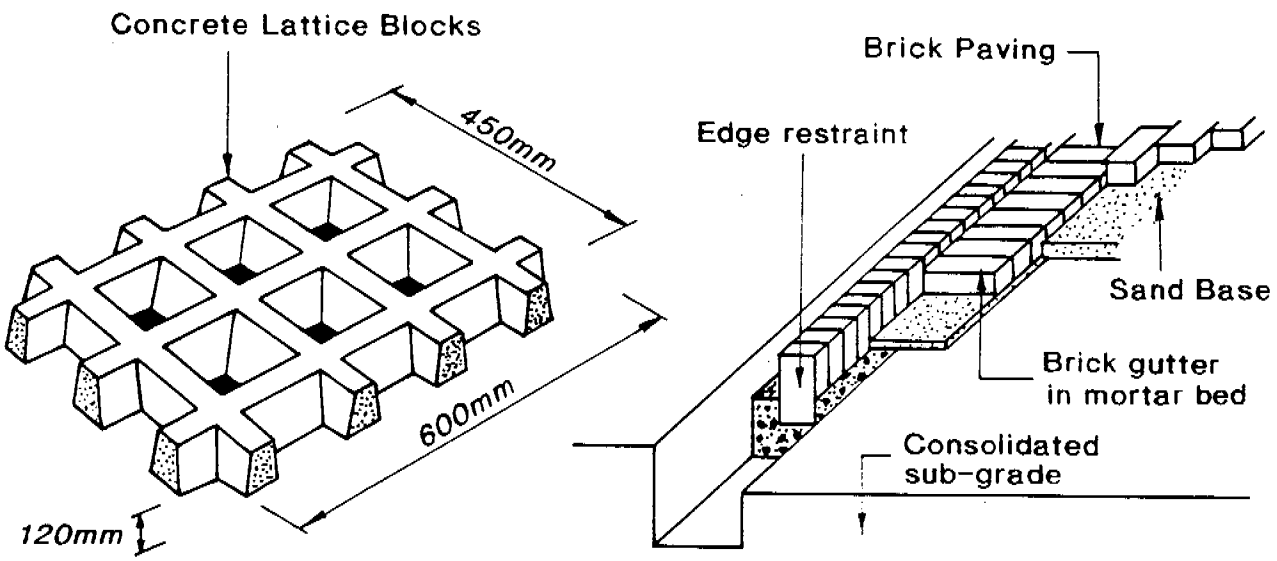
900mm diameter retention/overflow well
located on private property

FIGURE 7

POROUS ROAD PAVEMENTS & POROUS PARKING AREAS



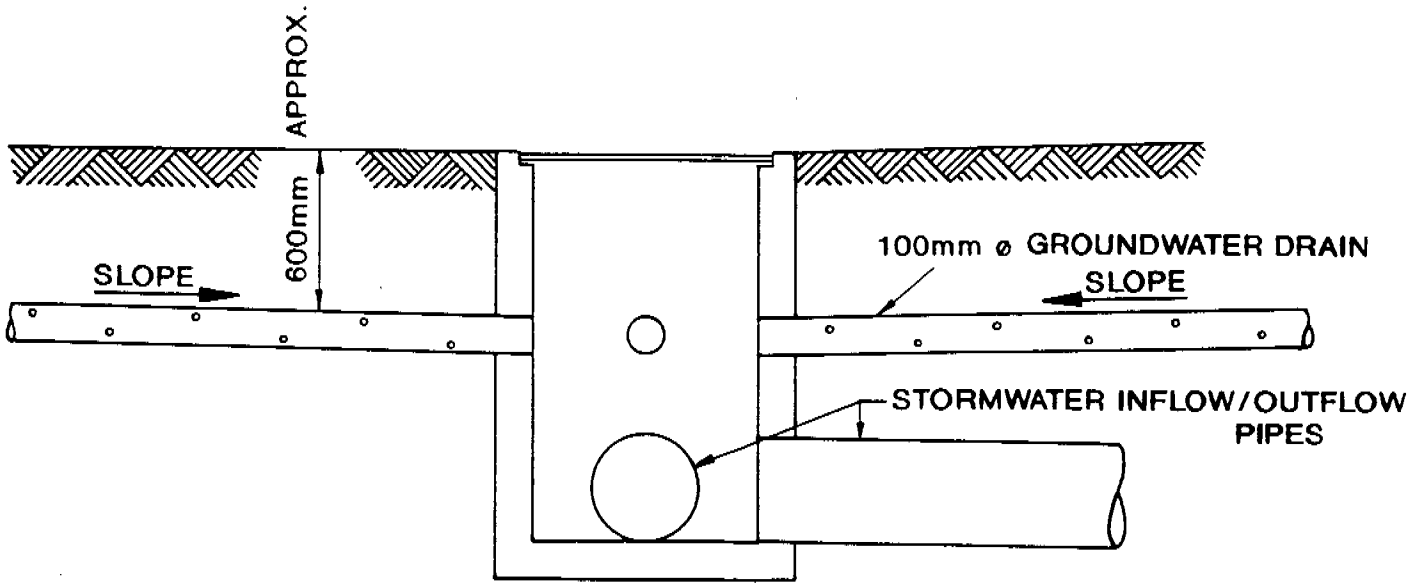
POROUS ROAD PAVEMENT



POROUS PARKING AREAS

FIGURE 8

GROUNDWATER DRAINAGE SYSTEM



STORMWATER GULLY PIT OR JUNCTION MH.

FIGURE 9

SURFACE RUNOFF COLLECTION FACILITY AT LOW POINTS

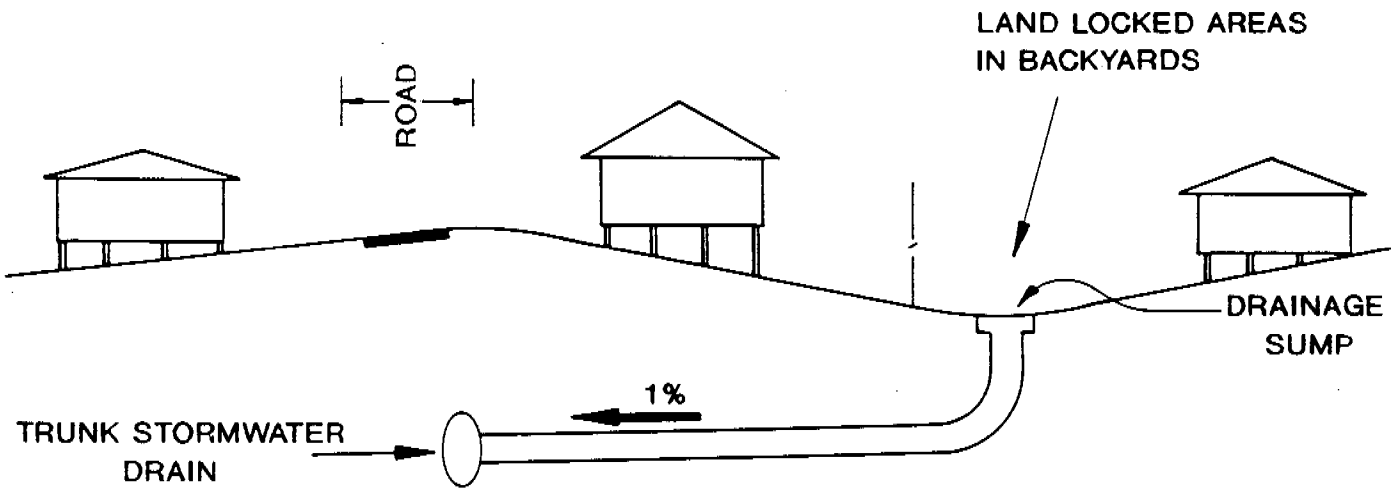


FIGURE 10

RYANS RD, VERON RD, DULKARA RD, NAMBUCCA DVE TO RAILWAY LINE HYDRAULIC GRADE LINES

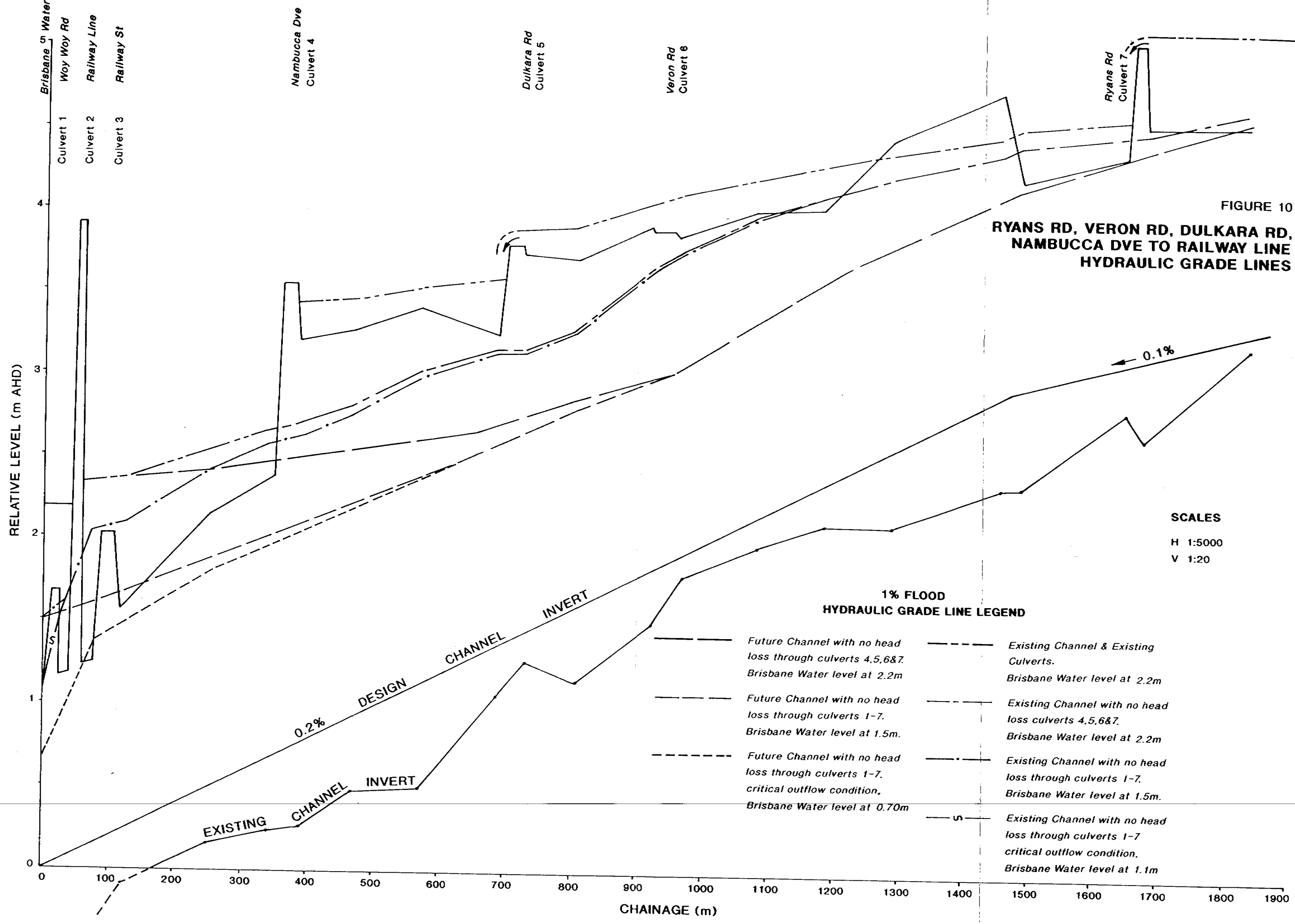


FIGURE 11(a)

ROSS ST, ROWAN RD TO BRISBANE WATER HYDRAULIC GRADE LINES EXISTING CATCHMENT AREA

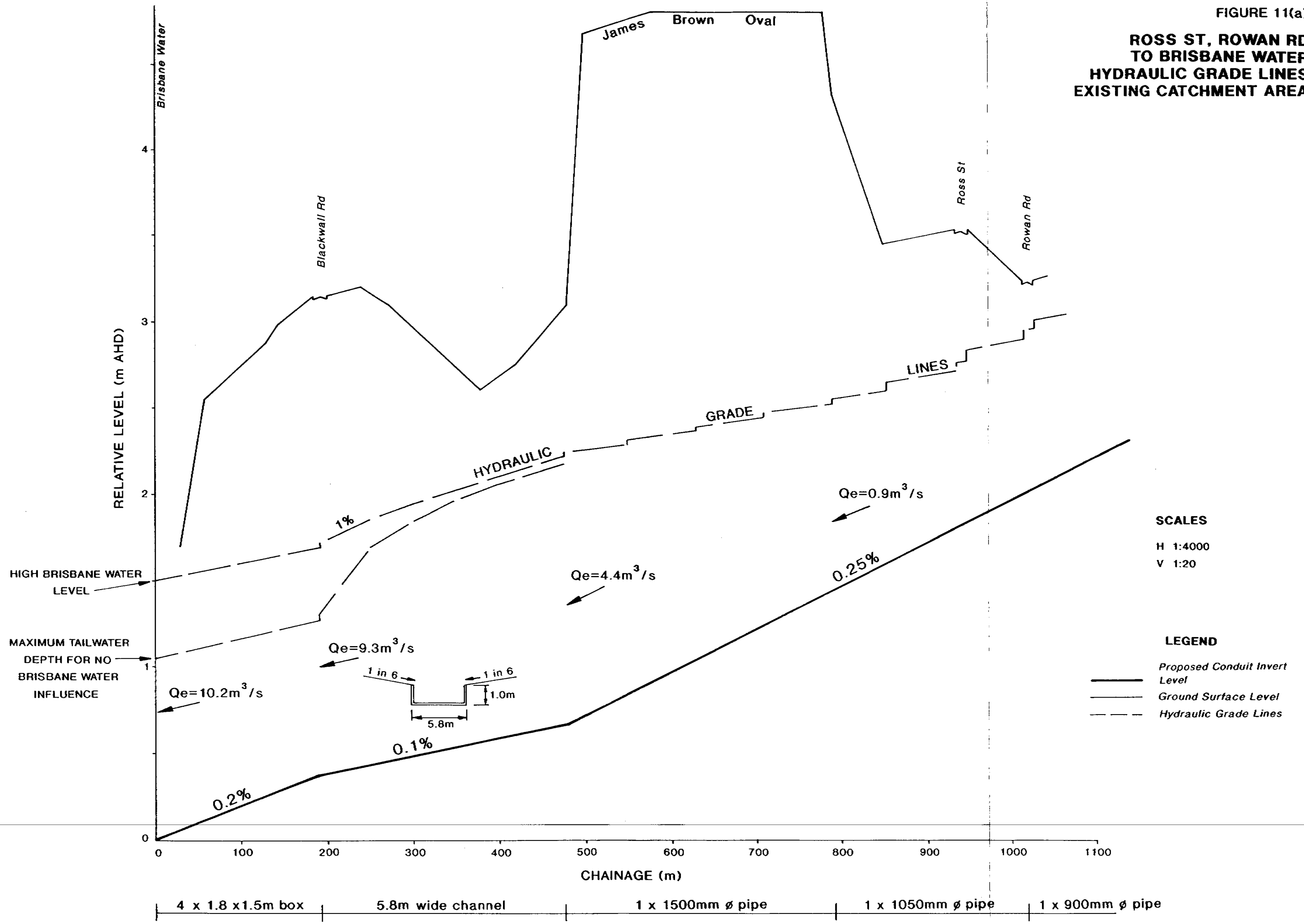
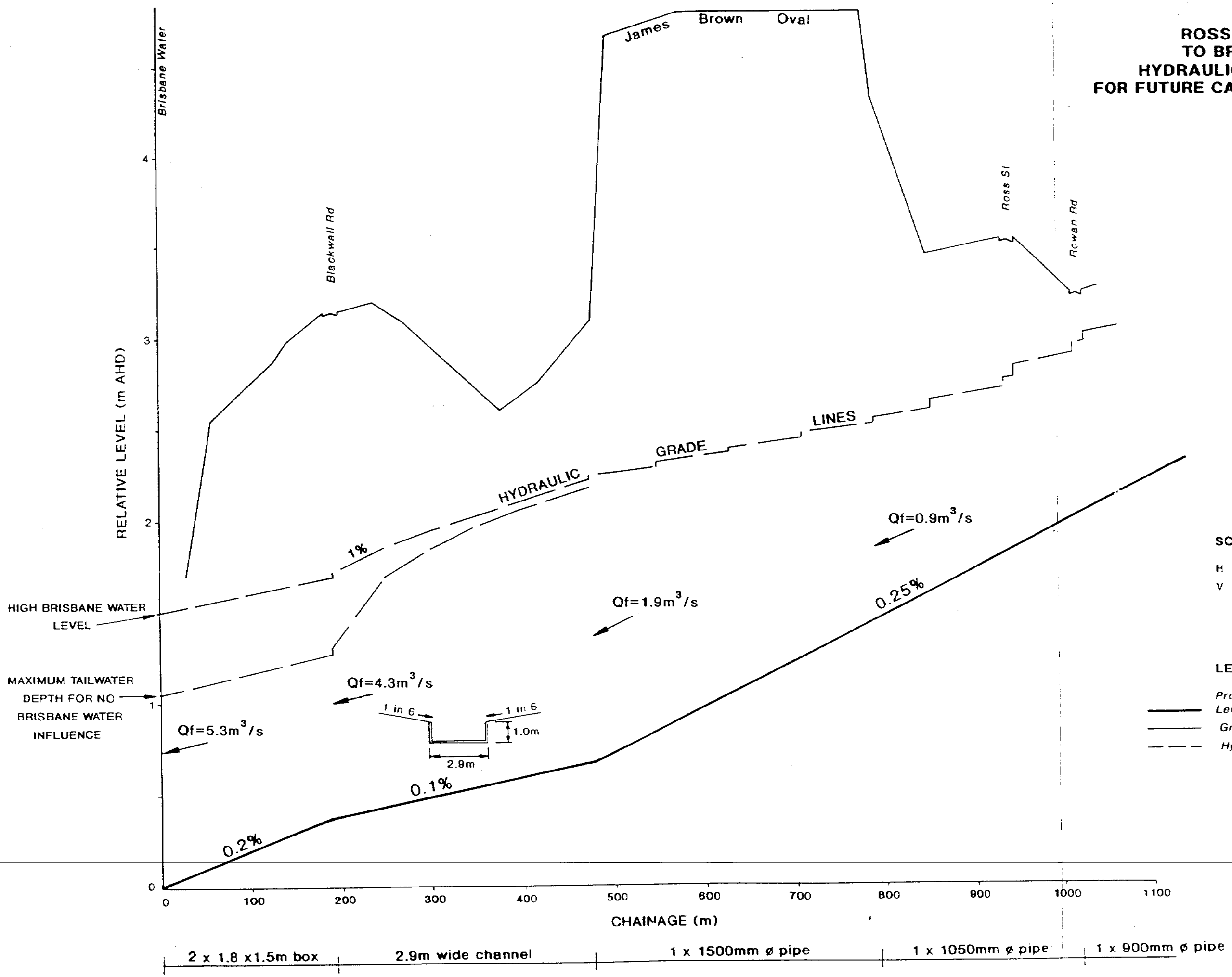


FIGURE 11(b)

ROSS ST, ROWAN RD TO BRISBANE WATER HYDRAULIC GRADE LINES FOR FUTURE CATCHMENT AREA



SCALES

H 1:4000

V 1:20

LEGEND

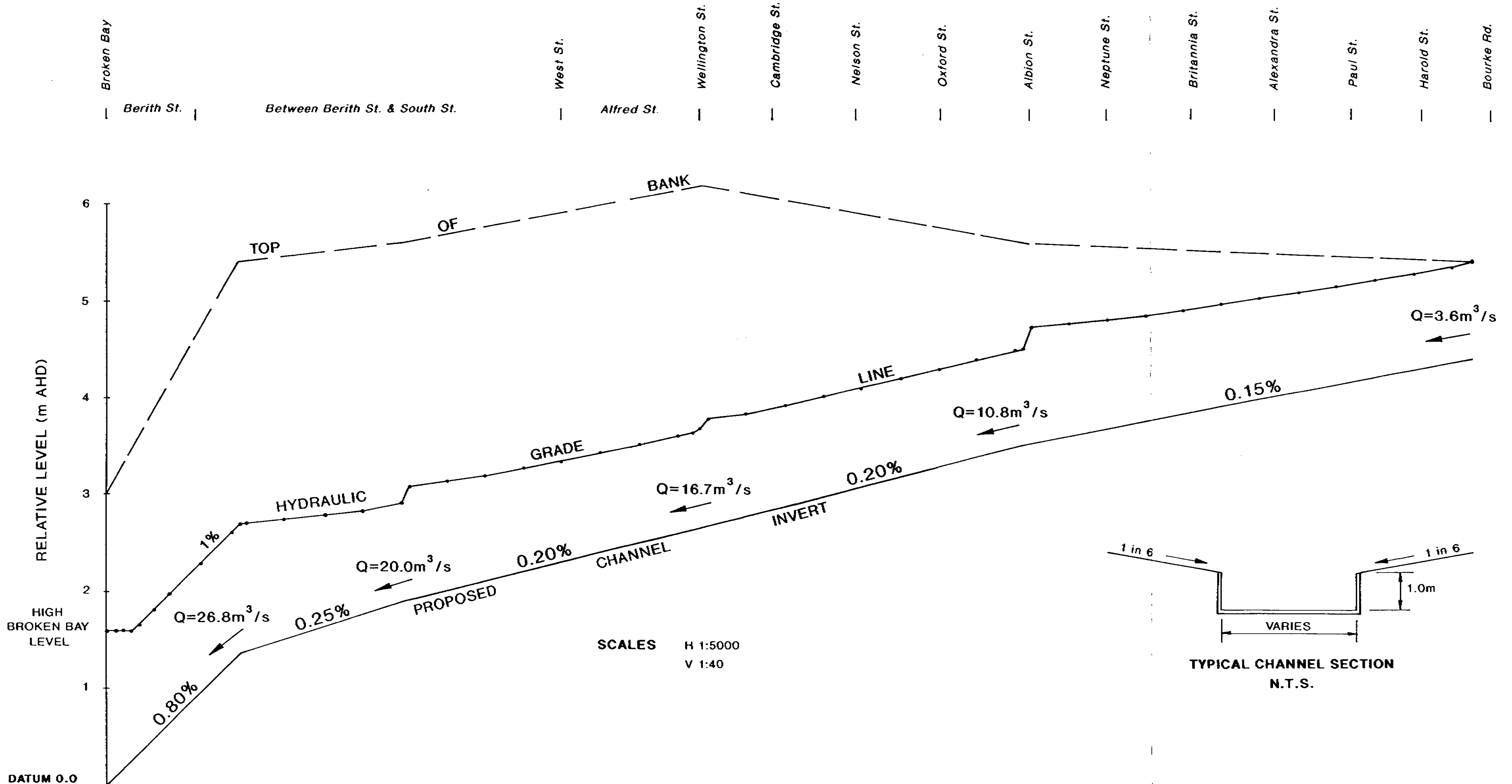
Proposed Conduit Invert Level

Ground Surface Level

Hydraulic Grade Lines

FIGURE 12

BOURKE ROAD TO BROKEN BAY HYDRAULIC GRADE LINE



FLOOD LEVEL	1.50	5.5m Channel	2.70	7.1m Channel	2.93	6.7m Wide Channel	3.64	4.6m Wide Channel	4.50	2.2m Wide Channel	5.40
GROUND LEVEL	3.0		5.5		4.8		6.2		5.6		5.4
INVERT LEVEL	0.00		1.38		1.89		2.67		3.51		4.39
CHAINAGE (m)	0		170		380	500	770	1000	1180	1500	1780

APPENDIX A

APPENDIX A

ILSAX OUTPUT COLUMN DESCRIPTION

INPUT DATA

Network

1. Branch name. Each pipe branch (or arm) in each drainage system is given a alphabetic code,
2. Reach name. Each pipe reach, within a pipe branch, is given a numeric code. A pipe reach is the length of pipe downstream of a pit until the next pit,
3. At the end of a pipe branch the continuing branch name is specified so that ILSAX knows to combine the hydrographs at that location,

Conduit Details

4. Reach length (m),
5. Slope (%), assumed from existing ground levels,
6. Existing conduit size,

Catchment Details

7. Sub-catchment area (ha),
8. Directly connected paved area, as a %,
9. Paved area entry time (minutes),
10. Supplementary paved area, as a %,
11. Grassed area, as a %,
12. Grassed area travel time across the grassed surface (minutes),
13. Lag time for grassed area flow to begin to contribute to flow at the pit (minutes),

Levels

14. Invert level at the pit (mAHD), based on 5 above,
15. Ground level at the pit (mAHD),

OUTPUT DATA

Hydrology for chosen AEP

16. Critical storm duration for pipe reach (minutes),
17. Peak flowrate (m3/s),

Upgrade Option 1 - Supplement Existing with Extra Pipes

18. Number of pipes,
19. Diameter of pipes (mm),

Upgrade Option 2 - New Pipes

20. Number of pipes,
21. Diameter of pipes (mm),

Upgrade Option 3 - New Open Channels

22. Channel width (m) (see Fig.5 for channel dimensions),
23. Calculated normal depth in channel (m),

Proposed Option

24. Recommended upgrade option description,
25. Proposed easement width for open channels (see Fig.5).

Cost Breakdown

26. Cost estimate for trunk drainage works ($K),
27. Estimate of extra cost for culverts under roads ($K),
28. Cost estimate for services relocation (say 5%),
29. Total Cost (26 + 27 + 28) ($K).

APPENDIX A1

ILSAX RESULTS
1 IN 10 AEP FLOOD
EXISTING CATCHMENTS

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
Network			**Reach Details**			**Catchment Area Parameters**							**Levels**		**Hydrology 1 in 10 AEP**		**Proposed Upgrade Options**						**Proposed Upgrade Works**		**Cost Breakdown**			**Total Cost**
branch & reach		add hyd to	L (m)	S (%)	existing conduit size (mm)	area (ha)	paved direct (%)	paved time (min)	paved sup. (%)	grass (%)	grass time (min)	grass lag (min)	invert level mAHD	ground level mAHD	critical duration (min)	flowrate (m3/s)	Extra Pipes no.	Extra Pipes dia. (mm)	New Pipes no.	New Pipes dia. (mm)	Open Channel w (m)	Open Channel d (m)	Description	Easement Width (m)	Trunk Drainage ($1000)	Proposed Culverts ($1000)	Services Relocation ($1000)	($1000)
AA	1		335	0.20	675	13.13	30	14	10	60	55	7	3.8	5.2	20	1.4	1	825	1	1050	1.2	0.80	1 x 825mm dia pipe		109	9	6	124
AB	1	AA	230	0.50	600	3.41	30	8	10	60	33	4	4.3	5.3	10	0.4			1	600	1.2	0.23						
AA	2		290	0.20	2 x 750	10.99	30	13	10	60	52	6	3.1	5.1	25	2.9	1	1200	1	1500	1.7	1.00	1 x 1200mm dia pipe		153	15	8	176
AA	3		185	0.20	2 x 900	6.85	30	11	10	60	43	5	2.6	5.1	25	3.5	1	825	1	1500	1.9	1.00	1 x 825mm dia pipe		60	9	3	73
AC	1	AA	190	0.50	750	4.61	30	9	10	60	37	5	3.1	4.4	20	0.6			1	675	1.2	0.30						
AA	4		130	0.20	2 x 900	5.58	30	10	10	60	40	5	2.2	4.6	25	4.4	1	1200	1	1650	2.3	1.00	2.3m wide channel	19	110	15	6	132
AA	5		220	0.20	2 x 900	3.32	30	8	10	60	33	4	1.9	4.4	25	4.7	1	1350	1	1800	2.4	1.00	2.4m wide channel	20	190	18	10	219
AD	1		585	0.20	600	14.58	30	14	10	60	58	7	4.3	5.5	20	1.5	1	1050	1	1200	1.2	0.84	1 x 1050mm dia pipe		259	13	14	286
AE	1	AD	130	0.20	600	8.82	30	12	10	60	48	6	3.4	4.9	20	1.0	1	900	1	1050	1.2	0.62	1 x 900mm dia pipe		48	10	3	61
AD	2		255	0.20	1050	4.63	30	9	10	60	37	5	3.1	5.2	25	2.8	1	1200	1	1500	1.6	1.00	1 x 1200mm dia pipe		134	15	7	157
AF	1	AD	90	1.00	1050	4.11	30	9	10	60	36	4	3.5	4.8	15	0.5			1	525	1.2	0.21						
AD	3		355	0.20	1200	1.42	30	6	10	60	24	3	2.6	5.0	25	3.1	1	900	1	1500	1.7	1.00	1 x 900mm dia pipe		130	10	7	147
AG	1	AD	190	0.20	open channel	23.85	20	17	5	75	70	9	2.3	4.5	90	2.7			1	1500	1.6	1.00	1.6m wide channel	16	145		7	152
AD	4	AA	205	0.20	open channel	1.99	30	7	10	60	27	3	1.9	5.0	90	5.4			1	1800	2.6	1.00	2.6m wide channel	28	184		9	193
AA	6		490	0.10	open channel	6.58	30	11	10	60	43	5	1.5	4.3	25	10.5			3	1650	6.0	1.00	6.0m wide channel	28	651		33	684
AH	1	AA	310	3.80	900	7.88	30	11	10	60	46	6	12.8	14.1	15	1.1			1	600	1.2	0.23						
AI	1		60	0.20	750	8.10	5	12		95	46	6	2.0	5.0	25	0.2			1	450	1.2	0.20						
AJ	1	AI	40	0.30	750	2.97	30	8	10	60	32	4	2.0	4.2	20	0.4			1	600	1.2	0.28						
AK	1	AI	50	0.40	825	4.86	30	10	10	60	38	5	2.1	4.2	20	0.6			1	675	1.2	0.33						
AL	1		180	0.15	975	5.33	30	10	10	60	39	5	3.2	4.7	25	0.7			1	900	1.2	0.53						
AL	2		120	0.15	1275	4.26	30	9	10	60	36	5	2.9	4.7	20	1.1			1	1050	1.2	0.74						
AL	3		110	0.15	1500	5.63	30	10	10	60	40	5	2.7	4.6	20	1.8			1	1350	1.3	1.00						
AL	4		100	0.15	1950	4.06	30	9	10	60	36	4	2.5	5.3	20	2.2			1	1350	1.5	1.00						
AL	5		290	0.15	1800	3.27	30	8	10	60	33	4	2.4	4.9	20	2.5			1	1500	1.6	1.00						
AL	6	AI	50	0.15	1800	3.29	30	8	10	60	33	4	2.0	4.2	25	2.8			1	1500	1.8	1.00						
AI	2		40	0.50	2x1350	7.23		11		100	44	6	1.9	3.9	60	0.4			1	1500	1.2	0.23						
AM	1	AI	60	0.50	600	2.94	30	8	10	60	31	4	2.0	4.0	20	0.4			1	525	1.2	0.23						
AN	1	AI	130	0.27	825	5.28	30	10	10	60	39	5	2.0	4.9	15	0.6			1	750	1.2	0.38						
AI	3		10	0.50	3x1350	2.19		7		100	28	4	1.7	3.8	90	0.9			1	750	1.2	0.41						
AI	4		20	0.50	3x1350	2.31		7		100	29	4	1.6	3.7	25	0.8			1	750	1.2	0.38						
AI	5		20	0.50	3x1350	3.22		8		100	33	4	1.5	3.6	60	0.5			1	750	1.2	0.27						
AI	6		10	0.50	3x1350	3.14		8		100	32	4	1.4	3.5	90	0.5			1	750	1.2	0.27						
AI	7		10	0.50	3x1350	0.70		6		100	18	3	1.4	3.4	90	0.5			1	750	1.2	0.27						
AI	8		30	0.30	2x1050 + 825	1.42		6		100	24	3	1.3	3.3	90	0.5			1	750	1.2	0.32						
AO	1	AI	30	1.09	900	3.91	15	9		85	35	4	1.6	4.3	10	0.2			1	375	1.2	0.12						
AI	9	AA	80	0.30	2x1050 + 825	1.50	30	6	10	60	24	3	1.2	4.3	90	0.5	1	1050	1	1500	1.2	0.32						
AA	7		250	0.10	open channel	20.94	5	17		95	66	8	1.0	4.5	25	11.1			3	1650	6.3	1.00	6.3m wide channel	36	342		17	359
AP	1		120	5.00	900	20.16	30	16	10	60	65	8	11.9	23.1	15	0.8			1	525	1.2	0.17						
AQ	1	AP	200	5.00	750	10.12	30	13	10	60	50	6	15.9	32.5	20	0.5			1	375	1.2	0.13						
AP	2		290	1.00	1200	5.43	30	10	10	60	40	5	5.9	8.5	25	2.1			1	900	1.2	0.59						
AR	1		95	5.00		5.46	30	10	10	60	40	5	11.7	17.0	25		1	375	1	375	1.2	0.01	1 x 375mm dia pipe		42	5	2	49
AR	2	AP	215	1.80	1200	5.53	30	10	10	60	40	5	6.9	8.6	15	0.3			1	375	1.2	0.13						
AP	3		185	1.00	open channel	10.37	30	13	10	60	51	6	3.0	4.9	25	4.3			1	1200	1.2	1.00	1.2m wide channel	12	133		7	140
AP	4	AA	215	0.20	1800	2.92		8	5	95	31	4	1.2	3.1	25	4.3			1	1650	2.2	1.00				8	0	8
AA	8		230	0.10	open channel	6.33	10	11	5	85	42	5	0.8	3.8	90	13.5			3	1800	7.5	1.00	7.5m wide channel	32	349		17	366

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
Network			**Reach Details**			**Catchment Area Parameters**							**Levels**		**Hydrology 1 in 10 AEP**		**Proposed Upgrade Options**						**Proposed Upgrade Works**		**Cost Breakdown**			**Total Cost**
branch & reach		add hyd to	L (m)	S (%)	existing conduit size (mm)	area (ha)	paved direct (%)	paved time (min)	paved sup. (%)	grass (%)	grass time (min)	grass lag (min)	invert level mAHD	ground level mAHD	critical duration (min)	flowrate (m3/s)	Extra Pipes no.	Extra Pipes dia. (mm)	New Pipes no.	New Pipes dia. (mm)	Open Channel w (m)	Open Channel d (m)	Description	Easement Width (m)	Trunk Drainage ($1000)	Proposed Culverts ($1000)	Services Relocation ($1000)	($1000)
AS	1	AA	470	1.70	600	5.23	30	10	10	60	39	5	8.5	10.0	90				1	375	1.2	0.01						
AA	9		290	0.10	open channel	17.45	15	15	5	80	62	8	0.5	3.4	90	14.2			3	1800	7.8	1.00	7.8m wide channel	30	452		23	475
AT	1		335	0.50	open channel	4.74	20	9	5	75	38	5	3.1	4.4	15	0.4			1	600	1.2	0.23	1.2m wide channel	4	240		12	252
AT	2	AA	245	0.50	open channel	10.82	25	13	10	65	52	6	1.5	3.0	20	1.3			1	900	1.2	0.53	1.2m wide channel	8	176		9	184
AA	10		175	0.10	open channel	22.38	20	17	5	75	68	8	0.2	3.0	90	16.4			4	1650	8.9	1.00	8.9m wide channel	30	297		15	312
AU	1		710	0.40	750	3.91	25	9	10	65	35	4	3.8	4.5	15	0.4			1	600	1.2	0.25						
AU	2	AA	220	0.40	1500	8.32	25	12	10	65	47	6	0.9	2.5	20	1.1			1	825	1.2	0.52						
AV	1	AA	235	1.00		1.50	30	6	10	60	24	3	2.4	4.0	10	0.2	1	375	1	375	1.2	0.12	1 x 375mm dia pipe		104	4	5	114
AA	11		60	0.10	4 x 1500	6.18		10		100	42	5	0.1	1.5	90	17.3	1	1500	4	1650	9.3	1.00	9.3m wide channel	15	105	21	6	132
					total area	365.2	ha																		$4,415	$152	$228	$4,795
BA	1		100	0.40		5.36	30	10	10	60	39	5	3.4	4.2	10	0.6	1	675	1	675	1.2	0.30	1 x 675mm dia pipe		26	7	2	34
BB	1	BA	90	0.40		5.91	30	10	10	60	41	5	3.3	4.9	20	0.7	1	675	1	675	1.2	0.34	1 x 675mm dia pipe		23	7	2	32
BA	2		125	0.40		2.64	30	8	10	60	36	4	3.0	4.6	25	1.7	1	1050	1	1050	1.2	0.65	1 x 1050mm dia pipe		55	13	3	72
BA	3		65	0.40		3.49	30	8	10	60	34	4	2.5	4.5	25	2.1	1	1050	1	1050	1.2	0.77	1 x 1050mm dia pipe		29	13	2	44
BA	4		60	0.40		2.39	30	7	10	60	29	4	2.2	4.6	20	2.3	1	1050	1	1050	1.2	0.82	1 x 1050mm dia pipe		27	13	2	42
BA	5		60	0.40		3.14	30	8	10	60	32	4	2.0	4.6	25	2.7	1	1200	1	1200	1.2	0.93	1 x 1200mm dia pipe		32	15	2	49
BA	6		70	0.40		3.51	30	8	10	60	34	4	1.7	4.1	25	3.1	1	1200	1	1200	1.2	1.00	1 x 1200mm dia pipe		37	15	3	54
BA	7		140	0.40		2.97	30	8	10	60	32	4	1.5	4.3	20	3.4	1	1350	1	1350	1.3	1.00	1 x 1350mm dia pipe		86	18	5	109
BA	8		240	0.10		2.17	30	7	10	60	28	3	0.9	4.6	25	3.7	1	1800	1	1800	2.6	1.00	2.6m wide channel	35	214	26	12	252
BA	9		165	0.40		5.03	30	10	10	60	39	5	0.7	4.6	20	4.1	1	1800	1	1800	1.5	1.00	1.5m wide channel	37	125	26	8	159
					total area	36.6	ha																		$653	$153	$40	$846
CA	1		165	0.50	750	3.05	30	8	10	60	32	4	2.3	4.7	15	0.4			1	525	1.2	0.23						
CA	2		225	0.50	900	3.40	30	8	10	60	33	4	1.5	4.4	20	0.8			1	750	1.2	0.38						
CA	3		75	0.50	1050	6.30	30	10	10	60	42	5	0.4	5.0	20	1.5			1	1050	1.2	0.59						
					total area	12.8	ha																					
DA	1		70	0.20	675	4.36	30	9	10	60	36	5	0.3	1.2	10	0.5	1	375	1	750	1.2	0.38	1 x 375mm dia pipe		10	4	1	15
DA	2		65	0.20	675	1.12	30	6	10	60	22	3	0.1	1.5	25	0.7	1	525	1	825	1.2	0.48	1 x 525mm dia pipe		13	6	1	20
					total area	5.5	ha																		$23	$10	$2	$34
EA	1		60	0.50	750	2.12	30	7	10	60	28	3	0.3	1.2	15	0.3			1	525	1.2	0.20						
					total area	2.1	ha																					
FA	1		70	0.10	1050	1.94	60	7	20	20	27	3	0.2	1.2	10	0.5			1	825	1.2	0.48						
FB	1	FA	80	0.1		0.75	60	6	20	20	19	3	0.2	1.2	10	0.2	1	600	1	600	1.2	0.25	1 x 600mm dia pipe		18	6	1	25
FA	2		145	0.1	1050	0.50	60	6	20	20	16	3	0.2	1.1	20	0.9			1	1050	1.2	0.74						
FA	3		10	0.10	1050	1.22	60	6	20	20	22	3	0.0	1.1	25	1.2	1	600	1	1200	1.2	0.93	1 x 600mm dia pipe		2	6	0	9
					total area	4.4	ha																		$20	$12	$2	$34
GA	1		50	0.50	525	1.05	30	6	10	60	21	3	0.4	1.2	10	0.1			1	375	1.2	0.09						
GA	2		20	0.50	525	0.55	30	6	10	60	17	3	0.1	1.0	10	0.2			1	450	1.2	0.15						
					total area	1.6	ha																					

APPENDIX A1

ILSAX RESULTS
1 IN 10 AEP FLOOD
EXISTING CATCHMENTS

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
Network			**Reach Details**			**Catchment Area Parameters**							**Levels**		**Hydrology 1 in 10 AEP**		**Proposed Upgrade Options**						**Proposed Upgrade Works**		**Cost Breakdown**			**Total Cost**
branch & reach		add byd to	L (m)	S (%)	existing conduit size (mm)	area (ha)	paved direct (%)	paved time (min)	paved sup. (%)	grass (%)	grass time (min)	grass lag (min)	invert level mAHD	ground level mAHD	critical duration (min)	flowrate (m3/s)	Extra Pipes no.	Extra Pipes dia. (mm)	New Pipes no.	New Pipes dia. (mm)	Open Channel w (m)	Open Channel d (m)	Description	Easement Width (m)	Trunk Drainage ($1000)	Proposed Culverts ($1000)	Services Relocation ($1000)	($1000)
HA	1		40	1.00		1.50	30	6	10	60	24	3	0.4	1.2	10	0.2	1	375	1	375	1.2	0.12	1 x 375mm dia pipe			4	0	4
					total area	1.5	ha																			$4	$0	$4
IA	1		90	0.10	600	5.73	30	10	10	60	40	5	1.2	2.5	20	0.7	1	900	1	1050	1.2	0.61	1 x 900mm dia pipe		33	10	2	45
IB	1	IA	155	1.00	450	5.65	30	10	10	60	40	5	2.7	4.0	20	0.7	1	450	1	600	1.2	0.27	1 x 450mm dia pipe		26	5	2	32
IA	2		285	0.10	900	4.25	30	9	10	60	36	5	1.1	2.2	25	1.9	1	1050	1	1350	1.6	1.00	1 x 1050mm dia pipe		126	13	7	146
IA	3		185	0.10		8.30	30	12	10	60	47	6	0.8	1.8	25	2.7	1	1650	1	1650	2.0	1.00	1 x 1650mm dia pipe		150	23	9	181
IA	4		90	0.10		4.26	30	9	10	60	36	5	0.7	1.4	20	3.0	1	1650	1	1650	2.2	1.00	1 x 1650mm dia pipe		73	23	5	101
IC	1	IA	170	0.80	450	3.14	30	8	10	60	32	4	1.9	3.1	15	0.4	1	375	1	525	1.2	0.20	1 x 375mm dia pipe		24	4	1	30
IA	5		165	0.10	open channel	3.49	30	8	10	60	34	4	0.6	1.3	25	3.6	1	675	1	1800	2.5	1.00	2.5m wide channel	6	146	7	8	161
IA	6		160	0.10	open channel	7.10	25	11	10	65	44	5	0.4	1.3	25	4.1			2	1500	2.8	1.00	2.8m wide channel	6	147		7	154
IA	7		100	0.10	open channel	5.48		10	10	90	40	5	0.2	1.1	25	4.1			2	1500	2.8	1.00	2.8m wide channel	6	92		5	96
ID	1	IA	260	0.25		0.65	30	6	10	60	18	3	0.8	1.7	10	0.1	1	375	1	375	1.2	0.12	1 x 375mm dia pipe		67	4	4	74
IE	1	IA	105	0.75		0.70	30	6	10	60	18	3	0.9	1.7	10	0.1	1	375	1	375	1.2	0.08	1 x 375mm dia pipe		27	4	2	33
IA	8		115	0.10	open channel	4.80	5	9	5	90	38	5	0.1	1.0	25	4.3			2	1500	2.9	1.00	2.9m wide channel	6	107		5	112
IA	9		20	0.10	2x1000x1800	2.54	30	7	10	60	30	4	0.0	1.3	25	4.3			2	1500	2.9	1.00						
					total area	56.1	ha																		$1 017	$93	$56	$1 166
JA	1		140	0.30		1.94	30	7	10	60	27	3	0.5	1.5	10	0.2	1	525	1	525	1.2	0.17	1 x 525mm dia pipe		27	6	2	35
JA	2		20	0.30		1.72	30	6	10	60	26	3	0.1	1.2	25	0.5	1	675	1	675	1.2	0.32	1 x 675mm dia pipe		5	7	1	13
					total area	3.7	ha																		$33	$13	$2	$48
KA	1		80	0.15		0.90	15	6		85	20	3	0.1	0.8	10	0.1	1	375	1	375	1.2	0.14	1 x 375mm dia pipe			4	0	4
					total area	0.9	ha																			$4	$0	$4
LA	1		70	0.20		2.24	15	7		85	28	4	0.1	0.8	10	0.1	1	450	1	450	1.2	0.13	1 x 450mm dia pipe		12	5	1	18
					total area	2.2	ha																		$12	$5	$1	$18
MA	1		70	0.20		2.07	30	7	10	60	27	3	0.5	1.4	15	0.3	1	600	1	600	1.2	0.27	1 x 600mm dia pipe		16	6	1	23
MA	2		120	0.20		0.90	30	6	10	60	20	3	0.3	1.3	15	0.4	1	675	1	675	1.2	0.32	1 x 675mm dia pipe		31	7	2	40
MB	1		115	0.10	375	0.50	30	6	10	60	16	3	0.2	0.8	10	0.1			1	375	1.2	0.16				4	0	4
MA	3		80	0.10	450	0.90	30	6	10	60	20	3	0.1	0.8	15	0.5	1	750	1	825	1.2	0.48	1 x 750mm dia pipe		23	9	2	34
					total area	4.4	ha																		$70	$26	$5	$101
NA	1		110	0.30		1.46	30	6	10	60	24	3	1.0	2.0	10	0.1	1	375	1	375	1.2	0.11	1 x 375mm dia pipe			4	0	4
NA	2		88	0.30		0.48	30	6	10	60	16	3	0.7	2.0	10	0.2	1	450	1	450	1.2	0.17	1 x 450mm dia pipe		15	5	1	21
NA	3		58	0.30		0.39	30	6	10	60	16	3	0.5	1.7	10	0.2	1	525	1	525	1.2	0.17	1 x 525mm dia pipe		11	6	1	18
NB	1		57	0.15		2.55	10	7	5	85	30	4	0.5	1.5	10	0.1	1	450	1	450	1.2	0.14	1 x 450mm dia pipe		10	5	1	15
NB	2		68	0.15		0.87	30	6	10	60	20	3	0.5	1.6	10	0.2	1	525	1	525	1.2	0.22	1 x 525mm dia pipe		13	6	1	20
NC	1	NB	36	0.15		0.48	30	6	10	60	16	3	0.3	1.6	15	0.2	1	525	1	525	1.2	0.22	1 x 525mm dia pipe		7	6	1	14
NB	3	NA	53	0.15		0.69	30	6	10	60	18	3	0.4	1.5	15	0.5	1	750	1	750	1.2	0.41	1 x 750mm dia pipe		15	8	1	24
NA	4		46	0.10		0.48	30	6	10	60	16	3	0.3	1.4	15	0.8	1	1050	1	1050	1.2	0.67	1 x 1050mm dia pipe		20	13	2	35
ND	1		77	0.80		0.90	30	6	10	60	20	3	1.2	1.9	10	0.1	1	375	1	375	1.2	-0.08	1 x 375mm dia pipe		34	4	2	40

APPENDIX A1

ILSAX RESULTS
1 IN 10 AEP FLOOD
EXISTING CATCHMENTS

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
Network			**Reach Details**			**Catchment Area Parameters**							**Levels**		**Hydrology 1 in 10 AEP**		**Proposed Upgrade Options**						**Proposed Upgrade Works**		**Cost Breakdown**			**Total Cost**
branch & reach		add hyd to	L (m)	S (%)	existing conduit size (mm)	area (ha)	paved direct (%)	paved time (min)	paved sup. (%)	grass (%)	grass time (min)	grass lag (min)	invert level mAHD	ground level mAHD	critical duration (min)	flowrate (m3/s)	Extra Pipes no.	dia. (mm)	New Pipes no.	dia. (mm)	Open Channel w (m)	d (m)	Description	Easement Width (m)	Trunk Drainage ($1000)	Proposed Culverts ($1000)	Services Relocation ($1000)	($1000)
ND	2	NA	38	0.80		1.65	30	6	10	60	25	3	0.5	1.8	10	0.3	1	450	1	450	1.2	0.16	1 x 450mm dia pipe		6	5	1	12
NA	5		131	0.10		0.57	30	6	10	60	17	3	0.2	1.5	20	1.2	1	1200	1	1200	1.2	0.93	1 x 1200mm dia pipe		69	15	4	88
NE	1	NA	114	0.15	375	0.60	30	6	10	60	17	3	0.3	1.0	10	0.1			1	375	1.2	0.14				4	0	4
NA	6		104	0.10		1.00	30	6	10	60	21	3	0.1	1.0	20	1.4	1	1200	1	1200	1.3	1.00	1 x 1200mm dia pipe		55	15	3	73
					total area	12.1	ha																		$256	$96	$18	$370
OA	1		120	0.80	750	2.59	30	7	20	50	30	4	2.4	3.5	10	0.3			1	450	1.2	0.16						
OA	2		155	0.80	750	0.75	5	6		95	19	3	1.4	3.8	25	0.4			1	525	1.2	0.20						
OB	1	OA	150	0.10	375	0.87	30	6	10	60	20	3	0.3	1.0	10	0.1	1	375	1	450	1.2	0.16	1 x 375mm dia pipe		21	4	1	27
OA	3		80	0.20		1.99	30	7	10	60	27	3	0.2	1.5	15	0.7	1	825	1	825	1.2	0.48	1 x 825mm dia pipe		26	9	2	37
					total area	6.2	ha																		$48	$13	$3	$64
PA	1		100	0.50		13.05	30	14	10	60	55	7	0.5	4.5	25	1.4	1	900	1	900	1.2	0.56	1 x 900mm dia pipe		37	10	2	49
					total area	13.1	ha																		$37	$10	$2	$49
QA	1		195	0.70		2.25	30	7	10	60	28	4	4.0	5.0	15	0.3	1	450	1	450	1.2	0.17	1 x 450mm dia pipe		33	5	2	39
QB	1	QA	95	0.40	675	1.80	30	7	10	60	26	3	3.0	4.1	10	0.2			1	450	1.2	0.16						
QA	2		130	0.40	675	2.37	10	7		90	29	4	2.6	4.5	15	0.6			1	675	1.2	0.33						
QA	3		175	0.40	750	8.77	20	12	5	75	48	6	2.1	3.6	15	1.0	1	375	1	825	1.2	0.48	1 x 375mm dia pipe		25	4	1	30
QA	4		190	0.40	900	4.69	10	9	20	70	38	5	1.4	3.2	20	1.2			1	900	1.2	0.55						
QC	1		135	0.35	750	5.55	30	10	10	60	40	5	1.8	3.6	20	0.7			1	750	1.2	0.39						
QC	2	QA	195	0.35	750	2.99	30	8	10	60	32	4	1.3	3.3	20	1.0	1	375	1	825	1.2	0.50	1 x 375mm dia pipe		28	4	2	33
QA	5		115	0.10	2 x 900	3.34	5	8	5	90	33	4	0.6	2.5	25	2.3	1	825	1	1500	1.8	1.00	1 x 825mm dia pipe		37	9	2	49
QD	1		185	0.50	900	4.78	25	9	10	65	38	5	3.6	4.8	15	0.5			1	600	1.2	0.27						
QD	2	QA	305	0.70	1050	2.17	25	7	10	65	28	3	2.7	5.2	15	0.7			1	675	1.2	0.30						
QE	1		255	0.50	600	6.03	30	10	10	60	41	5	1.8	4.6	15	0.7	1	375	1	675	1.2	0.34	1 x 375mm dia pipe		36	4	2	42
QF	1	QE	90	1.00	525	4.83	15	9	5	80	38	5	1.4	4.6	10	0.3			1	450	1.2	0.15						
QE	2	QA	310	0.50		9.48	25	12	5	70	49	6	2.1	4.3	25	1.9	1	1050	1	1050	1.2	0.71	1 x 1050mm dia pipe		137	13	8	158
QA	6		405	0.10	open channel	11.20	10	13	5	85	52	7	0.5	3.0	25	5.2			2	1500	3.4	1.00	3.4m wide channel	21	401		20	421
QA	7		120	0.10	1050 + 1200	8.95	25	12	5	70	48	6	0.1	3.2	25	5.8	1	1500	2	1500	3.7	1.00	1 x 1500mm dia pipe		85	21	5	111
					total area	79.2	ha																		$783	$60	$42	$885
RA	1		135	0.30	750	6.85	30	11	10	60	43	5	0.8	2.2	20	0.8	1	375	1	825	1.2	0.45	1 x 375mm dia pipe		19	4	1	24
RA	2		80	0.50	900	1.85	30	7	10	60	26	3	0.4	3.5	20	1.0			1	825	1.2	0.44						
					total area	8.7	ha																		$19	$4	$1	$24
SA	1		285	0.25		4.69	30	9	10	60	38	5	5.0	6.1	20	0.6	1	750	1	750	1.2	0.39	1 x 750mm dia pipe		82	8	5	95
SA	2		345	0.25		12.15	30	13	10	60	54	7	4.3	5.9	20	1.8	1	1200	1	1200	1.2	0.89	1 x 1200mm dia pipe		182	15	10	207
SA	3		325	0.25		14.70	30	14	10	60	58	7	3.4	5.5	25	3.3	1	1500	1	1500	1.7	1.00	1 x 1500mm dia pipe		230	21	13	264
SA	4		200	0.25	900	9.63	30	12	10	60	49	6	2.6	5.0	20	4.1	1	1500	1	1650	2.0	1.00	1 x 1500mm dia pipe		142	23	8	173
SB	1		250	0.50		4.83	15	9	5	80	38	5	3.9	5.0	10	0.3	1	525	1	525	1.2	0.20	1 x 525mm dia pipe		49	6	3	58
SB	2	SA	100	0.50		2.03	30	7	10	60	27	3	2.6	4.8	15	0.5	1	600	1	600	1.2	0.27	1 x 600mm dia pipe		23	6	1	30
SA	5		195	0.25	1200	4.83	30	9	10	60	38	5	2.1	5.1	25	5.0	1	1200	1	1650	2.3	1.00	1 x 1200mm dia pipe		103	15	6	124
SA	6		160	0.25	1350	2.18	30	7	10	60	28	4	1.6	4.6	25	5.1	1	1050	1	1650	2.3	1.00	1 x 1050mm dia pipe		71	13	4	88
SC	1		175	0.20		3.48	30	8	10	60	33	4	3.5	5.9	10	0.4	1	675	1	675	1.2	0.32	1 x 675mm dia pipe		45	7	3	55

ILSAX RESULTS
1 IN 10 AEP FLOOD
EXISTING CATCHMENTS

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
Network			***Reach Details***			***Catchment Area Parameters***							***Levels***		***Hydrology 1 in 10 AEP***		***Proposed Upgrade Options***						***Proposed Upgrade Works***		***Cost Breakdown***			***Total Cost***
branch & reach		add byd to	L (m)	S (%)	existing conduit size (mm)	area (ha)	paved direct (%)	paved time (min)	paved sup. (%)	grass (%)	grass time (min)	grass lag (min)	invert level mAHD	ground level mAHD	critical duration (min)	flowrate (m3/s)	Extra Pipes no.	Extra Pipes dia. (mm)	New Pipes no.	New Pipes dia. (mm)	Open Channel w (m)	Open Channel d (m)	Description	Easement Width (m)	Trunk Drainage ($1000)	Proposed Culverts ($1000)	Services Relocation ($1000)	($1000)
SC	2		235	0.20		6.10	30	10	10	60	41	5	3.1	6.3	20	1.2	1	1050	1	1050	1.2	0.71	1 x 1050mm dia pipe		104	13	6	123
SC	3		240	0.20		8.58	30	12	10	60	47	6	2.7	5.7	25	2.1	1	1350	1	1350	1.3	1.00	1 x 1350mm dia pipe		147	18	8	173
SC	4		90	0.20		9.93	30	12	10	60	50	6	2.2	4.9	20	3.0	1	1500	1	1500	1.7	1.00	1 x 1500mm dia pipe		64	21	4	89
SC	5		280	0.20	1200	6.83	30	11	10	60	43	5	2.0	4.9	20	3.7	1	1200	1	1650	2.0	1.00	1 x 1200mm dia pipe		148	15	8	171
SC	6		110	0.20	1350	9.45	30	12	10	60	49	6	1.5	4.3	20	4.6	1	1200	1	1800	2.3	1.00	1 x 1200mm dia pipe		58	15	4	77
SC	7	SA	135	0.20	1500	1.13	30	6	10	60	22	3	1.5	4.1	20	4.7	1	1050	1	1800	2.4	1.00	1 x 1050mm dia pipe		60	13	4	76
SA	7		85	0.25	1800	3.55	30	8	10	60	34	4	1.2	4.8	25	10.0	1	1650	2	1800	3.9	1.00	1 x 1650mm dia pipe		69	23	5	96
SA	8		130	0.25	1800	2.20	30	7	10	60	28	4	1.0	4.5	25	10.1	1	1650	2	1800	4.0	1.00	1 x 1650mm dia pipe		105	23	6	135
SD	1	SA	220	0.70	675	3.87	30	9	10	60	35	4	2.2	3.4	20	0.5			1	600	1.2	0.24						
SA	9		220	0.25	1800	3.97	30	9	10	60	35	4	0.7	3.2	25	10.7	1	1650	2	1800	4.2	1.00	1 x 1650mm dia pipe		178	23	10	211
SA	10		60	0.25	1800	3.95	30	9	10	60	35	4	0.2	3.3	25	10.9	1	1650	2	1800	4.2	1.00	1 x 1650mm dia pipe		49	23	4	75
					total area	118.1	ha																		$1 907	$301	$110	$2 318
TA	1		285	0.30	600	14.27	30	14	10	60	57	7	1.8	3.3	20	1.5	1	900	1	1050	1.2	0.72	1 x 900mm dia pipe		105	10	6	120
TA	2		170	0.30	600	5.50	30	10	10	60	40	5	1.0	3.9	25	2.1	1	1050	1	1200	1.2	0.94	1 x 1050mm dia pipe		75	13	4	93
TB	1	TA	50	2.00	600	2.39	30	7	10	60	29	4	1.5	2.7	10	0.3			1	375	1.2	0.12						
TA	3		120	0.30		5.93	30	10	10	60	41	5	0.5	2.5	25	2.9	1	1350	1	1350	1.4	1.00	1 x 1350mm dia pipe		73	13	4	91
TA	4		30	0.30		1.32	30	6	10	60	23	3	0.1	1.8	25	3.0	1	1350	1	1350	1.5	1.00	1 x 1350mm dia pipe		18	13	2	33
					total area	29.4	ha																		$272	$49	$16	$337
UA	1		65	0.50	450 + 600	3.61	30	8	10	60	34	4	0.3	1.5	25	0.5			1	600	1.2	0.27						
					total area	3.6	ha																					
VA	1		75	1.00	525	1.57	30	6	10	60	25	3	0.8	2.0	10	0.2			1	375	1.2	0.12						
					total area	1.6	ha																					
WA	1		25	5.00	375	0.72	30	6	10	60	18	3	1.3	12.0	10	0.1			1	375	1.2	0.05						
					total area	0.7	ha																					
XA	1		50	5.00	2 x 525	17.97	30	16	10	60	63	8	2.5	7.8	20	1.7			1	675	1.2	0.29						
					total area	18.0	ha																					
YA	1		70	5.00		6.51	30	11	10	60	42	5	3.5	7.0	25	0.8	1	450	1	450	1.2	0.17	1 x 450mm dia pipe		12	5	1	18
					total area	6.5	ha																		$12	$5	$1	$18
AAA	1		200	0.25	525	1.63	30	6	10	60	25	3	4.5	5.9	10	0.2			1	525	1.2	0.19						
AAA	2		280	0.25	675	5.65	30	10	10	60	40	5	4.0	5.7	20	0.9	1	600	1	900	1.2	0.52	1 x 600mm dia pipe		64	6	3	73
AAA	3		110	0.25	1050	4.44	30	9	10	60	37	5	3.3	5.3	15	1.3			1	1050	1.2	0.70						
AAA	4		145	0.25	1200	2.84	30	8	10	60	31	4	3.1	5.0	20	1.6			1	1200	1.2	0.81						
AAA	5		205	0.25	1350	3.04	30	8	10	60	32	4	2.7	5.2	25	2.0			1	1200	1.2	0.97						
AAA	6		150	0.25	1350	9.07	5	12	20	75	48	6	2.2	5.0	20	2.1			1	1200	1.2	1.00						
AAB	1	AAA	190	1.00	600	2.45	15	7	5	80	29	4	3.7	4.7	20	0.2			1	375	1.2	0.12						
AAA	7		320	0.25	1350	5.05	5	10	20	75	39	5	1.8	4.0	25	2.4			1	1350	1.3	1.00						
AAA	8		280	0.25	1500	5.93	5	10	10	85	41	5	1.0	3.9	20	2.4			1	1350	1.3	1.00						

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
Network			**Reach Details**			**Catchment Area Parameters**							**Levels**		**Hydrology 1 in 10 AEP**		**Proposed Upgrade Options**						**Proposed Upgrade Works**		**Cost Breakdown**			**Total Cost**
branch & reach		add hyd to	L (m)	S (%)	existing conduit size (mm)	area (ha)	paved direct (%)	paved time (min)	paved sup. (%)	grass (%)	grass time (min)	grass lag (min)	invert level mAHD	ground level mAHD	critical duration (min)	flowrate (m3/s)	Extra Pipes no.	Extra Pipes dia. (mm)	New Pipes no.	New Pipes dia. (mm)	Open Channel w (m)	Open Channel d (m)	Description	Easement Width (m)	Trunk Drainage ($1000)	Proposed Culverts ($1000)	Services Relocation ($1000)	($1000)
AAA	9		50	0.25	1500	6.73	30	11	10	60	43	5	0.3	2.6	25	2.7			1	1350	1.4	1.00						
AAC	1		110	0.50	675	2.70	30	8	10	60	30	4	1.9	3.5	10	0.3			1	525	1.2	0.20						
AAD	1	AAC	130	0.50	750	7.10	30	11	10	60	44	5	2.0	3.5	20	0.8			1	750	1.2	0.38						
AAC	2		140	0.50	900	2.02	30	7	10	60	27	3	1.4	3.3	25	1.4			1	900	1.2	0.56						
AAC	3	AAA	100	0.50	1050	2.78	30	8	10	60	31	4	0.7	2.1	25	1.6			1	1050	1.2	0.63						
AAA	10		70	0.25	2x1200+1050	0.75	30	6	10	60	19	3	0.2	2.1	25	3.8			1	1500	1.9	1.00						
					total area	62.2	ha																		$64	$6	$3	$73
ABA	1		70	1.00	750	1.55	30	6	10	60	25	3	0.7	1.9	10	0.2			1	375	1.2	0.12						
					total area	1.6	ha																					
ACA	1		100	0.50		4.54	30	9	10	60	37	5	0.5	1.8	25	0.6	1	675	1	675	1.2	0.30	1 x 675mm dia pipe		26	7	2	34
					total area	4.5	ha																		$26	$7	$2	$34
ADA	1		70	0.50	525	1.72	30	6	10	60	26	3	0.4	1.4	10	0.2			1	450	1.2	0.15						
					total area	1.7	ha																					
AEA	1		75	0.30		2.62	30	8	10	60	30	4	0.2	1.2	10	0.3	1	600	1	600	1.2	0.23	1 x 600mm dia pipe		17	6	1	24
					total area	2.6	ha																		$17	$6	$1	$24
AFA	1		60	0.50		1.37	30	6	10	60	24	3	0.3	1.5	10	0.2	1	450	1	450	1.2	0.15	1 x 450mm dia pipe		10	5	1	16
					total area	1.4	ha																		$10	$5	$1	$16
AGA	1		60	0.50		1.50	30	6	10	60	24	3	0.3	1.5	10	0.2	1	450	1	450	1.2	0.15	1 x 450mm dia pipe		10	5	1	16
					total area	1.5	ha																		$10	$5	$1	$16
AHA	1		80	0.30		0.87	30	6	10	60	20	3	0.2	1.1	10	0.1	1	375	1	375	1.2	0.11	1 x 375mm dia pipe			4	0	4
					total area	0.9	ha																			$4	$0	$4
AIA	1		70	0.30		7.48	30	11	10	60	45	6	0.2	1.6	25	0.9	1	825	1	825	1.2	0.49	1 x 825mm dia pipe		23	9	2	33
					total area	7.5	ha																		$23	$9	$2	$33
AJA	1		65	0.50		6.50	30	11	10	60	42	5	0.3	1.9	25	0.8	1	750	1	750	1.2	0.38	1 x 750mm dia pipe		19	8	1	28
					total area	6.5	ha																		$19	$8	$1	$28
AKA	1		35	5.00		0.55	30	6	10	60	17	3	1.8	3.2	10	0.1	1	375	1	375	1.2	0.05	1 x 375mm dia pipe			4	0	4
					total area	0.6	ha																			$4	$0	$4
ALA	1		100	2.50		6.05	30	10	10	60	41	5	2.5	3.9	15	0.7	1	525	1	525	1.2	0.20	1 x 525mm dia pipe		20	6	1	27
					total area	6.1	ha																		$20	$6	$1	$27
AM	1		90	3.00		5.03	30	10	10	60	39	5	2.7	3.9	15	0.6	1	450	1	450	1.2	0.17	1 x 450mm dia pipe		15	5	1	21
					total area	5.0	ha																		$15	$5	$1	$21

ILSAX RESULTS
1 IN 10 AEP FLOOD
EXISTING CATCHMENTS

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
Network			***Reach Details***			***Catchment Area Parameters***							***Levels***		***Hydrology 1 in 10 AEP***		***Proposed Upgrade Options***						***Proposed Upgrade Works***		***Cost Breakdown***			***Total Cost***
branch & reach		add hyd to	L (m)	S (%)	existing conduit size (mm)	area (ha)	paved direct (%)	paved time (min)	paved sup. (%)	grass (%)	grass time (min)	grass lag (min)	invert level mAHD	ground level mAHD	critical duration (min)	flowrate (m3/s)	Extra Pipes no.	Extra Pipes dia. (mm)	New Pipes no.	New Pipes dia. (mm)	Open Channel w (m)	Open Channel d (m)	Description	Easement Width (m)	Trunk Drainage ($1000)	Proposed Culverts ($1000)	Services Relocation ($1000)	($1000)
ANA	1		430	0.50	375	2.98	30	8	10	60	32	4	4.6	5.7	15	0.4	1	375	1	525	1.2	0.23	1 x 375mm dia pipe		61	4	3	69
ANA	2		185	0.50	900	5.95	30	10	10	60	41	5	2.5	4.3	20	1.1			1	825	1.2	0.47						
ANB	1	ANA	270	0.50	525	13.60	30	14	10	60	56	7	2.9	5.0	15	0.6	1	450	1	675	1.2	0.30	1 x 450mm dia pipe		45	5	3	53
ANA	3		70	1.00	1050	13.33	30	14	10	60	56	7	1.6	3.7	20	2.3			1	1050	1.2	0.63						
ANC	1	ANA	225	0.50	750	13.33	30	14	10	60	56	7	2.0	3.7	20	0.8			1	750	1.2	0.38						
ANA	4		85	1.00	1350	13.33	30	14	10	60	56	7	0.9	3.7	25	3.6			1	1200	1.2	0.89						
					total area	62.5	ha																		$107	$9	$6	$121
AOA	1		80	0.20		5.71	30	10	10	60	40	5	0.2	1.5	20	0.7	1	825	1	825	1.2	0.48	1 x 825mm dia pipe		26	9	2	37
					total area	5.7	ha																		$26	$9	$2	$37
APA	1		215	0.35	600	4.80	30	9	10	60	38	5	3.9	5.2	15	0.6	1	375	1	675	1.2	0.34	1 x 375mm dia pipe		31	4	2	36
APA	2		225	0.35	750	5.03	30	10	10	60	39	5	3.1	5.3	20	1.2	1	525	1	900	1.2	0.57	1 x 525mm dia pipe		44	6	3	53
APB	1	APA	270	0.20	1050	9.40	30	12	10	60	49	6	2.9	4.6	20	1.0			1	1050	1.2	0.62						
APA	3		360	0.35	1350	9.57	30	12	10	60	49	6	2.4	5.5	20	3.2			1	1350	1.4	1.00						
APC	1	APA	210	1.00	750	5.56	30	10	10	60	40	5	3.2	4.8	20	0.7			1	600	1.2	0.27						
APA	4		265	0.35	1350	12.86	30	14	10	60	55	7	1.1	3.5	25	5.0	1	1050	1	1650	2.0	1.00	1 x 1050mm dia pipe		117	13	7	137
APA	5		85	0.20	2 x 1350	7.88	25	11	5	70	46	6	0.2	1.8	25	5.6			1	1800	2.7	1.00						
					total area	55.1	ha																		$192	$23	$11	$226
AQA	1		110	0.50		3.24	30	8	10	60	33	4	1.9	3.2	10	0.4	1	525	1	525	1.2	0.23	1 x 525mm dia pipe		22	6	1	29
AQA	2		125	0.50		4.49	30	9	10	60	37	5	1.3	3.2	25	1.0	1	825	1	825	1.2	0.44	1 x 825mm dia pipe		41	9	2	52
AQB	1	AQA	305	0.50	525	2.97	30	8	10	60	32	4	2.2	3.7	15	0.4			1	525	1.2	0.23						
AQA	3		110	0.50	375	4.36	30	9	10	60	36	5	0.7	3.0	20	1.8	1	1050	1	1050	1.2	0.68	1 x 1050mm dia pipe		49	13	3	65
AQA	4		30	0.50		2.04	30	7	10	60	27	3	0.2	2.0	25	2.1	1	1050	1	1050	1.2	0.77	1 x 1050mm dia pipe		13	13	1	28
					total area	17.1	ha																		$124	$41	$8	$174
ARA	1		170	1.50	375	1.30	30	6	10	60	23	3	3.8	5.2	15	0.2			1	375	1.2	0.10						
ARA	2		60	2.00	450	1.62	30	6	10	60	25	3	1.2	5.2	15	0.4			1	450	1.2	0.15						
					total area	2.9	ha																					
ASA	1		30	5.00		0.62	30	6	10	60	17	3	1.5	4.8	10	0.1	1	375	1	375	1.2	0.05	1 x 375mm dia pipe			4	0	4
					total area	0.6	ha																			$4	$0	$4
ATA	1		30	5.00		1.72	30	6	10	60	26	3	1.5	4.6	10	0.2	1	375	1	375	1.2	0.07	1 x 375mm dia pipe			4	0	4
					total area	1.7	ha																			$4	$0	$4
AUA	1		590	0.30		6.93	30	11	10	60	44	5	3.9	5.3	20	0.8	1	825	1	825	1.2	0.45	1 x 825mm dia pipe		192	9	10	211
AUA	2		200	0.30	600	13.73	30	14	10	60	56	7	2.2	5.8	20	2.1	1	1050	1	1200	1.2	0.94	1 x 1050mm dia pipe		89	13	5	107
AUB	1		225	0.90		5.81	30	10	10	60	41	5	4.6	5.8	20	0.7	1	600	1	600	1.2	0.28	1 x 600mm dia pipe		51	6	3	60
AUB	2	AUA	110	0.90		7.68	30	11	10	60	45	6	2.6	6.0	25	1.6	1	825	1	825	1.2	0.50	1 x 825mm dia pipe		36	9	2	47
AUA	3		175	0.30		3.99	30	9	10	60	35	4	1.6	4.2	25	4.0	1	1500	1	1500	1.8	1.00	1 x 1500mm dia pipe		124	21	7	152
AUC	1	AUA	260	1.50	525	2.45	30	7	10	60	29	4	5.0	6.0	10	0.3			1	450	1.2	0.13						
AU	1	AUA	125	2.50	525	3.49	30	8	10	60	34	4	4.2	5.1	10	0.4			1	450	1.2	0.14						
AUA	4		290	0.30	1050	7.93	30	11	10	60	46	6	1.1	4.9	25	5.5	1	1350	1	1650	2.3	1.00	1 x 1350mm dia pipe		177	18	10	205
AUE	1		150	1.20	1050	2.74	30	8	10	60	31	4	3.7	4.6	10	0.3			1	450	1.2	0.14						

1 2 3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
Network	***Reach Details***			***Catchment Area Parameters***							***Levels***		***Hydrology 1 in 10 AEP***		***Proposed Upgrade Options***						***Proposed Upgrade Works***		***Cost Breakdown***			***Total Cost***
branch & reach / add byd to	L (m)	S (%)	existing conduit size (mm)	area (ha)	paved direct (%)	paved time (min)	paved sup. (%)	grass (%)	grass time (min)	grass lag (min)	invert level mAHD	ground level mAHD	critical duration (min)	flowrate (m3/s)	Extra Pipes no.	Extra Pipes dia. (mm)	New Pipes no.	New Pipes dia. (mm)	Open Channel w (m)	Open Channel d (m)	Description	Easement Width (m)	Trunk Drainage ($1000)	Proposed Culverts ($1000)	Services Relocation ($1000)	($1000)
AUE 2 AUA	145	1.20	1200	2.62	30	8	10	60	36	4	1.9	4.8	20	0.7			1	600	1.2	0.25						
AUA 5	60	0.30	1350	8.23	30	12	10	60	46	6	0.2	5.5	25	6.8	1	1200	1	1800	2.7	1.00	1 x 1200mm dia pipe		32	15	2	49
total area				65.6 ha																			$701	$91	$40	$831
AVA 1	130	0.50		3.65	30	9	10	60	34	4	2.3	5.9	25	0.5	1	600	1	600	1.2	0.27	1 x 600mm dia pipe		30	6	2	37
AVB 1 AVA	100	0.50		1.00	30	6	10	60	21	3	2.1	6.0	10	0.1	1	375	1	375	1.2	0.09	1 x 375mm dia pipe		14	4	1	19
AVA 2	215	0.50		1.48	30	6	10	60	24	3	1.6	6.0	25	0.8	1	750	1	750	1.2	0.38	1 x 750mm dia pipe		62	8	4	74
AVC 1 AVA	130	0.50		3.35	30	8	10	60	33	4	1.2	4.6	10	0.4	1	600	1	600	1.2	0.23	1 x 600mm dia pipe		30	6	2	37
AVA 3	110	0.50		2.83	30	8	10	60	31	4	0.6	5.0	20	1.5	1	900	1	900	1.2	0.59	1 x 900mm dia pipe		40	10	3	53
total area				12.3 ha																			$176	$34	$10	$220
AW 1	250	0.50	450	1.93	30	7	10	60	27	3	4.2	6.5	25	0.3	1	375	1	525	1.2	0.20	1 x 375mm dia pipe		36	4	2	42
AW 2	230	0.50	600	3.85	30	9	10	60	35	4	3.0	5.5	15	0.7	1	375	1	675	1.2	0.34	1 x 375mm dia pipe		33	4	2	39
AW 1 AW	160	0.50	750	0.80	30	6	10	60	19	3	2.6	5.0	10	0.1			1	375	1.2	0.09						
AW 3	140	0.50	750	6.30	20	10	5	75	42	5	1.8	5.0	20	1.3	1	525	1	900	1.2	0.53	1 x 525mm dia pipe		27	6	2	35
AW 4	225	0.50	900	4.08	20	9	5	75	36	4	1.1	6.0	20	1.6	1	600	1	1050	1.2	0.63	1 x 600mm dia pipe		51	6	3	60
total area				17.0 ha																			$147	$20	$8	$176
total area				1136.5 ha																			$11,251	$1,310	$628	$13,189

SUMMARY OF 2(b) AREA 2(b) AREA = 413 ha

2(b) AREA COST = 413 / 1137 x 13,189 K = $4,791 K

APPENDIX A2

ILSAX RESULTS
1 IN 100 AEP FLOOD
EXISTING CATCHMENTS

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	30
Network			**Reach Details**			**Catchment Area Parameters**							**Levels**		**Hydrology 1 in 100 AEP**		**Proposed Upgrade Options**						**Proposed Upgrade Works**		**Cost Breakdown**			**Total Cost**
branch & reach		add byd to	L (m)	S (%)	existing conduit size (mm)	area (ha)	paved direct (%)	paved time (min)	paved sup. (%)	grass (%)	grass time (min)	grass lag (min)	invert level mAHD	ground level mAHD	critical duration (min)	flowrate (m3/s)	Extra Pipes no.	Extra Pipes dia. (mm)	New Pipes no.	New Pipes dia. (mm)	Open Channel w (m)	Open Channel d (m)	Description	Easement Width (m)	Trunk Drainage ($1000)	Proposed Culverts ($1000)	Services Relocation ($1000)	($1000)
AA	1		335	0.20	675	13.13	30	14	10	60	55	7	3.8	5.2	20	2.1	1	1200	1	1350	1.3	1.00	1 x 1200mm dia pipe		177	15	10	201
AB	1	AA	230	0.50	600	3.41	30	8	10	60	33	4	4.3	5.3	20	0.7	1	375	1	675	1.2	0.34	1 x 375mm dia pipe		33	4	2	39
AA	2		290	0.20	2 x 750	10.99	30	13	10	60	52	6	3.1	5.1	20	4.5	1	1350	1	1650	2.3	1.00	1 x 1350mm dia pipe		177	18	10	205
AA	3		185	0.20	2 x 900	6.85	30	11	10	60	43	5	2.6	5.1	25	5.7	1	1350	1	1800	2.8	1.00	1 x 1350mm dia pipe		113	18	7	138
AC	1	AA	190	0.50	750	4.61	30	9	10	60	37	5	3.1	4.4	20	0.9			1	750	1.2	0.41						
AA	4		130	0.20	2 x 900	5.58	30	10	10	60	40	5	2.2	4.6	25	7.3	1	1800	2	1500	3.3	1.00	3.3m wide channel	20	129	50	9	187
AA	5		220	0.20	2 x 900	3.32	30	8	10	60	33	4	1.9	4.4	25	7.7	1	1800	2	1500	3.5	1.00	3.5m wide channel	21	222	55	14	290
AD	1		585	0.20	600	14.58	30	14	10	60	58	7	4.3	5.5	20	2.3	1	1350	1	1350	1.4	1.00	1 x 1350mm dia pipe		358	18	19	395
AE	1	AD	130	0.20	600	8.82	30	12	10	60	48	6	3.4	4.9	20	1.5	1	1050	1	1200	1.2	0.84	1 x 1050mm dia pipe		58	13	4	74
AD	2		255	0.20	1050	4.63	30	9	10	60	37	5	3.1	5.2	25	4.5	1	1350	1	1650	2.3	1.00	1 x 1350mm dia pipe		156	18	9	183
AF	1	AD	90	1.00	1050	4.11	30	9	10	60	36	4	3.5	4.8	20	0.8			1	675	1.2	0.30						
AD	3		355	0.20	1200	1.42	30	6	10	60	24	3	2.6	5.0	25	5.2	1	1350	1	1800	2.6	1.00	1 x 1350mm dia pipe		217	18	12	247
AG	1	AD	190	0.20	open channel	23.85	30	17	10	60	8		2.3	4.5	90	8.7			2	1800	3.9	1.00	3.9m wide channel	18	200	23	11	234
AD	4	AA	205	0.20	open channel	1.99	30	7	10	60	27	3	1.9	5.0	90	13.0			3	1650	5.4	1.00	5.4m wide channel	31	256	55	16	326
AA	6		490	0.10	open channel	6.58	30	11	10	60	43	5	1.5	4.3	90	21.0			4	1800	11.1	1.00	11.1m wide channel	33	968	124	55	1147
AH	1	AA	310	3.80	900	7.88	30	5	10	60	5	5	12.8	14.1	90	2.9			1	825	1.2	0.46						
AI	1		60	0.20	750	0.10	5	12		95	46	6	2.0	5.0	90	0.5			1	750	1.2	0.38						
AJ	1	AI	40	0.30	750	2.97	30	8	10	60	32	4	2.0	4.2	20	0.6			1	750	1.2	0.37						
AK	1	AI	50	0.40	825	4.86	30	10	10	60	38	5	2.1	4.2	20	0.9			1	825	1.2	0.45						
AL	1		180	0.15	975	5.33	30	10	10	60	39	5	3.2	4.7	20	1.0	1	450	1	1050	1.2	0.69	1 x 450mm dia pipe		30	5	2	37
AL	2		120	0.15	1275	4.26	30	9	10	60	36	5	2.9	4.7	20	1.8	1	450	1	1350	1.3	1.00	1 x 450mm dia pipe		20	5	1	26
AL	3		110	0.15	1500	5.63	30	10	10	60	40	5	2.7	4.6	20	2.8			1	1500	1.8	1.00						
AL	4		100	0.15	1950	4.06	30	9	10	60	36	4	2.5	5.3	20	3.5			1	1650	2.1	1.00						
AL	5		290	0.15	1800	3.27	30	8	10	60	33	4	2.4	4.9	20	4.1			1	1800	2.4	1.00						
AL	6	AI	50	0.15	1800	3.29	30	8	10	60	33	4	2.0	4.2	25	4.6			1	1800	2.6	1.00						
AI	2		40	0.50	lagoon link	7.23		11		100	44	6	1.9	3.9	90	1.3			1	1800	1.2	0.53						
AM	1	AI	60	0.50	600	2.94	30	8	10	60	31	4	2.0	4.0	20	0.6	1	375	1	675	1.2	0.30	1 x 375mm dia pipe		9	4	1	13
AN	1	AI	130	0.27	825	5.28	30	10	10	60	39	5	2.0	4.9	20	1.0	1	375	1	900	1.2	0.55	1 x 375mm dia pipe		19	4	1	24
AI	3		10	0.50	lagoon link	2.19		7		100	28	4	1.7	3.8	90	2.0			1	1050	1.2	0.74						
AI	4		20	0.50	lagoon link	2.31		7		100	29	4	1.6	3.7	60	2.0			1	1050	1.2	0.74						
AI	5		20	0.50	lagoon link	3.22		8		100	33	4	1.5	3.6	90	1.7			1	1050	1.2	0.65						
AI	6		10	0.50	lagoon link	3.14		8		100	32	4	1.4	3.5	90	1.5			1	1050	1.2	0.59						
AI	7		10	0.50	lagoon link	0.70		6		100	18	3	1.4	3.4	90	1.5			1	1050	1.2	0.59						
AI	8		30	0.30	2 x 825	1.42		6		100	24	3	1.3	3.3	90	1.5			1	1050	1.2	0.72						
AO	1	AI	30	1.09	900	3.91	15	9		85	35	4	1.6	4.3	90	0.5			1	525	1.2	0.21						
AI	9	AA	80	0.30	2 x 825	1.50	30	6	10	60	24	3	1.2	4.3	90	1.5	1	1500	1	1800	1.2	0.72	1 x 1500mm dia pipe		57		3	59
AA	7		250	0.10	open channel	20.94	5	15		95	15	8	1.0	4.5	90	26.5			5	1800	13.8	1.00	13.8m wide channel	44	578	142	36	756
AP	1		120	5.00	900	20.16	10	8		90	8	5	11.9	23.1	90	5.1	1	600	1	1050	1.2	0.63	1 x 600mm dia pipe		27		1	29
AQ	1	AP	200	5.00	750	10.12	10	5		90	5	5	15.9	32.5	90	3.6	1	525	1	900	1.2	0.48	1 x 525mm dia pipe		39		2	41
AP	2		290	1.00	1200	5.43	30	4		70	4	5	5.9	8.5	90	10.5	1	1350	1	1800	2.4	1.00	1 x 1350mm dia pipe		177	6	9	193
AR	1		95	5.00		5.46		4		100	4	5	11.7	17.0	90	2.3	1	750	1	750	1.2	0.35	1 x 750mm dia pipe		27	6	2	35
AR	2	AP	215	1.80	1200	5.53	10	4		90	4	5	6.9	8.6	90	4.3			1	1200	1.2	0.81						
AP	3		185	1.00	open channel	10.37	40	6		60	10	5	3.0	4.9	90	16.4			2	1500	3.4	1.00	3.4m wide channel	14	183	31	11	225
AP	4	AA	215	0.20	1800	2.92	10	3		90	5	5	1.2	3.1	90	16.9	2	1800	3	1800	6.7	1.00	2 x 1800mm dia pipe		395	23	21	439
AA	8		230	0.10	open channel	6.33	10	11	5	85	42	5	0.8	3.8	90	43.2			7	1800	21.7	1.00	21.7m wide channel	46	765	194	48	1007

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	30
Network			**Reach Details**			**Catchment Area Parameters**							**Levels**		**Hydrology 1 in 100 AEP**		**Proposed Upgrade Options**						**Proposed Upgrade Works**		**Cost Breakdown**			**Total Cost**
branch & reach		add byd to	L (m)	S (%)	existing conduit size (mm)	area (ha)	paved direct (%)	paved time (min)	paved sup. (%)	grass (%)	grass time (min)	grass lag (min)	invert level mAHD	ground level mAHD	critical duration (min)	flowrate (m3/s)	Extra Pipes no.	Extra Pipes dia. (mm)	New Pipes no.	New Pipes dia. (mm)	Open Channel w (m)	Open Channel d (m)	Description	Easement Width (m)	Trunk Drainage ($1000)	Proposed Culverts ($1000)	Services Relocation ($1000)	($1000)
AS	1	AA	470	1.70	600	5.23		4		100	4	5	8.5	10.0	90	2.1	1	675	1	900	1.2	0.48	1 x 675mm dia pipe		121	4	6	131
AA	9		290	0.10	open channel	17.45	15	15	5	80	25	10	0.5	3.4	90	46.0			4	1800	23.1	1.00	23.1m wide channel	46	1013	207	61	1281
AT	1		335	0.50	open channel	4.74	20	9	5	75	38	5	3.1	4.4	20	0.6			1	675	1.2	0.30	1.2m wide channel	4	240	17	13	270
AT	2	AA	245	0.50	open channel	10.82	25	13	10	65	52	6	1.5	3.0	20	2.2			1	1050	1.2	0.80	1.2m wide channel	8	176	17	10	202
AA	10		175	0.10	open channel	22.38	20	15	5	75	25	10	0.2	3.0	90	51.1			5	1800	25.5	1.00	25.5m wide channel	47	665	237	45	947
AU	1		710	0.40	750	3.91	25	9	10	65	35	4	3.8	4.5	20	0.7			1	750	1.2	0.37						
AU	2	AA	220	0.40	1500	8.32	25	12	10	65	47	6	0.9	2.5	20	1.8			1	1050	1.2	0.74						
AV	1	AA	235	1.00		1.50	30	4	10	60	5	3	2.4	4.0	25	0.6	1	600	1	600	1.2	0.24	1 x 600mm dia pipe		53	6	3	62
AA	11		60	0.10	4 x 1500	6.18		10		100	42	5	0.1	1.5	90	52.4	3	1650	5	1800	26.1	1.00	26.1m wide channel	31	233	263	25	521
					total area	365.2	ha																		$7,890	$1,600	$475	$9,965
BA	1		100	0.40		5.36	30	10	10	60	39	5	3.4	4.2	20	1.0	1	825	1	825	1.2	0.44	1 x 825mm dia pipe		33	9	2	44
BB	1	BA	90	0.40		5.91	30	10	10	60	41	5	3.3	4.9	20	1.1	1	825	1	825	1.2	0.47	1 x 825mm dia pipe		29	9	2	40
BA	2		125	0.40		2.64	30	8	10	60	30	4	3.0	4.6	20	2.7	1	1200	1	1200	1.2	0.93	1 x 1200mm dia pipe		66	15	4	85
BA	3		65	0.40		3.49	30	8	10	60	34	4	2.5	4.5	20	3.3	1	1350	1	1350	1.3	1.00	1 x 1350mm dia pipe		40	18	3	61
BA	4		60	0.40		2.39	30	7	10	60	29	4	2.2	4.6	20	3.7	1	1350	1	1350	1.4	1.00	1 x 1350mm dia pipe		37	18	3	57
BA	5		60	0.40		3.14	30	8	10	60	32	4	2.0	4.6	20	4.3	1	1350	1	1350	1.6	1.00	1 x 1350mm dia pipe		37	18	3	57
BA	6		70	0.40		3.51	30	8	10	60	34	4	1.7	4.1	25	5.0	1	1500	1	1500	1.8	1.00	1 x 1500mm dia pipe		50	21	4	74
BA	7		140	0.40		2.97	30	8	10	60	32	4	1.5	4.3	20	5.5	1	1500	1	1500	1.9	1.00	1 x 1500mm dia pipe		99	21	6	126
BA	8		240	0.10		2.17	30	7	10	60	28	3	0.9	4.6	25	6.0	2	1500	2	1500	3.8	1.00	3.8m wide channel	36	250	57	15	323
BA	9		165	0.40		5.83	30	10	10	60	39	5	0.7	4.6	25	6.8	2	1500	2	1500	2.2	1.00	2.2m wide channel	37	139	31	9	179
					total area	36.6	ha																		$780	$217	$50	$1,047
CA	1		165	0.50	750	3.05	30	8	10	60	32	4	2.3	4.7	15	0.6			1	675	1.2	0.30						
CA	2		225	0.50	900	3.40	30	8	10	60	33	4	1.5	4.4	20	1.3			1	900	1.2	0.53						
CA	3		75	0.50	1050	6.30	30	10	10	60	42	5	0.4	5.0	20	2.5	1	600	1	1200	1.2	0.88	1 x 600mm dia pipe		17	6	1	24
					total area	12.8	ha																		$17	$6	$1	$24
DA	1		70	0.20	675	4.36	30	9	10	60	36	5	0.3	1.2	20	0.8	1	600	1	900	1.2	0.52	1 x 600mm dia pipe		16	6	1	23
DA	2		65	0.20	675	1.12	30	6	10	60	22	3	0.1	1.5	20	1.1	1	825	1	1050	1.2	0.66	1 x 825mm dia pipe		21	9	2	32
					total area	5.5	ha																		$37	$15	$3	$55
EA	1		60	0.50	750	2.12	30	7	10	60	28	3	0.3	1.2	25	0.5			1	600	1.2	0.27						
					total area	2.1	ha																					
FA	1		70	0.10	1050	1.94	60	7	20	20	27	3	0.2	1.2	15	0.8			1	1050	1.2	0.67						
FB	1	FA	80	0.1		0.75	60	6	20	20	19	3	0.2	1.2	10	0.3	1	675	1	675	1.2	0.33	1 x 675mm dia pipe		21	7	1	29
FA	2		145	0.1	1050	0.50	60	6	20	20	16	3	0.2	1.1	25	1.4	1	600	1	1200	1.3	1.00	1 x 600mm dia pipe		33	6	2	41
FA	3		10	0.10	1050	1.22	60	6	20	20	22	3	0.0	1.1	20	1.8	1	900	1	1350	1.5	1.00	1 x 900mm dia pipe		4	10	1	14
					total area	4.4	ha																		$57	$23	$4	$84
GA	1		50	0.50	525	1.05	30	6	10	60	21	3	0.4	1.2	90	0.3			1	525	1.2	0.20						
GA	2		20	0.50	525	0.55	30	6	10	60	17	3	0.1	1.0	25	0.4	1	375	1	600	1.2	0.23	1 x 375mm dia pipe		3	4	0	7
					total area	1.6	ha																		$3	$4	$0	$7

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	30
Network			**Reach Details**			**Catchment Area Parameters**							**Levels**		**Hydrology 1 in 100 AEP**		**Proposed Upgrade Options**						**Proposed Upgrade Works**		**Cost Breakdown**			**Total Cost**
branch & reach		add byd to	L (m)	S (%)	existing conduit size (mm)	area (ha)	paved direct (%)	paved time (min)	paved sup. (%)	grass (%)	grass time (min)	grass lag (min)	invert level mAHD	ground level mAHD	critical duration (min)	flowrate (m3/s)	Extra Pipes no.	Extra Pipes dia. (mm)	New Pipes no.	New Pipes dia. (mm)	Open Channel w (m)	Open Channel d (m)	Description	Easement Width (m)	Trunk Drainage ($1000)	Proposed Culverts ($1000)	Services Relocation ($1000)	($1000)
HA	1		40	1.00		1.50	30	6	10	60	24	3	0.4	1.2	90	0.4	1	525	1	525	1.2	0.19	1 x 525mm dia pipe		8	6	1	15
					total area	1.5	ha																		$8	$6	$1	$15
IA	1		90	0.10	600	5.73	30	10	10	60	40	5	1.2	2.5	20	1.1	1	1050	1	1200	1.2	0.87	1 x 1050mm dia pipe		40	13	3	56
IB	1	IA	155	1.00	450	5.65	30	10	10	60	40	5	2.7	4.0	20	1.1	1	675	1	750	1.2	0.37	1 x 675mm dia pipe		40	7	2	49
IA	2		285	0.10	900	4.25	30	9	10	60	36	5	1.1	2.2	20	2.9	1	1500	1	1650	2.1	1.00	1 x 1500mm dia pipe		202	21	11	234
IA	3		185	0.10		8.30	30	12	10	60	47	6	0.8	1.8	20	4.3	2	1500	2	1500	2.9	1.00	2 x 1500mm dia pipe		262	42	15	319
IA	4		90	0.10		4.26	30	9	10	60	36	5	0.7	1.4	25	4.9	2	1500	2	1500	3.2	1.00	2 x 1500mm dia pipe		127	42	8	178
IC	1	IA	170	0.80	450	3.14	30	8	10	60	32	4	1.9	3.1	15	0.6	1	450	1	600	1.2	0.26	1 x 450mm dia pipe		28	5	2	35
IA	5		165	0.10	open channel	3.49	30	8	10	60	34	4	0.6	1.3	25	5.9	1	1350	2	1500	3.7	1.00	3.7m wide channel	7	171	57	11	239
IA	6		160	0.10	open channel	7.10	25	11	10	65	44	5	0.4	1.3	25	6.9	1	1500	2	1800	4.2	1.00	4.2m wide channel	7	176	60	12	248
IA	7		100	0.10	open channel	5.48		10	10	90	40	5	0.2	1.1	25	7.1	1	1500	2	1800	4.3	1.00	4.3m wide channel	7	111	61	9	181
ID	1	IA	260	0.25		0.65	30	6	10	60	18	3	0.8	1.7	25	0.2	1	450	1	450	1.2	0.19	1 x 450mm dia pipe		43	5	2	51
IE	1	IA	105	0.75		0.70	30	6	10	60	18	3	0.9	1.7	20	0.2	1	375	1	375	1.2	0.13	1 x 375mm dia pipe		15	4	1	20
IA	8		115	0.10	open channel	4.80	5	9	5	90	36	5	0.1	1.0	25	7.6	1	1500	2	1800	4.6	1.00	4.6m wide channel	8	132	65	10	207
IA	9		20	0.10	2x1000x1800	2.54	30	7	10	60	30	4	0.0	1.3	25	7.8	1	1200	2	1800	4.7	1.00	1 x 1200mm dia pipe		11	15	1	27
					total area	56.1	ha																		$1 359	$397	$88	$1 844
JA	1		140	0.30		1.94	30	7	10	60	27	3	0.5	1.5	15	0.4	1	600	1	600	1.2	0.28	1 x 600mm dia pipe		32	6	2	40
JA	2		20	0.30		1.72	30	6	10	60	26	3	0.1	1.2	20	0.8	1	825	1	825	1.2	0.45	1 x 825mm dia pipe		7	9	1	16
					total area	3.7	ha																		$38	$15	$3	$56
KA	1		80	0.15		0.90	15	6		85	20	3	0.1	0.8	10	0.1	1	375	1	375	1.2	0.14	1 x 375mm dia pipe		11	4	1	16
					total area	0.9	ha																		$11	$4	$1	$16
LA	1		70	0.20		2.24	15	7		85	28	4	0.1	0.8	90	0.3	1	600	1	600	1.2	0.27	1 x 600mm dia pipe		16	6	1	23
					total area	2.2	ha																		$16	$6	$1	$23
MA	1		70	0.20		2.07	30	7	10	60	27	3	0.5	1.4	25	0.5	1	750	1	750	1.2	0.38	1 x 750mm dia pipe		20	8	1	30
MA	2		120	0.20		0.90	30	6	10	60	20	3	0.3	1.3	25	0.7	1	825	1	825	1.2	0.48	1 x 825mm dia pipe		39	9	2	51
MB	1		115	0.10	375	0.50	30	6	10	60	16	3	0.2	0.8	10	0.1	1	375	1	450	1.2	0.16	1 x 375mm dia pipe		16	4	1	21
MA	3		80	0.10	450	0.90	30	6	10	60	20	3	0.1	0.8	25	0.9	1	1050	1	1050	1.2	0.74	1 x 1050mm dia pipe		35	13	2	51
					total area	4.4	ha																		$111	$34	$7	$152
NA	1		110	0.30		1.46	30	6	10	60	24	3	1.0	2.0	10	0.3	1	525	1	525	1.2	0.23	1 x 525mm dia pipe		22	6	1	29
NA	2		88	0.30		0.48	30	6	10	60	16	3	0.7	2.0	25	0.5	1	675	1	675	1.2	0.32	1 x 675mm dia pipe		23	7	1	31
NA	3		58	0.30		0.39	30	6	10	60	16	3	0.5	1.7	90	0.6	1	750	1	750	1.2	0.37	1 x 750mm dia pipe		17	8	1	26
NB	1		57	0.15		2.55	10	7	5	85	30	4	0.5	1.5	90	0.3	1	600	1	600	1.2	0.29	1 x 600mm dia pipe		13	6	1	20
NB	2		68	0.15		0.87	30	6	10	60	20	3	0.5	1.6	90	0.5	1	750	1	750	1.2	0.41	1 x 750mm dia pipe		20	8	1	29
NC	1	NB	36	0.15		0.48	30	6	10	60	16	3	0.3	1.6	10	0.1	1	450	1	450	1.2	0.14	1 x 450mm dia pipe		6	5	1	12
NB	3	NA	53	0.15		0.69	30	6	10	60	18	3	0.4	1.5	25	0.7	1	900	1	900	1.2	0.53	1 x 900mm dia pipe		19	10	1	31
NA	4		46	0.10		0.48	30	6	10	60	16	3	0.3	1.4	90	1.4	1	1200	1	1200	1.3	1.00	1 x 1200mm dia pipe		24	15	2	41
ND	1		77	0.80		0.90	30	6	10	60	20	3	1.2	1.9	10	0.2	1	375	1	375	1.2	0.13	1 x 375mm dia pipe		41	4	2	47

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	30
Network			**Reach Details**			**Catchment Area Parameters**							**Levels**		**Hydrology 1 in 100 AEP**		**Proposed Upgrade Options**						**Proposed Upgrade Works**		**Cost Breakdown**			**Total Cost**
branch & reach		add hyd to	L (m)	S (%)	existing conduit size (mm)	area (ha)	paved direct (%)	paved time (min)	paved sup. (%)	grass (%)	grass time (min)	grass lag (min)	invert level mAHD	ground level mAHD	critical duration (min)	flowrate (m3/s)	Extra Pipes no.	Extra Pipes dia. (mm)	New Pipes no.	New Pipes dia. (mm)	Open Channel w (m)	Open Channel d (m)	Description	Easement Width (m)	Trunk Drainage ($1000)	Proposed Culverts ($1000)	Services Relocation ($1000)	($1000)
ND	2	NA	38	0.80		1.65	30	6	10	60	25	3	0.5	1.8	25	0.6	1	600	1	600	1.2	0.26	1 x 600mm dia pipe		9	6	1	15
NA	5		131	0.10		0.57	30	6	10	60	17	3	0.2	1.5	90	2.1	1	1500	1	1500	1.7	1.00	1 x 1500mm dia pipe		93	21	6	119
NE	1	NA	114	0.15	375	0.60	30	6	10	60	17	3	0.3	1.0	90	0.2	1	375	1	525	1.2	0.22	1 x 375mm dia pipe		16	4	1	21
NA	6		104	0.10		1.00	30	6	10	60	21	3	0.1	1.0	90	2.4	1	1500	1	1500	1.9	1.00	1 x 1500mm dia pipe		74	21	5	99
					total area	12.1	ha																		$375	$121	$25	$521
OA	1		120	0.80	750	2.59	30	7	20	50	30	4	2.4	3.5	25	0.6			1	600	1.2	0.26						
OA	2		155	0.80	750	0.75	5	6		95	19	3	1.4	3.8	90	0.7			1	675	1.2	0.29						
OB	1	OA	150	0.10	375	0.87	30	6	10	60	20	3	0.3	1.0	10	0.2	1	375	1	525	1.2	0.25	1 x 375mm dia pipe		21	4	1	27
OA	3		80	0.20		1.99	30	7	10	60	27	3	0.2	1.5	90	1.3	1	1050	1	1050	1.2	0.76	1 x 1050mm dia pipe		35	13	2	51
					total area	6.2	ha																		$57	$17	$4	$78
PA	1		100	0.50		13.05	30	14	10	60	55	7	0.5	4.5	20	2.1	1	1050	1	1050	1.2	0.77	1 x 1050mm dia pipe		44	13	3	60
					total area	13.1	ha																		$44	$13	$3	$60
QA	1		195	0.70		2.25	30	7	10	60	28	4	4.0	5.0	20	0.5	1	600	1	600	1.2	0.24	1 x 600mm dia pipe		44	6	3	53
QB	1	QA	95	0.40	675	1.80	30	7	10	60	26	3	3.0	4.1	15	0.4			1	600	1.2	0.25						
QA	2		130	0.40	675	2.37	10	7		90	29	4	2.6	4.5	25	1.1	1	525	1	825	1.2	0.52	1 x 525mm dia pipe		25	6	2	33
QA	3		175	0.40	750	8.77	20	12	5	75	48	6	2.1	3.6	20	2.1	1	1050	1	1200	1.2	0.84	1 x 1050mm dia pipe		78	13	5	95
QA	4		190	0.40	900	4.69	10	9	20	70	38	5	1.4	3.2	90	2.7	1	825	1	1200	1.2	1.00	1 x 825mm dia pipe		62	9	4	74
QC	1		135	0.35	750	5.55	30	10	10	60	40	5	1.8	3.6	20	1.1	1	525	1	900	1.2	0.54	1 x 525mm dia pipe		26	6	2	34
QC	2	QA	195	0.35	750	2.99	30	8	10	60	32	4	1.3	3.3	20	1.6	1	750	1	1050	1.2	0.71	1 x 750mm dia pipe		56	8	3	68
QA	5		115	0.10	2 x 900	3.34	5	8	5	90	33	4	0.6	2.5	90	4.4	1	1500	2	1500	2.9	1.00	1 x 1500mm dia pipe		81	21	5	108
QD	1		185	0.50	900	4.78	25	9	10	65	38	5	3.6	4.8	20	0.8			1	750	1.2	0.38						
QD	2	QA	305	0.70	1050	2.17	25	7	10	65	28	3	2.7	5.2	20	1.1			1	825	1.2	0.42						
QE	1		255	0.50	600	6.03	30	10	10	60	41	5	1.8	4.6	20	1.2	1	600	1	825	1.2	0.50	1 x 600mm dia pipe		58	6	3	67
QF	1	QE	90	1.00	525	4.83	15	9	5	80	38	5	1.4	4.6	20	0.5			1	525	1.2	0.21						
QE	2	QA	310	0.50		9.48	25	12	5	70	49	6	2.1	4.3	20	3.0	1	1200	1	1200	1.2	1.00	1 x 1200mm dia pipe		163	15	9	187
QA	6		405	0.10	open channel	11.20	10	13	5	85	52	7	0.5	3.0	90	9.3			3	1650	5.4	1.00	5.4m wide channel	23	508	78	29	615
QA	7		120	0.10	1050 + 1200	8.95	25	12	5	70	48	6	0.1	3.2	90	10.2	2	1800	3	1650	5.9	1.00	2 x 1800mm dia pipe		220	52	14	286
					total area	79.2	ha																		$1 323	$220	$77	$1 620
RA	1		135	0.30	750	6.85	30	11	10	60	43	5	0.8	2.2	20	1.3	1	750	1	1050	1.2	0.65	1 x 750mm dia pipe		39	8	2	49
RA	2		80	0.50	900	1.85	30	7	10	60	26	3	0.4	3.5	20	1.6	1	600	1	1050	1.2	0.63	1 x 600mm dia pipe		18	6	1	25
					total area	8.7	ha																		$57	$14	$4	$75
SA	1		285	0.25		4.69	30	9	10	60	38	5	5.0	6.1	20	0.9	1	900	1	900	1.2	0.52	1 x 900mm dia pipe		105	10	6	120
SA	2		345	0.25		12.15	30	13	10	60	54	7	4.3	5.9	20	2.9	1	1350	1	1350	1.5	1.00	1 x 1350mm dia pipe		211	18	11	241
SA	3		325	0.25		14.70	30	14	10	60	58	7	3.4	5.5	20	5.2	1	1650	1	1650	2.3	1.00	1 x 1650mm dia pipe		263	23	14	300
SA	4		200	0.25	900	9.63	30	12	10	60	49	6	2.6	5.0	25	6.6	1	1800	2	1500	2.8	1.00	1 x 1800mm dia pipe		184	26	10	220
SB	1		250	0.50		4.83	15	9	5	80	38	5	3.9	5.0	20	0.5	1	600	1	600	1.2	0.27	1 x 600mm dia pipe		57	6	3	66
SB	2	SA	100	0.50		2.03	30	7	10	60	27	3	2.6	4.8	20	0.9	1	750	1	750	1.2	0.41	1 x 750mm dia pipe		29	8	2	39
SA	5		195	0.25	1200	4.83	30	9	10	60	38	5	2.1	5.1	25	8.0	1	1800	2	1500	3.3	1.00	1 x 1800mm dia pipe		179	26	10	215
SA	6		160	0.25	1350	2.18	30	7	10	60	28	4	1.6	4.6	25	8.3	1	1650	2	1500	3.4	1.00	1 x 1650mm dia pipe		129	23	8	160
SC	1		175	0.20		3.48	30	8	10	60	33	4	3.5	5.9	20	0.7	1	825	1	825	1.2	0.48	1 x 825mm dia pipe		57	9	3	69

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	30
Network			***Reach Details***			***Catchment Area Parameters***							***Levels***		***Hydrology 1 in 100 AEP***		***Proposed Upgrade Options***						***Proposed Upgrade Works***		***Cost Breakdown***			***Total Cost***
branch & reach		add byd to	L (m)	S (%)	existing conduit size (mm)	area (ha)	paved direct (%)	paved time (min)	paved sup. (%)	grass (%)	grass time (min)	grass lag (min)	invert level mAHD	ground level mAHD	critical duration (min)	flowrate (m3/s)	Extra Pipes no.	Extra Pipes dia. (mm)	New Pipes no.	New Pipes dia. (mm)	Open Channel w (m)	Open Channel d (m)	Description	Easement Width (m)	Trunk Drainage ($1000)	Proposed Culverts ($1000)	Services Relocation ($1000)	($1000)
SC	2		235	0.20		6.10	30	10	10	60	41	5	3.1	6.3	20	1.9	1	1200	1	1200	1.2	1.00	1 x 1200mm dia pipe		124	15	7	146
SC	3		240	0.20		8.58	30	12	10	60	47	6	2.7	5.7	20	3.3	1	1500	1	1500	1.8	1.00	1 x 1500mm dia pipe		170	21	10	200
SC	4		90	0.20		9.93	30	12	10	60	50	6	2.2	4.9	20	4.9	1	1800	1	1800	2.4	1.00	1 x 1800mm dia pipe		83	26	5	114
SC	5		280	0.20	1200	6.83	30	11	10	60	43	5	2.0	4.9	20	6.0	1	1650	2	1500	2.9	1.00	1 x 1650mm dia pipe		227	23	12	262
SC	6		110	0.20	1350	9.45	30	12	10	60	49	6	1.5	4.3	20	7.4	1	1650	2	1500	3.4	1.00	1 x 1650mm dia pipe		89	23	6	118
SC	7	SA	135	0.20	1500	1.13	30	6	10	60	22	3	1.5	4.1	20	7.6	1	1500	2	1500	3.5	1.00	1 x 1500mm dia pipe		96	21	6	122
SA	7		85	0.25	1800	3.55	30	8	10	60	34	4	1.2	4.8	25	16.2	2	1500	3	1650	5.9	1.00	2 x 1500mm dia pipe		120	42	8	170
SA	8		130	0.25	1800	2.20	30	7	10	60	28	4	1.0	4.5	25	16.4	2	1500	3	1650	6.0	1.00	2 x 1500mm dia pipe		184	42	11	237
SD	1	SA	220	0.70	675	3.87	30	9	10	60	35	4	2.2	3.4	20	0.8			1	675	1.2	0.34						
SA	9		220	0.25	1800	3.97	30	9	10	60	35	4	0.7	3.2	25	17.6	2	1500	3	1650	6.3	1.00	2 x 1500mm dia pipe		312	42	18	371
SA	10		60	0.25	1800	3.95	30	9	10	60	35	4	0.2	3.3	25	18.1	2	1500	3	1650	6.5	1.00	2 x 1500mm dia pipe		85	42	6	133
					total area	118.1	ha																		$2 702	$446	$157	$3 305
TA	1		285	0.30	600	14.27	30	14	10	60	57	7	1.8	3.3	20	2.3	1	1050	1	1200	1.2	1.00	1 x 1050mm dia pipe		126	13	7	146
TA	2		170	0.30	600	5.50	30	10	10	60	40	5	1.0	3.9	20	3.2	1	1350	1	1350	1.5	1.00	1 x 1350mm dia pipe		104	18	6	128
TB	1	TA	50	2.00	600	2.39	30	7	10	60	29	4	1.5	2.7	20	0.5			1	450	1.2	0.17						
TA	3		120	0.30		5.93	30	10	10	60	41	5	0.5	2.5	25	4.7	1	1650	1	1650	2.0	1.00	1 x 1650mm dia pipe		97	23	6	126
TA	4		30	0.30		1.32	30	6	10	60	23	3	0.1	1.8	25	4.9	1	1650	1	1650	2.1	1.00	1 x 1650mm dia pipe		24	23	2	50
					total area	29.4	ha																		$352	$77	$21	$450
UA	1		65	0.50	450 + 600	3.61	30	8	10	60	34	4	0.3	1.5	20	0.7			1	750	1.2	0.34						
					total area	3.6	ha																					
VA	1		75	1.00	525	1.57	30	6	10	60	25	3	0.8	2.0	25	0.4			1	525	1.2	0.19						
					total area	1.6	ha																					
WA	1		25	5.00	375	0.72	30	6	10	60	18	3	1.3	12.0	15	0.2			1	375	1.2	0.07						
					total area	0.7	ha																					
XA	1		50	5.00	2 x 525	17.97	30	16	10	60	63	8	2.5	7.8	20	2.6			1	750	1.2	0.38						
					total area	18.0	ha																					
YA	1		70	5.00		6.51	30	11	10	60	42	5	3.5	7.0	20	1.2	1	600	1	600	1.2	0.22	1 x 600mm dia pipe		16	6	1	23
					total area	6.5	ha																		$16	$6	$1	$23
AAA	1		200	0.25	525	1.63	30	6	10	60	25	3	4.5	5.9	25	0.4	1	450	1	675	1.2	0.30	1 x 450mm dia pipe		33	5	2	40
AAA	2		280	0.25	675	5.65	30	10	10	60	40	5	4.0	5.7	20	1.4	1	825	1	1050	1.2	0.73	1 x 825mm dia pipe		91	9	5	105
AAA	3		110	0.25	1050	4.44	30	9	10	60	37	5	3.3	5.3	20	2.2	1	600	1	1200	1.2	1.00	1 x 600mm dia pipe		25	6	2	33
AAA	4		145	0.25	1200	2.84	30	8	10	60	31	4	3.1	5.0	20	2.7	1	675	1	1350	1.4	1.00	1 x 675mm dia pipe		37	7	2	46
AAA	5		205	0.25	1350	3.04	30	8	10	60	32	4	2.7	5.2	20	3.2	1	675	1	1500	1.6	1.00	1 x 675mm dia pipe		53	7	3	63
AAA	6		150	0.25	1350	9.07	5	12	20	75	48	6	2.2	5.0	90	3.9	1	675	1	1500	1.9	1.00	1 x 675mm dia pipe		39	7	2	48
AAB	1	AAA	190	1.00	600	2.45	15	7	5	80	29	4	3.7	4.7	20	0.3			1	450	1.2	0.15						
AAA	7		320	0.25	1350	5.05	5	10	20	75	39	5	1.8	4.0	90	4.7	1	1050	1	1650	2.2	1.00	1 x 1050mm dia pipe		142	13	8	162
AAA	8		280	0.25	1500	5.93	5	10	10	85	41	5	1.0	3.9	90	5.1	1	750	1	1650	2.3	1.00	1 x 750mm dia pipe		81	8	4	93

ILSAX RESULTS
1 IN 100 AEP FLOOD
EXISTING CATCHMENTS

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	30
Network			***Reach Details***			***Catchment Area Parameters***							***Levels***		***Hydrology 1 in 100 AEP***		***Proposed Upgrade Options***						***Proposed Upgrade Works***		***Cost Breakdown***			***Total Cost***
branch & reach		add hyd to	L (m)	S (%)	existing conduit size (mm)	area (ha)	paved direct (%)	paved time (min)	paved sup. (%)	grass (%)	grass time (min)	grass lag (min)	invert level mAHD	ground level mAHD	critical duration (min)	flowrate (m3/s)	Extra Pipes no.	Extra Pipes dia. (mm)	New Pipes no.	New Pipes dia. (mm)	Open Channel w (m)	Open Channel d (m)	Description	Easement Width (m)	Trunk Drainage ($1000)	Proposed Culverts ($1000)	Services Relocation ($1000)	($1000)
AAA	9		50	0.25	1500	6.73	30	11	10	60	43	5	0.3	2.6	90	5.8	1	1050	1	1800	2.6	1.00	1 x 1050mm dia pipe		22	13	2	37
AAC	1		110	0.50	675	2.70	30	8	10	60	30	4	1.9	3.5	90	0.6			1	675	1.2	0.30						
AAD	1	AAC	130	0.50	750	7.10	30	11	10	60	44	5	2.0	3.5	20	1.3	1	525	1	900	1.2	0.53	1 x 525mm dia pipe		25	6	2	33
AAC	2		140	0.50	900	2.02	30	7	10	60	27	3	1.4	3.3	20	2.2	1	600	1	1050	1.2	0.80	1 x 600mm dia pipe		32	6	2	40
AAC	3	AAA	100	0.50	1050	2.78	30	8	10	60	31	4	0.7	2.1	25	2.8	1	600	1	1200	1.2	0.96	1 x 600mm dia pipe		23	6	1	30
AAA	10		70	0.25	2x1200+1050	0.75	30	6	10	60	19	3	0.2	2.1	90	8.0			2	1500	3.3	1.00						
					total area	62.2	ha																		$603	$93	$35	$731
ABA	1		70	1.00	750	1.55	30	6	10	60	25	3	0.7	1.9	25	0.4			1	525	1.2	0.19						
					total area	1.6	ha																					
ACA	1		100	0.50		4.54	30	9	10	60	37	5	0.5	1.8	20	0.9	1	750	1	750	1.2	0.41	1 x 750mm dia pipe		29	8	2	39
					total area	4.5	ha																		$29	$8	$2	$39
ADA	1		70	0.50	525	1.72	30	6	10	60	26	3	0.4	1.4	20	0.4			1	525	1.2	0.23						
					total area	1.7	ha																					
AEA	1		75	0.30		2.62	30	8	10	60	30	4	0.2	1.2	10	0.5	1	675	1	675	1.2	0.32	1 x 675mm dia pipe		19	7	1	28
					total area	2.6	ha																		$19	$7	$1	$28
AFA	1		60	0.50		1.37	30	6	10	60	24	3	0.3	1.5	15	0.3	1	525	1	525	1.2	0.20	1 x 525mm dia pipe		12	6	1	19
					total area	1.4	ha																		$12	$6	$1	$19
AGA	1		60	0.50		1.50	30	6	10	60	24	3	0.3	1.5	90	0.4	1	525	1	525	1.2	0.23	1 x 525mm dia pipe		12	6	1	19
					total area	1.5	ha																		$12	$6	$1	$19
AHA	1		80	0.30		0.87	30	6	10	60	20	3	0.2	1.1	10	0.2	1	450	1	450	1.2	0.17	1 x 450mm dia pipe		13	5	1	19
					total area	0.9	ha																		$13	$5	$1	$19
AIA	1		70	0.30		7.48	30	11	10	60	45	6	0.2	1.6	20	1.4	1	1050	1	1050	1.2	0.68	1 x 1050mm dia pipe		31	13	2	46
					total area	7.5	ha																		$31	$13	$2	$46
AJA	1		65	0.50		6.50	30	11	10	60	42	5	0.3	1.9	20	1.2	1	900	1	900	1.2	0.50	1 x 900mm dia pipe		24	10	2	36
					total area	6.5	ha																		$24	$10	$2	$36
AKA	1		35	5.00		0.55	30	6	10	60	17	3	1.8	3.2	10	0.1	1	375	1	375	1.2	0.05	1 x 375mm dia pipe		5	4	0	9
					total area	0.6	ha																		$5	$4	$0	$9
ALA	1		100	2.50		6.05	30	10	10	60	41	5	2.5	3.9	20	1.2	1	675	1	675	1.2	0.29	1 x 675mm dia pipe		26	7	2	34
					total area	6.1	ha																		$26	$7	$2	$34
AM	1		90	3.00		5.03	30	10	10	60	39	5	2.7	3.9	20	1.0	1	600	1	600	1.2	0.23	1 x 600mm dia pipe		20	6	1	28
					total area	5.0	ha																		$20	$6	$1	$28

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	30
Network			***Reach Details***			***Catchment Area Parameters***							***Levels***		***Hydrology 1 in 100 AEP***		***Proposed Upgrade Options***						***Proposed Upgrade Works***		***Cost Breakdown***			***Total Cost***
branch & reach		add hyd to	L (m)	S (%)	existing conduit size (mm)	area (ha)	paved direct (%)	paved time (min)	paved sup. (%)	grass (%)	grass time (min)	grass lag (min)	invert level mAHD	ground level mAHD	critical duration (min)	flowrate (m3/s)	Extra Pipes no.	Extra Pipes dia. (mm)	New Pipes no.	New Pipes dia. (mm)	Open Channel w (m)	Open Channel d (m)	Description	Easement Width (m)	Trunk Drainage ($1000)	Proposed Culverts ($1000)	Services Relocation ($1000)	($1000)
ANA	1		430	0.50	375	2.98	30	8	10	60	32	4	4.6	5.7	20	0.6	1	600	1	675	1.2	0.30	1 x 600mm dia pipe		98	6	5	109
ANA	2		185	0.50	900	5.95	30	10	10	60	41	5	2.5	4.3	20	1.7	1	600	1	1050	1.2	0.65	1 x 600mm dia pipe		42	6	2	50
ANB	1	ANA	270	0.50	525	13.60	30	14	10	60	56	7	2.9	5.0	20	2.2	1	1050	1	1050	1.2	0.80	1 x 1050mm dia pipe		120	13	7	139
ANA	3		70	1.00	1050	13.33	30	14	10	60	56	7	1.6	3.7	20	5.9	1	900	1	1350	1.5	1.00	1 x 900mm dia pipe		26	10	2	37
ANC	1	ANA	225	0.50	750	13.33	30	14	10	60	56	7	2.0	3.7	20	2.1	1	750	1	1050	1.2	0.77	1 x 750mm dia pipe		65	8	4	77
ANA	4		85	1.00	1350	13.33	30	14	10	60	56	7	0.9	3.7	20	10.1	1	1050	1	1650	2.3	1.00	1 x 1050mm dia pipe		38	13	3	53
					total area	62.5	ha																		$388	$56	$22	$466
AOA	1		80	0.20		5.71	30	10	10	60	40	5	0.2	1.5	20	1.1	1	1050	1	1050	1.2	0.66	1 x 1050mm dia pipe		35	13	2	51
					total area	5.7	ha																		$35	$13	$2	$51
APA	1		215	0.35	600	4.80	30	9	10	60	38	5	3.9	5.2	20	0.9	1	600	1	825	1.2	0.46	1 x 600mm dia pipe		49	6	3	58
APA	2		225	0.35	750	5.03	30	10	10	60	39	5	3.1	5.3	20	1.9	1	750	1	1050	1.2	0.81	1 x 750mm dia pipe		65	8	4	77
APB	1	APA	270	0.20	1050	9.40	30	12	10	60	49	6	2.9	4.6	20	1.6	1	600	1	1200	1.2	0.89	1 x 600mm dia pipe		61	6	3	71
APA	3		360	0.35	1350	9.57	30	12	10	60	49	6	2.4	5.5	20	5.1	1	1050	1	1650	2.0	1.00	1 x 1050mm dia pipe		159	13	9	181
APC	1	APA	210	1.00	750	5.56	30	10	10	60	40	5	3.2	4.8	20	1.1			1	750	1.2	0.37						
APA	4		265	0.35	1350	12.86	30	14	10	60	55	7	1.1	3.5	20	8.0	1	1500	2	1500	2.9	1.00	1 x 1500mm dia pipe		188	13	10	211
APA	5		85	0.20	2 x 1350	7.88	25	11	5	70	46	6	0.2	1.8	20	8.9	1	1500	2	1800	3.9	1.00	1 x 1500mm dia pipe		60	21	4	85
					total area	55.1	ha																		$582	$67	$32	$682
AQA	1		110	0.50		3.24	30	8	10	60	33	4	1.9	3.2	25	0.7	1	675	1	675	1.2	0.34	1 x 675mm dia pipe		28	7	2	37
AQA	2		125	0.50		4.49	30	9	10	60	37	5	1.3	3.2	20	1.5	1	1050	1	1050	1.2	0.59	1 x 1050mm dia pipe		55	13	3	72
AQB	1	AQA	305	0.50	525	2.97	30	8	10	60	32	4	2.2	3.7	20	0.6	1	450	1	675	1.2	0.30	1 x 450mm dia pipe		51	5	3	59
AQA	3		110	0.50	375	4.36	30	9	10	60	36	5	0.7	3.0	20	2.9	1	1200	1	1200	1.2	0.99	1 x 1200mm dia pipe		58	15	4	77
AQA	4		30	0.50		2.04	30	7	10	60	27	3	0.2	2.0	20	3.3	1	1350	1	1350	1.3	1.00	1 x 1350mm dia pipe		18	18	2	38
					total area	17.1	ha																		$211	$58	$13	$282
ARA	1		170	1.50	375	1.30	30	6	10	60	23	3	3.8	5.2	15	0.3	1	375	1	450	1.2	0.13	1 x 375mm dia pipe		24	4	1	30
ARA	2		60	2.00	450	1.62	30	6	10	60	25	3	1.2	5.2	25	0.7	1	375	1	525	1.2	0.21	1 x 375mm dia pipe		9	4	1	13
					total area	2.9	ha																		$33	$8	$2	$43
ASA	1		30	5.00		0.62	30	6	10	60	17	3	1.5	4.8	25	0.2	1	375	1	375	1.2	0.07	1 x 375mm dia pipe		4	4	0	9
					total area	0.6	ha																		$4	$4	$0	$9
ATA	1		30	5.00		1.72	30	6	10	60	26	3	1.5	4.6	20	0.4	1	375	1	375	1.2	0.11	1 x 375mm dia pipe		4	4	0	9
					total area	1.7	ha																		$4	$4	$0	$9
AUA	1		590	0.30		6.93	30	11	10	60	44	5	3.9	5.3	20	1.3	1	1050	1	1050	1.2	0.65	1 x 1050mm dia pipe		261	13	14	288
AUA	2		200	0.30	600	13.73	30	14	10	60	56	7	2.2	5.8	20	3.4	1	1500	1	1500	1.6	1.00	1 x 1500mm dia pipe		142	21	8	171
AUB	1		225	0.90		5.81	30	10	10	60	41	5	4.6	5.8	20	1.1	1	750	1	750	1.2	0.38	1 x 750mm dia pipe		65	8	4	77
AUB	2	AUA	110	0.90		7.68	30	11	10	60	45	6	2.6	6.0	20	2.5	1	1050	1	1050	1.2	0.70	1 x 1050mm dia pipe		49	13	3	65
AUA	3		175	0.30		3.99	30	9	10	60	35	4	1.6	4.2	20	6.3	1	1800	1	1800	2.5	1.00	1 x 1800mm dia pipe		161	26	9	196
AUC	1	AUA	260	1.50	525	2.45	30	7	10	60	29	4	5.0	6.0	15	0.5			1	525	1.2	0.19						
AU	1	AUA	125	2.50	525	3.49	30	8	10	60	34	4	4.2	5.1	20	0.7			1	525	1.2	0.20						
AUA	4		290	0.30	1050	7.93	30	11	10	60	46	6	1.1	4.9	20	8.6	1	1650	2	1500	3.2	1.00	1 x 1650mm dia pipe		235	23	13	270
AUE	1		150	1.20	1050	2.74	30	8	10	60	31	4	3.7	4.6	20	0.6			1	525	1.2	0.23						

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	30
Network			***Reach Details***			***Catchment Area Parameters***							***Levels***		***Hydrology 1 in 100 AEP***		***Proposed Upgrade Options***						***Proposed Upgrade Works***		***Cost Breakdown***			***Total Cost***
branch & reach		add hyd to	L (m)	S (%)	existing conduit size (mm)	area (ha)	paved direct (%)	paved time (min)	paved sup. (%)	grass (%)	grass time (min)	grass lag (min)	invert level mAHD	ground level mAHD	critical duration (min)	flowrate (m3/s)	Extra no.	Pipes dia. (mm)	New no.	Pipes dia. (mm)	Open Channel w (m)	Open Channel d (m)	Description	Easement Width (m)	Trunk Drainage ($1000)	Proposed Culverts ($1000)	Services Relocation ($1000)	($1000)
AUE	2	AUA	145	1.20	1200	2.62	30	8	10	60	30	4	1.9	4.8	20	1.1			1	675	1.2	0.34						
AUA	5		60	0.30	1350	8.23	30	12	10	60	46	6	0.2	5.5	25	10.9	2	1500	2	1800	3.9	1.00	2 x 1500mm dia pipe		85	42	6	133
					total area	65.6	ha																		$997	$146	$57	$1,200
AVA	1		130	0.50		3.65	30	9	10	60	34	4	2.3	5.9	20	0.7	1	750	1	750	1.2	0.34	1 x 750mm dia pipe		38	8	2	48
AVB	1	AVA	100	0.50		1.00	30	6	10	60	21	3	2.1	6.0	10	0.2	1	450	1	450	1.2	0.15	1 x 450mm dia pipe		17	5	1	23
AVA	2		215	0.50		1.48	30	6	10	60	24	3	1.6	6.0	25	1.3	1	900	1	900	1.2	0.53	1 x 900mm dia pipe		79	10	4	93
AVC	1	AVA	130	0.50		3.35	30	8	10	60	33	4	1.2	4.6	20	0.7	1	675	1	675	1.2	0.34	1 x 675mm dia pipe		33	7	2	42
AVA	3		110	0.50		2.83	30	8	10	60	31	4	0.6	5.0	25	2.5	1	1200	1	1200	1.2	0.88	1 x 1200mm dia pipe		58	15	4	77
					total area	12.3	ha																		$225	$45	$13	$283
AW	1		250	0.50	450	1.93	30	7	10	60	27	3	4.2	6.5	15	0.4	1	450	1	600	1.2	0.23	1 x 450mm dia pipe		42	5	2	49
AW	2		230	0.50	600	3.85	30	9	10	60	35	4	3.0	5.5	20	1.2	1	600	1	825	1.2	0.50	1 x 600mm dia pipe		52	6	3	61
AW	1	AW	160	0.50	750	0.80	30	6	10	60	19	3	2.6	5.0	15	0.2			1	450	1.2	0.15						
AW	3		140	0.50	750	6.30	20	10	5	75	42	5	1.8	5.0	20	2.2	1	750	1	1050	1.2	0.80	1 x 750mm dia pipe		40	8	2	51
AW	4		225	0.50	900	4.08	20	9	5	75	36	4	1.1	6.0	20	2.7	1	825	1	1200	1.2	0.93	1 x 825mm dia pipe		73	9	4	86
					total area	17.0	ha																		$208	$28	$12	$248
					total area	1136.5	ha																		$18,735	$3,835	$1,128	$23,698

SUMMARY OF 2(b) AREA 2(b) AREA = 413 ha

2(b) AREA COST = 413 / 1137 x 23,698 K = $8,608 K

APPENDIX A2

ILSAX RESULTS

1 IN 100 AEP FLOOD

EXISTING CATCHMENTS

APPENDIX B

ILSAX RESULTS
1 IN 100 AEP FLOOD
PROPOSED CATCHMENTS

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	30
Network			**Reach Details**			**Catchment Area Parameters**							**Levels**		**Hydrology 1 in 100 AEP**		**Proposed Upgrade Options**						**Proposed Upgrade Works**		**Cost Breakdown**			**Total Cost**
branch & reach		add byd to	L (m)	S (%)	existing conduit size (mm)	area (ha)	paved direct (%)	paved time (min)	paved sup. (%)	grass (%)	grass time (min)	grass lag (min)	invert level mAHD	ground level mAHD	critical duration (min)	flowrate (m3/s)	Extra Pipes no.	Extra Pipes dia. (mm)	New Pipes no.	New Pipes dia. (mm)	Open Channel w (m)	Open Channel d (m)	Description	Easement Width (m)	Trunk Drainage ($1000)	Proposed Culverts ($1000)	Services Relocation ($1000)	($1000)
AA	1		295	0.30	no existing	13.78	50	14	10	40	57	7	4.5	5.6	25	3.6	1	1500	1	1500	1.7	1.00	1.7m wide channel	4.7	229	23	13	264
AA	2		240	0.10	no existing	9.30	50	12	10	40	49	6	3.6	4.7	20	6.1	2	1500	2	1500	3.8	1.00	3.8m wide channel	6.8	252	53	15	320
AA	3		400	0.10	open channel	11.72	30	8	10	60	8		3.3	4.5	25	9.7	3	1650	3	1650	5.6	1.00	5.6m wide channel	8.6	512	65	29	606
AB	1		290	0.15	2 x 900mm pipes	11.49	50	13	10	40	53	7	3.8	5.0	25	3.1	1	825	1	1500	1.9	1.00	1.9m wide channel	4.9	235	23	13	271
AB	2	AA	300	0.15	2 x 900mm pipes	10.57	50	13	10	40	51	6	3.4	4.5	20	5.8	1	1500	2	1500	3.1	1.00	3.1m wide channel	6.1	288	39	16	344
AA	4		230	0.20	open channel	10.57	50	13	10	40	51	6	2.9	4.4	25	18.2	3	1800	3	1800	7.2	1.00	7.2m wide channel	12.7	340	85	21	446
AA	5		285	0.20	open channel	12.18	20	13	10	70	20		2.5	3.9	25	20.0	3	1800	3	1800	7.8	1.00	7.8m wide channel	12.8	443	92	27	562
AC	1		60	0.20	750mm pipe	5.93		10	10	90	41	5	2.7	5.0	90	0.4			1	675	1.2	0.32		-				
AD	1	AC	23	0.30	750mm pipe	3.11	50	8	10	40	32	4	2.6	4.2	20	1.0	1	525	1	900	1.2	0.53	1 x 525mm dia pipe	-	5	4	0	9
AE	1	AC	48	0.40	825mm pipe	4.47	50	9	10	40	37	5	2.7	4.2	20	1.4	1	675	1	1050	1.2	0.61	1 x 675mm dia pipe	-	12	4	1	17
AF	1		115	0.15	1275mm pipe	5.13	50	10	10	40	39	5	3.5	4.7	20	1.6			1	1200	1.2	0.99		-				
AF	2		108	0.15	1500mm pipe	5.05	50	10	10	40	39	5	3.3	4.6	20	3.1			1	1500	1.9	1.00		-				
AF	3		109	0.15	1950mm pipe	3.63	50	9	10	40	34	4	3.2	5.3	20	4.1			1	1800	2.4	1.00		-				
AF	4		284	0.15	1800mm pipe	4.81	50	9	10	40	38	5	3.0	4.9	20	5.5	1	750	2	1500	3.0	1.00	1 x 750mm dia pipe	-	82		4	86
AF	5	AC	32	0.15	1800mm pipe	1.27	50	6	10	40	23	3	2.6	4.2	25	5.8	1	750	2	1500	3.1	1.00	1 x 750mm dia pipe	-	9	8	1	18
AC	2		41	0.30	2 x 1350mm pipes	7.47		11		100	45	6	2.5	3.9	90	1.5	1	450	2	1500	1.2	0.72	1 x 450mm dia pipe	-	7	4	1	11
AG	1	AC	72	0.50	600mm pipe	2.60	50	7	10	40	30	4	2.8	4.0	25	0.9	1	450	1	750	1.2	0.41	1 x 450mm dia pipe	-	12	7	1	20
AH	1	AC	142	0.27	825mm pipe	4.59	50	9	10	40	37	5	2.8	4.9	20	1.4	1	675	1	1050	1.2	0.71	1 x 675mm dia pipe	-	36		2	38
AC	3		5	0.30	3 x 1350mm pipes	2.42		7		100	29	4	2.4	3.8	90	2.3			1	1200	1.2	1.00		-				
AC	4		18	0.30	3 x 1350mm pipes	3.06		8		100	32	4	2.4	3.7	90	2.3			1	1200	1.2	1.00		-				
AC	5		12	0.30	3 x 1350mm pipes	4.05		9		100	35	4	2.3	3.6	90	2.0			1	1200	1.2	0.90		-				
AC	6		7	0.30	3 x 1350mm pipes	3.24		8		100	33	4	2.3	3.5	90	1.9			1	1200	1.2	0.87		-				
AC	7		20	0.30	3 x 1350mm pipes	1.01		6		100	21	3	2.3	3.4	90	1.9			1	1200	1.2	0.87		-				
AC	8		43	0.27	2x1050 + 825mm	0.96		6		100	21	3	2.2	3.3	90	1.9			1	1200	1.2	0.91		-				
AI	1	AC	340	0.30	2 x 375mm pipes	4.82	30	9	10	60	38	5	3.1	4.5	20	0.9	1	750	1	900	1.2	0.49	1 x 900mm dia pipe	-	125	10	7	142
AC	9	AA	76	0.27	2x1050 + 825mm	3.79	20	9	20	60	35	4	2.1	4.3	90	1.9	1	1050	2	1500	1.2	0.91	1 x 1050mm dia pipe	-	34	6	2	42
AA	6		165	0.20	open channel	16.54	50	15	10	40	20		1.9	3.9	25	25.6	4	1650	4	1650	9.7	1.00	9.7m wide channel	21.6	297	113	20	430
AA	7		130	0.20	open channel	4.02	20	9	5	75	35	4	1.6	3.8	25	25.9	4	1650	4	1650	9.8	1.00	9.8m wide channel	24.4	236	113	17	366
AJ	1		330	3.00	900mm pipe	18.60	10	7		90	7		13.9	20.0	90	5.9	1	825	1	1200	1.2	0.85	1 x 1200mm dia pipe	-	174	15	9	198
AJ	2		200	1.00	open channel	28.45	30	9	10	60	9	3	4.0	5.1	90	15.3	2	1500	2	1500	3.2	1.00	3.2m wide channel	6.2	194	39	12	244
AJ	3	AA	280	0.25	no existing	14.33	30	9	20	50	9	3	2.0	3.0	90	19.9	3	1800	3	1800	7.1	1.00	3 x 1800mm dia pipe	-	771	69	42	882
AA	8		410	0.20	open channel	16.19	30	15	10	60	30	8	1.3	3.5	90	45.9	6	1800	6	1800	16.6	1.00	16.6m wide channel	30.8	1096	188	64	1348
AK	1	AA	215	1.10	open channel	9.19	30	12	10	60	48	6	2.9	3.9	20	1.6	1	825	1	825	1.2	0.46	1.2m wide channel	4.2	154	17	9	180
AA	9		170	0.20	open channel	23.20	30	17	10	60	15	9	0.5	3.0	90	51.8	6	1800	6	1800	18.6	1.00	18.6m wide channel	36.6	497	210	35	743
AL	1		160	0.20	750mm pipe	6.06	50	10	10	40	41	5	1.9	4.3	20	1.9	1	1050	1	1200	1.2	1.00	1 x 1200mm dia pipe	-	84	15	5	104
AL	2		230	0.20	900mm pipe	5.70	50	10	10	40	40	5	1.6	4.5	20	3.5	1	1350	1	1500	1.9	1.00	1 x 1500mm dia pipe	-	163	21	9	193
AL	3		130	0.20	1050mm pipe	4.87	50	10	15	35	38	5	1.1	4.0	25	4.9	1	1500	1	1800	2.4	1.00	1 x 1800mm dia pipe	-	119	23	7	149
AL	4		160	0.20	open channel	5.38	50	10	10	40	40	5	0.8	4.1	20	6.3	2	1500	2	1500	3.0	1.00	2 x 1500mm dia pipe	-	227	42	13	282
AL	5	AA	180	0.20	open channel	1.73	20	6	10	70	26	3	0.5	2.5	20	6.6	2	1500	2	1500	3.1	1.00	2 x 1500mm dia pipe	-	255	42	15	312
AA	10		80	0.20	open channel	8.61	20	12	10	70	20	6	0.2	3.0	90	59.3	7	1800	7	1800	21.1	1.00	21.1m wide channel	43.2	260	241	25	526
					total area	337.0	ha			2(b) area	4.5	ha	2(b) cost	$122											$7,147	$1,571	$436	$9,154

ILSAX RESULTS
1 IN 100 AEP FLOOD
PROPOSED CATCHMENTS

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	30
Network			**Reach Details**			**Catchment Area Parameters**							**Levels**		**Hydrology 1 in 100 AEP**		**Proposed Upgrade Options**						**Proposed Upgrade Works**		**Cost Breakdown**			**Total Cost**
branch & reach		add hyd to	L (m)	S (%)	existing conduit size (mm)	area (ha)	paved direct (%)	paved time (min)	paved sup. (%)	grass (%)	grass time (min)	grass lag (min)	invert level mAHD	ground level mAHD	critical duration (min)	flowrate (m3/s)	Extra Pipes no.	Extra Pipes dia. (mm)	New Pipes no.	New Pipes dia. (mm)	Open Channel w (m)	Open Channel d (m)	Description	Easement Width (m)	Trunk Drainage ($1000)	Proposed Culverts ($1000)	Services Relocation ($1000)	($1000)
BA	1		235	0.20	no existing	6.29	50	10	10	40	42	5	3.7	4.7	20	1.9	1	1200	1	1200	1.2	1.00	1 x 1200mm dia pipe	-	124	15	7	146
BA	2		315	0.30	no existing	9.12	50	12	10	40	48	6	3.3	5.1	20	4.4	1	1500	1	1500	1.9	1.00	1 x 1500mm dia pipe	-	223	21	12	256
BA	3		330	0.30	no existing	8.52	50	12	15	35	47	6	2.3	4.5	20	6.7	1	1800	1	1800	2.7	1.00	1 x 1800mm dia pipe	-	303	26	16	345
BA	4		330	0.40	no existing	9.37	50	12	15	35	49	6	1.3	4.6	20	9.0	2	1500	2	1500	3.0	1.00	2 x 1500mm dia pipe	-	467	42	25	535
					total area	33.3	ha			2(b) area	14.0	ha	2(b) cost	$539											$1,117	$104	$61	$1,282
CA	1		325	0.20	750mm pipe	9.53	45	12	15	40	49	6	3.9	4.9	20	2.4	1	1200	1	1350	1.4	1.00	1 x 1350mm dia pipe	-	199	18	11	228
CA	2		150	1.00	no existing	8.73	60	12	20	20	48	6	3.3	4.4	25	5.3	1	1350	1	1350	1.4	1.00	1 x 1350mm dia pipe	-	92	18	5	115
CA	3		125	1.40	1050mm pipe	5.33	60	10	20	20	39	5	1.8	5.8	25	7.1	1	900	1	1350	1.6	1.00	1 x 1350mm dia pipe	-	77	21	5	102
					total area	23.6	ha			2(b) area	19.9	ha	2(b) cost	$376											$367	$57	$21	$445
DA	1		130	0.40	900mm pipe	7.31	60	11	20	20	44	6	1.2	2.2	20	2.6	1	825	1	1200	1.2	0.99	1 x 1200mm dia pipe	-	69	15	4	88
DA	2		220	0.20	no existing	9.62	60	12	20	20	49	6	0.7	1.7	20	5.8	2	1500	2	1500	2.8	1.00	2 x 1500mm dia pipe	-	312	42	18	371
DA	3		110	0.20	no existing	3.29	60	8	20	20	33	4	0.2	1.5	25	7.0	2	1500	2	1500	3.2	1.00	2 x 1500mm dia pipe	-	156	42	10	208
					total area	20.2	ha			2(b) area	20.0	ha	2(b) cost	$659											$536	$99	$32	$667
EA	1		350	0.10	no existing	4.27	50	9	10	40	36	5	1.0	2.0	20	1.3	1	1200	1	1200	1.2	0.99	1 x 1200mm dia pipe	-	184	15	10	209
EA	2		255	0.20	open channel	11.49	30	13	5	65	53	7	0.6	1.7	20	3.1	1	1500	1	1500	1.7	1.00	1.7m wide channel	4.7	200	26	11	237
EA	3		115	0.10	open channel	12.59	20	14	5	75	55	7	0.1	1.0	20	4.5	2	1500	2	1500	3.0	1.00	3.0m wide channel	6.0	109	47	8	163
					total area	28.3	ha			2(b) area	6.0	ha	2(b) cost	$129											$493	$88	$29	$610
FA	1		110	0.10	no existing	6.43	50	11	10	40	42	5	0.4	1.4	20	1.9	1	1350	1	1350	1.6	1.00	1 x 1350mm dia pipe	-	67	18	4	90
FA	2		200	0.15	no existing	4.82	50	9	10	40	38	5	0.3	1.5	20	3.3	1	1650	1	1650	2.0	1.00	1 x 1650mm dia pipe	-	162	21	9	192
					total area	11.3	ha			2(b) area	0.9	ha	2(b) cost	$23											$229	$39	$13	$282
GA	1		200	0.20	no existing	4.36	60	9	20	20	37	5	2.6	3.6	20	1.7	1	1200	1	1200	1.2	0.93	1 x 1200mm dia pipe	-	105	15	6	126
GA	2		105	0.40	750mm pipe	4.02	50	9	15	35	35	4	2.2	3.9	20	2.9	1	1200	1	1350	1.3	1.00	1 x 1350mm dia pipe	-	64	18	4	86
GA	3		180	1.00	no existing	2.30	60	7	20	20	29	4	1.8	3.1	25	3.8	1	1350	1	1350	1.2	0.93	1 x 1350mm dia pipe	-	110	18	6	135
					total area	10.7	ha			2(b) area	6.8	ha	2(b) cost	$221											$280	$51	$17	$347
HA	1		260	0.20	no existing	8.73	50	12	15	35	48	6	3.6	4.6	20	2.5	1	1350	1	1350	1.5	1.00	1 x 1350mm dia pipe	-	159	18	9	186
HA	2		200	0.80	no existing	10.11	60	13	20	20	50	6	3.1	5.1	20	5.7	1	1500	1	1500	1.6	1.00	1 x 1500mm dia pipe	-	142	21	8	171
HA	3		150	1.00	no existing	5.74	60	10	20	20	41	5	1.5	4.7	25	7.7	1	1500	1	1500	1.9	1.00	1 x 1500mm dia pipe	-	106	23	6	136
					total area	24.6	ha			2(b) area	21.2	ha	2(b) cost	$425											$407	$62	$23	$492
IA	1		260	0.25	no existing	5.97	20	10	10	70	41	5	1.8	3.0	20	0.8	1	825	1	825	1.2	0.48	1 x 825mm dia pipe	-	85	10	5	99
IA	2		250	0.25	2x900	7.23	20	11	10	70	44	6	1.2	3.2	20	1.7			1	1200	1.2	0.85	1 x 1200mm dia pipe	-	132	15	7	154
IA	3		335	0.10	open channel	11.03	50	13	10	40	52	6	0.6	3.0	20	4.5	2	1500	2	1500	3.0	1.00	3.0m wide channel	20.3	317	44	18	379
IA	4		50	0.20	1200mm pipe	4.23	35	9	10	55	36	5	0.3	3.0	20	5.1	1	1650	2	1500	2.5	1.00	2 x 1500mm dia pipe	-	71	42	6	118
IA	5		110	0.20	1050+1200mm pi	1.98	35	7	10	55	27	3	0.2	2.5	25	5.5	1	1200	2	1500	2.7	1.00	2 x 1500mm dia pipe	-	156	42	10	208
					total area	30.4	ha			2(b) area	6.1	ha	2(b) cost	$192											$760	$153	$46	$958

ILSAX RESULTS
1 IN 100 AEP FLOOD
PROPOSED CATCHMENTS

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	30
Network			**Reach Details**			**Catchment Area Parameters**							**Levels**		**Hydrology 1 in 100 AEP**		**Proposed Upgrade Options**						**Proposed Upgrade Works**		**Cost Breakdown**			**Total Cost**
branch & reach		add hyd to	L (m)	S (%)	existing conduit size (mm)	area (ha)	paved direct (%)	paved time (min)	paved sup. (%)	grass (%)	grass time (min)	grass lag (min)	invert level mAHD	ground level mAHD	critical duration (min)	flowrate (m3/s)	Extra Pipes no.	Extra Pipes dia. (mm)	New Pipes no.	New Pipes dia. (mm)	Open Channel w (m)	Open Channel d (m)	Description	Easement Width (m)	Trunk Drainage ($1000)	Proposed Culverts ($1000)	Services Relocation ($1000)	($1000)
JA	1		220	0.10	no existing	5.31	50	10	10	40	39	5	4.0	5.0	20	1.6	1	1350	1	1350	1.4	1.00	1 x 1350mm dia pipe	-	135	18	8	160
JA	2		275	0.15	no existing	7.10	50	11	10	40	44	5	3.8	5.3	20	3.6	1	1650	1	1650	2.2	1.00	1 x 1650mm dia pipe	-	222	23	12	258
JA	3		240	0.25	no existing	8.44	50	12	10	40	47	6	3.4	5.3	20	5.8	1	1800	1	1800	2.6	1.00	1 x 1800mm dia pipe	-	220	23	12	255
JA	4		325	0.25	no existing	9.33	50	12	10	40	49	6	2.8	4.7	20	8.2	2	1500	2	1500	3.4	1.00	2 x 1500mm dia pipe	-	460	42	25	527
JA	5		235	0.25	no existing	13.32	50	14	10	40	56	7	1.9	3.7	20	11.4	2	1800	2	1800	4.4	1.00	2 x 1800mm dia pipe	-	431	52	24	508
JA	6		160	0.25	750mm pipe	5.38	50	10	10	40	40	5	1.4	3.5	25	12.6	2	1800	2	1800	4.8	1.00	2 x 1800mm dia pipe	-	294	52	17	363
JB	1		230	0.45	no existing	4.50	45	9	15	40	37	5	4.8	5.8	20	1.3	1	900	1	900	1.2	0.55	1 x 900mm dia pipe	-	84	10	5	99
JB	2		215	0.20	no existing	6.62	45	11	15	40	43	5	3.8	4.8	20	3.1	1	1500	1	1500	1.7	1.00	1 x 1500mm dia pipe	-	152	21	9	182
JB	3		215	0.30	900mm pipe	5.65	50	10	10	40	40	5	3.4	5.4	20	4.6	1	1500	1	1650	2.0	1.00	1 x 1650mm dia pipe	-	174	23	10	207
JB	4		175	0.30	1200mm pipe	3.12	50	8	10	40	32	4	2.7	5.2	20	5.4	1	1200	1	1650	2.3	1.00	1 x 1650mm dia pipe	-	142	23	8	173
JB	5		150	0.30	1350mm pipe	2.74	50	8	10	40	31	4	2.2	4.6	25	6.2	1	1200	1	1800	2.5	1.00	1 x 1200mm dia pipe	-	79	15	5	99
JB	6	JA	200	0.40	1800mm pipe	1.91	50	7	10	40	27	3	1.8	4.9	25	6.6			1	1800	2.4	1.00		-				
JA	7		140	0.40	1800mm pipe	3.72	50	9	10	40	34	4	1.0	3.2	25	19.9	2	1500	3	1650	5.8	1.00	2 x 1500mm dia pipe	-	198	42	12	252
JA	8		100	0.40	1800mm pipe	2.66	50	8	10	40	30	4	0.4	3.6	25	20.4	2	1500	3	1650	5.9	1.00	2 x 1500mm dia pipe	-	142	42	9	193
					total area	79.8	ha			2(b) area	5.6	ha	2(b) cost	$230											$2,734	$386	$156	$3,276
KA	1		365	0.30	1200mm pipe	16.77	60	15	20	20	61	8	4.3	5.3	25	5.1	1	1200	1	1650	2.2	1.00	1 x 1200mm dia pipe	-	192	15	10	218
KA	2		250	0.30	1350mm pipe	9.65	45	12	10	45	49	6	3.2	4.3	25	7.4	1	1500	2	1500	2.9	1.00	1 x 1500mm dia pipe	-	177	21	10	208
KA	3		175	0.40	no existing	10.34	50	13	10	40	51	6	2.5	4.3	25	10.0	2	1500	2	1500	3.3	1.00	2 x 1500mm dia pipe	-	248	42	14	304
KB	1		270	0.25	no existing	9.19	50	12	20	30	12	6	3.0	4.1	60	3.4	1	1500	1	1500	1.7	1.00	1 x 1500mm dia pipe	-	191	18	10	220
KB	2	KA	120	0.50	600mm pipe	13.89	50	14	20	30	14	7	2.4	4.9	60	8.1	1	1800	1	1800	2.5	1.00	1 x 1800mm dia pipe	-	110	21	7	138
KA	4		150	0.50	600mm pipe	2.53	50	7	10	40	30	4	1.8	3.5	25	18.1	2	1800	2	1800	4.8	1.00	2 x 1800mm dia pipe	-	275	52	16	344
KA	5		200	0.50	no existing	7.00	50	11	10	40	44	5	1.0	2.7	25	19.7	3	1650	3	1650	5.2	1.00	3 x 1650mm dia pipe	-	485	52	27	564
					total area	69.4	ha			2(b) area	26.1	ha	2(b) cost	$751											$1,679	$221	$95	$1,995
LA	1		285	0.40	1350mm pipe	14.47	5	14	25	70	14	7	3.1	4.1	90	3.6			1	1350	1.5	1.00		-				
LA	2		300	0.40	1500mm pipe	8.15	5	12	25	70	12	6	2.0	3.9	90	5.6	1	750	1	1650	2.1	1.00	1 x 750mm dia pipe	-	87		4	91
LA	3		110	0.50	1500mm pipe	4.02	60	9	20	20	35	4	0.8	3.5	90	6.3	1	750	1	1650	2.1	1.00	1 x 750mm dia pipe	-	32		2	33
LB	1		140	0.60	750mm pipe	6.89	60	11	20	20	43	5	2.5	3.5	20	2.5	1	1050	1	1200	1.2	0.82	1 x 1200mm dia pipe	-	74	15	4	93
LB	2		140	0.60	900mm pipe	6.31	60	11	20	20	42	5	1.7	3.3	20	4.7	1	1050	1	1350	1.6	1.00	1 x 1350mm dia pipe	-	86	21	5	112
LB	3	LA	105	0.60	1050mm pipe	5.97	60	10	20	20	41	5	0.8	2.7	20	6.8	1	1350	1	1650	2.1	1.00	1 x 1650mm dia pipe	-	85	23	5	113
LA	4		35	0.60	2x1200 + 1050m	0.92	60	6	20	20	20	3	0.2	2.0	90	11.1			2	1500	3.0	1.00		-				
					total area	46.7	ha			2(b) area	24.0	ha	2(b) cost	$227											$363	$59	$21	$443
MA	1		330	0.20	no existing	8.73	60	12	20	20	48	6	4.3	5.3	20	3.0	1	1500	1	1500	1.7	1.00	1 x 1500mm dia pipe	-	234	21	13	267
MA	2		220	0.20	no existing	8.04	60	12	20	20	46	6	3.6	5.7	20	5.6	1	1800	1	1800	2.7	1.00	1 x 1800mm dia pipe	-	202	42	12	256
MA	3		320	0.40	no existing	12.52	60	14	20	20	54	7	3.2	5.4	25	9.5	2	1500	2	1500	3.1	1.00	2 x 1500mm dia pipe	-	453	42	25	520
MB	1		275	0.35	no existing	11.14	60	13	20	20	52	7	4.9	5.9	20	3.6	1	1350	1	1350	1.6	1.00	1 x 1350mm dia pipe	-	168	21	9	199
MB	2	MA	395	0.50	no existing	4.47	60	9	20	20	37	5	3.9	5.5	25	5.2	1	1500	1	1500	1.8	1.00	1 x 1500mm dia pipe	-	280	21	15	316
MA	4		150	0.50	900mm pipe	5.51	50	10	15	35	40	5	1.9	4.9	25	16.0	2	1800	2	1800	4.4	1.00	2 x 1800mm dia pipe	-	275	52	16	344
MC	1	MA	400	0.75	525mm pipe	5.85	60	10	20	20	41	5	4.2	5.2	20	2.2	1	1050	1	1050	1.2	0.68	1 x 1050mm dia pipe	-	177	13	10	200
MA	5		95	0.70	1050mm pipe	7.12	60	11	20	20	44	5	1.2	4.5	25	20.3	2	1800	2	1800	4.6	1.00	2 x 1800mm dia pipe	-	174	52	11	238
MD	1	MA	350	0.95	no existing	10.55	50	13	20	30	51	6	3.8	4.9	20	2.9	1	1050	1	1050	1.2	0.77	1 x 1050mm dia pipe	-	155	15	9	179
MA	6		50	1.00	no existing	5.51	50	10	10	40	40	5	0.5	3.3	25	24.6	2	1800	2	1800	4.7	1.00	2 x 1800mm dia pipe	-	92	52	7	151
					total area	79.4	ha			2(b) area	79.4	ha	2(b) cost	$2,669											$2,211	$331	$127	$2,669

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	30
Network			**Reach Details**			**Catchment Area Parameters**							**Levels**		**Hydrology 1 in 100 AEP**		**Proposed Upgrade Options**						**Proposed Upgrade Works**		**Cost Breakdown**			**Total Cost**
branch & reach		add hyd to	L (m)	S (%)	existing conduit size (mm)	area (ha)	paved direct (%)	paved time (min)	paved sup. (%)	grass (%)	grass time (min)	grass lag (min)	invert level mAHD	ground level mAHD	critical duration (min)	flowrate (m3/s)	Extra Pipes no.	Extra Pipes dia. (mm)	New Pipes no.	New Pipes dia. (mm)	Open Channel w (m)	Open Channel d (m)	Description	Easement Width (m)	Trunk Drainage ($1000)	Proposed Culverts ($1000)	Services Relocation ($1000)	($1000)
NA	1		355	0.30	no existing	6.31	60	11	20	20	42	5	4.1	5.0	20	2.3	1	1200	1	1200	1.2	1.00	1 x 1200mm dia pipe	-	187	18	10	215
NA	2		265	0.40	525mm pipe	5.74	60	10	20	20	41	5	3.0	3.9	20	4.2	1	1500	1	1500	1.7	1.00	1 x 1500mm dia pipe	-	188	21	10	219
NB	1		305	0.40	no existing	3.79	60	9	20	20	35	4	3.6	4.5	20	1.5	1	1050	1	1050	1.2	0.65	1 x 1050mm dia pipe	-	135	13	7	156
NB	2	NA	130	0.30	no existing	3.22	60	8	20	20	33	4	2.3	3.2	25	2.7	1	1350	1	1350	1.4	1.00	1 x 1350mm dia pipe	-	80	18	5	102
NA	3		210	0.50	no existing	3.56	60	8	20	20	34	4	2.0	3.0	25	8.1	1	1800	1	1800	2.5	1.00	2.5m wide channel	5.5	186	42	11	239
NC	1	NA	700	0.45	no existing	7.23	60	11	20	20	44	6	4.1	5.1	20	2.6	1	1200	1	1200	1.2	0.95	1 x 1200mm dia pipe	-	369	15	19	403
NA	4		115	0.50	no existing	5.16	60	10	20	20	39	5	0.9	3.5	25	12.3	2	1500	2	1500	3.5	1.00	3.5m wide channel	22.6	116	57	9	182
ND	1		345	0.50	no existing	5.39	60	10	20	20	40	5	4.5	5.5	20	2.0	1	1050	1	1050	1.2	0.74	1 x 1050mm dia pipe	-	153	13	8	174
ND	2		110	0.50	no existing	3.33	60	6	20	20			2.8	5.0	25	3.4	1	1350	1	1350	1.3	1.00	1 x 1350mm dia pipe	-	67	18	4	90
NE	1	ND	345	0.70	no existing	3.22	60	8	20	20	33	4	4.6	5.5	20	1.3	1	825	1	825	1.2	0.47	1 x 825mm dia pipe	-	112	9	6	128
ND	3		115	0.50	750mm pipe	5.16	60	10	20	20	39	5	2.2	5.0	25	6.5	1	1500	1	1650	2.1	1.00	1 x 1650mm dia pipe	-	93	23	6	122
NF	1	ND	350	0.50	no existing	4.25	60	9	20	20	36	5	3.4	5.5	20	1.6	1	1050	1	1050	1.2	0.63	1 x 1050mm dia pipe	-	155	13	8	176
ND	4	NA	265	0.50	no existing	6.08	60	10	20	20	41	5	1.7	4.1	25	10.3	2	1500	2	1500	3.1	1.00	3.1m wide channel	20.4	252	50	15	317
NA	5		55	0.60	2 x 1350mm pipes	3.79	60	9	20	20	35	4	0.3	1.4	25	23.7	2	1500	3	1650	5.6	1.00	5.6m wide channel	8.6	70	86	8	164
					total area	66.2	ha			2(b) area	66.2	ha	2(b) cost	$2,688												$2,164	$396	$128	$2,688
OA	1		590	0.15	no existing	12.40	50	14	20	30	54	7	4.4	5.4	20	3.3	1	1650	1	1650	2.0	1.00	2.0m wide channel	5.0	484	31	26	541
OA	2		420	0.20	no existing	27.45	55	18	20	25	73	9	3.5	5.6	25	10.1	2	1800	2	1800	4.4	1.00	4.4m wide channel	17.5	469	65	27	561
OA	3		390	0.20	no existing	19.87	60	16	20	20	65	8	2.7	6.2	25	15.5	3	1650	3	1650	6.3	1.00	6.3m wide channel	36.7	530	97	31	658
OA	4		210	0.25	no existing	13.78	50	14	20	30	57	7	1.9	4.8	25	18.5	3	1650	3	1650	6.6	1.00	6.6m wide channel	29.6	295	102	20	417
OB	1		240	0.20	no existing	5.28	50	10	15	35	39	5	4.0	5.0	20	1.7	1	1200	1	1200	1.2	0.93	1 x 1200mm dia pipe	-	126	15	7	149
OB	2		140	0.65	no existing	4.02	55	9	20	25	35	4	3.5	5.5	25	3.0	1	1200	1	1200	1.2	0.91	1 x 1200mm dia pipe	-	74	15	4	93
OC	1	OB	320	0.40	no existing	2.64	50	8	15	35	30	4	3.9	5.0	20	0.9	1	825	1	825	1.2	0.45	1 x 825mm dia pipe	-	104	9	6	119
OB	3	OA	155	0.80	no existing	3.68	55	9	20	25	34	4	2.6	5.0	20	5.0	1	1350	1	1350	1.5	1.00	1 x 1350mm dia pipe	-	95	18	6	119
OA	5		170	0.80	no existing	8.50	55	12	20	25	47	6	1.4	5.5	60	24.8	3	1650	3	1650	5.2	1.00	5.2m wide channel	42.9	208	79	14	301
					total area	97.6	ha			2(b) area	90.5	ha	2(b) cost	$2,741												$2,385	$431	$141	$2,957
PA	1		180	0.20	no existing	6.20	50	10	10	40	42	5	4.4	5.4	20	1.9	1	1200	1	1200	1.2	1.00	1.2m wide channel	4.2	129	20	7	157
PA	2		220	0.20	no existing	9.42	50	12	10	40	49	6	4.1	5.8	20	4.5	1	1650	1	1650	2.3	1.00	2.3m wide channel	10.9	188	37	11	236
PA	3		425	0.20	no existing	11.72	50	13	10	40	53	7	3.6	5.8	20	7.5	2	1500	2	1500	3.4	1.00	3.4m wide channel	17.3	424	56	24	504
PA	4		260	0.65	no existing	24.35	50	18	10	40	70	9	2.8	6.0	20	12.8	2	1500	2	1500	3.3	1.00	3.3m wide channel	29.8	255	55	15	325
PA	5		110	1.00	no existing	11.03	50	13	10	40	52	6	1.1	6.0	25	15.5	2	1500	2	1500	3.2	1.00	3.2m wide channel	50.0	107	53	8	168
					total area	62.7	ha			2(b) area	22.2	ha	2(b) cost	$492												$1,103	$221	$66	$1,391
OA	1		140	0.50	750mm pipe	5.24	50	10	10	40	39	5	1.3	2.3	20	1.6	1	750	1	1050	1.2	0.63	1 x 750mm dia pipe	-	40	6	2	49
OA	2		100	0.60	900mm pipe	2.69	50	8	10	40	30	4	0.6	1.9	20	2.4	1	600	1	1050	1.2	0.79	1 x 600mm dia pipe	-	23	6	1	30
					total area	7.9	ha			2(b) area	0.0	ha	2(b) cost	$0												$63	$12	$4	$79
TOTAL SUMMARY,					total area	1029	ha			2(b) area	413	ha	2(b) cost	$12,484												$24,038	$4,281	$1,416	$29,735

APPENDIX C

APPENDIX C

RECOMMENDED SHORT/MEDIUM TERM UPGRADING OF EXISTING DRAINAGE SYSTEM FOR EXISTING LEVEL OF DEVELOPMENT

RECOMMENDED UPGRADING SHORT TO MEDIUM TERM EXISTING CATCHMENTS

Network			Reach Details			Hydrology Peak Flow		Proposed Upgrade Options		Proposed Culverts	Cost Breakdown			Total Cost
branch & reach		add hyd to	L (m)	S (%)	existing conduit size (mm)	1 in 10 AEP (m3/s)	1 in 100 AEP (m3/s)	1 in 10 AEP	1 in 100 AEP	Size (mm)	Trunk Drainage ($1000)	Proposed Culverts ($1000)	Services Relocation ($1000)	($1000)
AA	1		335	0.20	675	1.4	2.1	1 x 825mm dia pipe		825	109	9	6	124
AB	1	AA	230	0.50	600	0.4	0.7							
AA	2		290	0.20	2 x 750	2.9	4.5	1 x 1200mm dia pipe		1200	153	15	8	176
AA	3		185	0.20	2 x 900	3.5	5.7		1 x 1350mm dia pipe	1350	113	18	7	138
AC	1	AA	190	0.50	750	0.6	0.9							
AA	4		130	0.20	2 x 900	4.4	7.3		3.3m wide channel	3300 BC	129	50	9	187
AA	5		220	0.20	2 x 900	4.7	7.7		3.5m wide channel	3500 BC	222	55	14	290
AD	1		585	0.20	600	1.5	2.3	1 x 1050mm dia pipe		1050	259	13	14	286
AE	1	AD	130	0.20	600	1.0	1.5		1 x 1050mm dia pipe	1050	58	13	4	74
AD	2		255	0.20	1050	2.8	4.5		1 x 1350mm dia pipe	1350	156	18	9	183
AF	1	AD	90	1.00	1050	0.5	0.8							
AD	3		355	0.20	1200	3.1	5.2		1 x 1350mm dia pipe	1350	217	18	12	247
AG	1	AD	190	0.20	oc	1.5	2.3			3900 BC		64	1	65
AD	4	AA	205	0.20	oc	4.6	7.7							
AA	6		490	0.10	oc	9.7	16.1							
AH	1	AA	310	3.80	900	0.9	1.4							
AJ	1		60	0.20	750	0.2	0.5							
AJ	1	AI	40	0.30	750	0.4	0.6							
AK	1	AI	50	0.40	825	0.6	0.9							
AL	1		180	0.15	975	0.7	1.0							
AL	2		120	0.15	1275	1.1	1.8							
AL	3		110	0.15	1500	1.8	2.8							
AL	4		100	0.15	1950	2.2	3.5							
AL	5		290	0.15	1800	2.5	4.1							
AL	6	AI	50	0.15	1800	2.8	4.6							
AI	2		40	0.50	2 x 1350	0.4	1.3							
AM	1	AI	60	0.50	600	0.4	0.6							
AN	1	AI	130	0.27	825	0.6	1.0							
AI	3		10	0.50	3 x 1350	0.9	2.0							
AI	4		20	0.50	3 x 1350	0.8	2.0							
AI	5		20	0.50	3 x 1350	0.5	1.7							
AI	6		10	0.50	3 x 1350	0.5	1.5							
AI	7		10	0.50	3 x 1350	0.5	1.5							
AI	8		30	0.30	2x1050 + 825	0.5	1.5							
AO	1	AI	30	1.09	900	0.2	0.5							
AI	9	AA	80	0.30	2x1050 + 825	0.5	1.5	1 x 1050mm dia pipe		1050	35	13	3	51
AA	7		250	0.10	oc	10.6	18.2			13800 BC		200	7	207
AP	1		120	5.00	900	1.9	3.0		1 x 600mm dia pipe		27		1	29
AQ	1	AP	200	5.00	750	1.1	1.7		1 x 525mm dia pipe		39		2	41
AP	2		290	1.00	1200	3.6	5.5		1 x 1350mm dia pipe	675	177	6	9	193
AR	1		95	5.00		0.7	1.1		1 x 750mm dia pipe	450	27	6	2	35
AR	2	AP	215	1.80	1200	1.3	2.1							
AP	3		185	1.00	oc	6.0	9.3		3.4m wide channel		183	31	11	225
AP	4	AA	215	0.20	1800	5.9	9.3		2 x 1800mm dia pipe		395	23	21	439
AA	8		230	0.10	oc	15.2	27.0			22000 BC		305	10	315
AS	1	AA	470	1.70	600	0.6	1.0		1 x 675mm dia pipe		121	4	6	131
AA	9		290	0.10	oc	16.0	29.1			23000 BC		317	10	327
AT	1		335	0.50	oc	0.4	0.6							
AT	2	AA	245	0.50	oc	1.3	2.2							
AA	10		175	0.10	oc	17.9	32.8							
AU	1		710	0.40	750	0.4	0.7							
AU	2	AA	220	0.40	1500	1.1	1.8							
AV	1	AA	235	1.00		0.2	0.4	1 x 375mm dia pipe		375	68	4	4	76
AA	11		60	0.10	4 x 1500	18.7	34.7							
CATCHMENT A SUMMARY											$2,489	$1,182	$168	$3,839
BA	1		100	0.40		0.6	1.0	1 x 675mm dia pipe		675	26	7	2	34
BB	1	BA	90	0.40		0.7	1.1		1 x 825mm dia pipe	825	29	9	2	40
BA	2		125	0.40		1.7	2.7		1 x 1200mm dia pipe	1200	66	15	4	85
BA	3		65	0.40		2.1	3.3	1 x 1050mm dia pipe		1050	29	13	2	44
BA	4		60	0.40		2.3	3.7	1 x 1050mm dia pipe		1050	27	13	2	42
BA	5		60	0.40		2.7	4.3	1 x 1200mm dia pipe		1200	32	15	2	49
BA	6		70	0.40		3.1	5.0	1 x 1200mm dia pipe		1200	37	15	3	54
BA	7		140	0.40		3.4	5.5	1 x 1350mm dia pipe		1350	86	18	5	109
BA	8		240	0.10		3.7	6.0	2.6m wide channel		1800	214	26	12	252
BA	9		165	0.40		4.1	6.8	1.5m wide channel		1800	125	26	8	159
CATCHMENT B SUMMARY											$669	$157	$41	$868

RECOMMENDED UPGRADING SHORT TO MEDIUM TERM EXISTING CATCHMENTS

Network			Reach Details			Hydrology Peak Flow		Proposed Upgrade Options		Proposed Culverts	Cost Breakdown			Total Cost
branch & reach	add hyd to		L (m)	S (%)	existing conduit size (mm)	1 in 10 AEP (m3/s)	1 in 100 AEP (m3/s)	1 in 10 AEP	1 in 100 AEP	Size (mm)	Trunk Drainage ($1000)	Proposed Culverts ($1000)	Services Relocation ($1000)	($1000)
CA	1		165	0.50	750	0.4	0.6							
CA	2		225	0.50	900	0.8	1.3							
CA	3		75	0.50	1050	1.5	2.5							
CATCHMENT C SUMMARY														
DA	1		70	0.20	675	0.5	0.8	1 x 375mm dia pipe		375	10	4	1	15
DA	2		65	0.20	675	0.7	1.1	1 x 525mm dia pipe		525	13	6	1	20
CATCHMENT D SUMMARY											$23	$10	$2	$34
EA	1		60	0.50	750	0.3	0.5							
CATCHMENT E SUMMARY														
FA	1		70	0.10	1050	0.5	0.8							
FB	1	FA	80	0.1		0.2	0.3	1 x 600mm dia pipe		600	18	6	1	25
FA	2		145	0.1	1050	0.9	1.4							
FA	3		10	0.10	1050	1.2	1.8	1 x 600mm dia pipe		600	2	6	0	9
CATCHMENT F SUMMARY											$20	$12	$2	$34
GA	1		50	0.50	525	0.1	0.3							
GA	2		20	0.50	525	0.2	0.4							
CATCHMENT G SUMMARY														
HA	1		40	1.00		0.2	0.4	1 x 375mm dia pipe		375		4	0	4
CATCHMENT H SUMMARY												$4	$0	$4
IA	1		90	0.10	600	0.7	1.1		1 x 1050mm dia pipe	1050	40	13	3	56
IB	1	IA	155	1.00	450	0.7	1.1	1 x 450mm dia pipe		450	26	5	2	32
IA	2		285	0.10	900	1.9	2.9		1 x 1500mm dia pipe	1500	202	21	11	234
IA	3		185	0.10		2.7	4.3		2 x 1500mm dia pipe	2x1500	262	42	15	319
IA	4		90	0.10		3.0	4.9		2 x 1500mm dia pipe	2x1500	127	42	8	178
IC	1	IA	170	0.80	450	0.4	0.6	1 x 375mm dia pipe		375	24	4	1	30
IA	5		165	0.10	oc	3.6	5.9	2.5m wide channel		675	146	7	8	161
IA	6		160	0.10	oc	4.1	6.9	2.8m wide channel			147		7	154
IA	7		100	0.10	oc	4.1	7.1	2.8m wide channel			92		5	96
ID	1	IA	260	0.25		0.1	0.2	1 x 375mm dia pipe		375	67	4	4	74
IE	1	IA	105	0.75		0.1	0.2	1 x 375mm dia pipe		375	27	4	2	33
IA	8		115	0.10	oc	4.3	7.6	2.9m wide channel			107		5	112
IA	9		20	0.10	2x1000x1800	4.3	7.8		1 x 1200mm dia pipe	1200	11	15	1	27
CATCHMENT I SUMMARY											$1,277	$157	$72	$1,506
JA	1		140	0.30		0.2	0.4	1 x 525mm dia pipe		525	27	6	2	35
JA	2		20	0.30		0.5	0.8	1 x 675mm dia pipe		675	5	7	1	13
CATCHMENT J SUMMARY											$33	$13	$2	$48
KA	1		80	0.15		0.1	0.1	1 x 375mm dia pipe		375		4	0	4
CATCHMENT K SUMMARY												$4	$0	$4
LA	1		70	0.20		0.1	0.3	1 x 450mm dia pipe		450	12	5	1	18
CATCHMENT L SUMMARY											$12	$5	$1	$18
MA	1		70	0.20		0.3	0.5	1 x 600mm dia pipe		600	16	6	1	23
MA	2		120	0.20		0.4	0.7	1 x 675mm dia pipe		675	31	7	2	40
MB	1		115	0.10	375	0.1	0.1					4	0	4
MA	3		80	0.10	450	0.5	0.9	1 x 750mm dia pipe		750	23	9	2	34
CATCHMENT M SUMMARY											$70	$26	$5	$101

RECOMMENDED UPGRADING SHORT TO MEDIUM TERM EXISTING CATCHMENTS

Network			Reach Details			Hydrology Peak Flow		Proposed Upgrade Options		Proposed Culverts	Cost Breakdown			Total Cost
branch & reach		add byd to	L (m)	S (%)	existing conduit size (mm)	1 in 10 AEP (m3/s)	1 in 100 AEP (m3/s)	1 in 10 AEP (m3/s)	1 in 100 AEP (m3/s)	Size (mm)	Trunk Drainage ($1000)	Proposed Culverts ($1000)	Services Relocation ($1000)	($1000)
NA	1		110	0.30		0.1	0.3	1 x 375mm dia pipe		375		4	0	4
NA	2		88	0.30		0.2	0.5	1 x 450mm dia pipe		450	15	5	1	21
NA	3		58	0.30		0.2	0.6	1 x 525mm dia pipe		525	11	6	1	18
NB	1		57	0.15		0.1	0.3	1 x 450mm dia pipe		450	10	5	1	15
NB	2		68	0.15		0.2	0.5	1 x 525mm dia pipe		525	13	6	1	20
NC	1	NB	36	0.15		0.2	0.1	1 x 525mm dia pipe		525	7	6	1	14
NB	3	NA	53	0.15		0.5	0.7	1 x 750mm dia pipe		750	15	8	1	24
NA	4		46	0.10		0.8	1.4	1 x 1050mm dia pipe		1050	20	13	2	35
ND	1		77	0.80		0.1	0.2	1 x 375mm dia pipe		375	34	4	2	40
ND	2	NA	38	0.80		0.3	0.6	1 x 450mm dia pipe		450	6	5	1	12
NA	5		131	0.10		1.2	2.1	1 x 1200mm dia pipe		1200	69	15	4	88
NE	1	NA	114	0.15	375	0.1	0.2					4	0	4
NA	6		104	0.10		1.4	2.4	1 x 1200mm dia pipe		1200	55	15	3	73
CATCHMENT N SUMMARY											$256	$96	$18	$370
OA	1		120	0.80	750	0.3	0.6							
OA	2		155	0.80	750	0.4	0.7							
OB	1	OA	150	0.10	375	0.1	0.2	1 x 375mm dia pipe		375	21	4	1	27
OA	3		80	0.20		0.7	1.3	1 x 825mm dia pipe		825	26	9	2	37
CATCHMENT O SUMMARY											$48	$13	$3	$64
PA	1		100	0.50		1.4	2.1		1 x 1050mm dia pipe	1050	44	13	3	60
CATCHMENT P SUMMARY											$44	$13	$3	$60
QA	1		195	0.70		0.3	0.5	1 x 450mm dia pipe		450	33	5	2	39
QB	1	QA	95	0.40	675	0.2	0.4							
QA	2		130	0.40	675	0.6	1.1							
QA	3		175	0.40	750	1.0	2.1		1 x 1050mm dia pipe	1050	78	13	5	95
QA	4		190	0.40	900	1.2	2.7		1 x 825mm dia pipe	825	62	9	4	74
QC	1		135	0.35	750	0.7	1.1							
QC	2	QA	195	0.35	750	1.0	1.6		1 x 750mm dia pipe	750	56	8	3	68
QA	5		115	0.10	2 x 900	2.3	4.4		1 x 1500mm dia pipe	1500	81	21	5	108
QD	1		185	0.50	900	0.5	0.8							
QD	2	QA	305	0.70	1050	0.7	1.1							
QE	1		255	0.50	600	0.7	1.2	1 x 375mm dia pipe		375	36	4	2	42
QF	1	QE	90	1.00	525	0.3	0.5							
QE	2	QA	310	0.50		1.9	3.0	1 x 1050mm dia pipe		1050	137	13	8	158
QA	6		405	0.10	open channel	5.2	9.3	3.4m wide channel			401		20	421
QA	7		120	0.10	1050 + 1200	5.8	10.2		2 x 1800mm dia pipe	2x1800	220	52	14	286
CATCHMENT Q SUMMARY											$1 105	$125	$62	$1 292
RA	1		135	0.30	750	0.8	1.3		1 x 750mm dia pipe	750	39	8	2	49
RA	2		80	0.50	900	1.0	1.6		1 x 600mm dia pipe	600	18	6	1	25
CATCHMENT R SUMMARY											$57	$14	$4	$75
SA	1		285	0.25		0.6	0.9	1 x 750mm dia pipe		750	82	8	5	95
SA	2		345	0.25		1.8	2.9	1 x 1200mm dia pipe		1200	182	15	10	207
SA	3		325	0.25		3.3	5.2		1 x 1650mm dia pipe	1650	263	23	14	300
SA	4		200	0.25	900	4.1	6.6		1 x 1800mm dia pipe	1800	184	26	10	220
SB	1		250	0.50		0.3	0.5		1 x 600mm dia pipe	600	57	6	3	66
SB	2	SA	100	0.50		0.5	0.9		1 x 750mm dia pipe	750	29	8	2	39
SA	5		195	0.25	1200	5.0	8.0		1 x 1800mm dia pipe	1800	179	26	10	215
SA	6		160	0.25	1350	5.1	8.3		1 x 1650mm dia pipe	1650	129	23	8	160
SC	1		175	0.20		0.4	0.7	1 x 675mm dia pipe		675	45	7	3	55
SC	2		235	0.20		1.2	1.9	1 x 1050mm dia pipe		1050	104	13	6	123
SC	3		240	0.20		2.1	3.3	1 x 1350mm dia pipe		1350	147	18	8	173
SC	4		90	0.20		3.0	4.9	1 x 1500mm dia pipe		1500	64	21	4	89
SC	5		280	0.20	1200	3.7	6.0	1 x 1200mm dia pipe		1200	148	15	8	171
SC	6		110	0.20	1350	4.6	7.4	1 x 1200mm dia pipe		1200	58	15	4	77
SC	7	SA	135	0.20	1500	4.7	7.6		1 x 1500mm dia pipe	1500	96	21	6	122
SA	7		85	0.25	1800	10.0	16.2		2 x 1500mm dia pipe	2x1500	120	42	8	170
SA	8		130	0.25	1800	10.1	16.4	1 x 1650mm dia pipe		1800	105	23	6	135
SD	1	SA	220	0.70	675	0.5	0.8			600				
SA	9		220	0.25	1800	10.7	17.6	1 x 1650mm dia pipe		1800	178	23	10	211
SA	10		60	0.25	1800	10.9	18.1		2 x 1500mm dia pipe	2x1500	85	42	6	133
CATCHMENT S SUMMARY											$2 254	$375	$131	$2 761

RECOMMENDED UPGRADING SHORT TO MEDIUM TERM EXISTING CATCHMENTS

Network		Reach Details			Hydrology Peak Flow		Proposed Upgrade Options		Proposed Culverts	Cost Breakdown			Total Cost
branch & reach	add hyd to	L (m)	S (%)	existing conduit size (mm)	1 in 10 AEP (m3/s)	1 in 100 AEP (m3/s)	1 in 10 AEP (m3/s)	1 in 100 AEP (m3/s)	Size (mm)	Trunk Drainage ($1000)	Proposed Culverts ($1000)	Services Relocation ($1000)	($1000)
TA 1		285	0.30	600	1.5	2.3	1 x 900mm dia pipe		900	105	10	6	120
TA 2		170	0.30	600	2.1	3.2	1 x 1050mm dia pipe		1050	75	13	4	93
TB 1	TA	50	2.00	600	0.3	0.5							
TA 3		120	0.30		2.9	4.7		1 x 1650mm dia pipe	1650	97	23	6	126
TA 4		30	0.30		3.0	4.9		1 x 1650mm dia pipe	1650	24	23	2	50
CATCHMENT T SUMMARY										$301	$69	$19	$389
UA 1		65	0.50	450 + 600	0.5	0.7							
CATCHMENT U SUMMARY													
VA 1		75	1.00	525	0.2	0.4							
CATCHMENT V SUMMARY													
WA 1		25	5.00	375	0.1	0.2							
CATCHMENT W SUMMARY													
XA 1		50	5.00	2 x 525	1.7	2.6							
CATCHMENT X SUMMARY													
YA 1		70	5.00		0.8	1.2	1 x 450mm dia pipe		450	12	5	1	18
CATCHMENT Y SUMMARY										$12	$5	$1	$18
AAA 1		200	0.25	525	0.2	0.4							
AAA 2		280	0.25	675	0.9	1.4	1 x 600mm dia pipe		600	64	6	3	73
AAA 3		110	0.25	1050	1.3	2.2							
AAA 4		145	0.25	1200	1.6	2.7							
AAA 5		205	0.25	1350	2.0	3.2							
AAA 6		150	0.25	1350	2.1	3.9							
AAB 1	AAA	190	1.00	600	0.2	0.3							
AAA 7		320	0.25	1350	2.4	4.7							
AAA 8		280	0.25	1500	2.4	5.1							
AAA 9		50	0.25	1500	2.7	5.8							
AAC 1		110	0.50	675	0.3	0.6							
AAD 1	AAC	130	0.50	750	0.8	1.3							
AAC 2		140	0.50	900	1.4	2.2							
AAC 3	AAA	100	0.50	1050	1.6	2.8							
AAA 10		70	0.25	2x1200+1050	3.8	8.0							
CATCHMENT AA SUMMARY										$64	$6	$3	$73
ABA 1		70	1.00	750	0.2	0.4							
CATCHMENT AB SUMMARY													
ACA 1		100	0.50		0.6	0.9	1 x 675mm dia pipe		675	26	7	2	34
CATCHMENT AC SUMMARY										$26	$7	$2	$34
ADA 1		70	0.50	525	0.2	0.4							
CATCHMENT AD SUMMARY													
AEA 1		75	0.30		0.3	0.5	1 x 600mm dia pipe		600	17	6	1	24
CATCHMENT AE SUMMARY										$17	$6	$1	$24
AFA 1		60	0.50		0.2	0.3	1 x 450mm dia pipe		450	10	5	1	16
CATCHMENT AF SUMMARY										$10	$5	$1	$16
AGA 1		60	0.50		0.2	0.4	1 x 450mm dia pipe		450	10	5	1	16
CATCHMENT AG SUMMARY										$10	$5	$1	$16
AHA 1		80	0.30		0.1	0.2	1 x 375mm dia pipe		375		4	0	4
CATCHMENT AH SUMMARY											$4	$0	$4
AIA 1		70	0.30		0.9	1.4	1 x 825mm dia pipe		825	23	9	2	33
CATCHMENT AI SUMMARY										$23	$9	$2	$33

RECOMMENDED UPGRADING SHORT TO MEDIUM TERM EXISTING CATCHMENTS

Network		Reach Details			Hydrology Peak Flow		Proposed Upgrade Options		Proposed Culverts	Cost Breakdown			Total Cost
branch & reach	add byd to	L (m)	S (%)	existing conduit size (mm)	1 in 10 AEP (m3/s)	1 in 100 AEP (m3/s)	1 in 10 AEP (m3/s)	1 in 100 AEP (m3/s)	Size (mm)	Trunk Drainage ($1000)	Proposed Culverts ($1000)	Services Relocation ($1000)	($1000)
AJA 1		65	0.50		0.8	1.2	1 x 750mm dia pipe		750	19	8	1	28
CATCHMENT AJ SUMMARY										$19	$8	$1	$28
AKA 1		35	5.00		0.1	0.1	1 x 375mm dia pipe		375		4	0	4
CATCHMENT AK SUMMARY											$4	$0	$4
ALA 1		100	2.50		0.7	1.2	1 x 525mm dia pipe		525	20	6	1	27
CATCHMENT AL SUMMARY										$20	$6	$1	$27
AM 1		90	3.00		0.6	1.0	1 x 450mm dia pipe		450	15	5	1	21
CATCHMENT AM SUMMARY										$15	$5	$1	$21
ANA 1		430	0.50	375	0.4	0.6	1 x 375mm dia pipe		375	61	4	3	69
ANA 2		185	0.50	900	1.1	1.7							
ANB 1	ANA	270	0.50	525	0.6	2.2	1 x 450mm dia pipe		450	45	5	3	53
ANA 3		70	1.00	1050	2.3	5.9		1 x 900mm dia pipe	900	26	10	2	37
ANC 1	ANA	225	0.50	750	0.8	2.1							
ANA 4		85	1.00	1350	3.6	10.1		1 x 1050mm dia pipe	1050	38	13	3	53
CATCHMENT AN SUMMARY										$170	$32	$10	$212
AOA 1		80	0.20		0.7	1.1	1 x 825mm dia pipe		825	26	9	2	37
CATCHMENT AO SUMMARY										$26	$9	$2	$37
APA 1		215	0.35	600	0.6	0.9		1 x 600mm dia pipe	600	49	6	3	58
APA 2		225	0.35	750	1.2	1.9		1 x 750mm dia pipe	750	65	8	4	77
APB 1	APA	270	0.20	1050	1.0	1.6		1 x 600mm dia pipe	600	61	6	3	71
APA 3		360	0.35	1350	3.2	5.1		1 x 1050mm dia pipe	1050	159	13	9	181
APC 1	APA	210	1.00	750	0.7	1.1							
APA 4		265	0.35	1350	5.0	8.0		1 x 1500mm dia pipe	1500	188	13	10	211
APA 5		85	0.20	2 x 1350	5.6	8.9		1 x 1500mm dia pipe	1500	60	21	4	85
CATCHMENT AP SUMMARY										$582	$67	$32	$682
AQA 1		110	0.50		0.4	0.7	1 x 525mm dia pipe		525	22	6	1	29
AQA 2		125	0.50		1.0	1.5	1 x 825mm dia pipe		825	41	9	2	52
AQB 1	AQA	305	0.50	525	0.4	0.6							
AQA 3		110	0.50	375	1.8	2.9	1 x 1050mm dia pipe		1050	49	13	3	65
AQA 4		30	0.50		2.1	3.3		1 x 1350mm dia pipe	1350	18	18	2	38
CATCHMENT AQ SUMMARY										$129	$46	$9	$184
ARA 1		170	1.50	375	0.2	0.3							
ARA 2		60	2.00	450	0.4	0.7							
CATCHMENT AR SUMMARY													
ASA 1		30	5.00		0.1	0.2	1 x 375mm dia pipe		375		4	0	4
CATCHMENT AS SUMMARY											$4	$0	$4
ATA 1		30	5.00		0.2	0.4	1 x 375mm dia pipe		375		4	0	4
CATCHMENT AT SUMMARY											$4	$0	$4
AUA 1		590	0.30		0.8	1.3	1 x 825mm dia pipe		825	192	9	10	211
AUA 2		200	0.30	600	2.1	3.4	1 x 1050mm dia pipe		1050	89	13	5	107
AUB 1		225	0.90		0.7	1.1	1 x 600mm dia pipe		600	51	6	3	60
AUB 2	AUA	110	0.90		1.6	2.5	1 x 825mm dia pipe		825	36	9	2	47
AUA 3		175	0.30		4.0	6.3	1 x 1500mm dia pipe		1500	124	21	7	152
AUC 1	AUA	260	1.50	525	0.3	0.5							
AU 1	AUA	125	2.50	525	0.4	0.7							
AUA 4		290	0.30	1050	5.5	8.6	1 x 1350mm dia pipe		1350	177	18	10	205
AUE 1		150	1.20	1050	0.3	0.6							
AUE 2	AUA	145	1.20	1200	0.7	1.1							
AUA 5		60	0.30	1350	6.8	10.9		2 x 1500mm dia pipe	2x1500	85	42	6	133
CATCHMENT AU SUMMARY										$754	$118	$44	$916

RECOMMENDED UPGRADING SHORT TO MEDIUM TERM EXISTING CATCHMENTS

Network		*Reach Details*			*Hydrology Peak Flow*		*Proposed Upgrade Options*		*Proposed Culverts*	*Cost Breakdown*			*Total Cost*
branch & reach	add hyd to	L (m)	S (%)	existing conduit size (mm)	1 in 10 AEP (m3/s)	1 in 100 AEP (m3/s)	1 in 10 AEP	1 in 100 AEP	Size (mm)	Trunk Drainage ($1000)	Proposed Culverts ($1000)	Services Relocation ($1000)	($1000)
AVA 1		130	0.50		0.5	0.7	1 x 600mm dia pipe		600	30	6	2	37
AVB 1	AVA	100	0.50		0.1	0.2	1 x 375mm dia pipe		375	14	4	1	19
AVA 2		215	0.50		0.8	1.3	1 x 750mm dia pipe		750	62	8	4	74
AVC 1	AVA	130	0.50		0.4	0.7	1 x 600mm dia pipe		600	30	6	2	37
AVA 3		110	0.50		1.5	2.5		1 x 1200mm dia pipe	1200	58	15	4	77
CATCHMENT AV SUMMARY										$193	$39	$12	$244
AW 1		250	0.50	450	0.3	0.4	1 x 375mm dia pipe		375	36	4	2	42
AW 2		230	0.50	600	0.7	1.2	1 x 375mm dia pipe		375	33	4	2	39
AW 1	AW	160	0.50	750	0.1	0.2							
AW 3		140	0.50	750	1.3	2.2	1 x 525mm dia pipe		525	27	6	2	35
AW 4		225	0.50	900	1.6	2.7	1 x 600mm dia pipe		600	51	6	3	60
CATCHMENT AW SUMMARY										$147	$20	$8	$176
TOTAL CATCHMENT SUMMARY										$10,875	$2,684	$663	$14,222

SUMMARY OF 2(b) AREA 2(b) AREA = 413 ha

2(b) AREA C = 413 / 1137 x 14,222 K = $ 5,166 K

APPENDIX D

APPENDIX D

SECTION 94 DRAINAGE CONTRIBUTION CALCULATIONS

Existing Conditions - see Appendix C

TRUNK DRAINAGE

The 2(b) area drainage cost was proportioned from the total drainage cost by the percentage 2(b) area for the whole Peninsula.

Data: Total Area = 1137 ha
2(b) Area = 413 ha
Total Cost = $14,222,000

2(b) Area Cost = 14,222,000 x (413 / 1137)
= $5,166,000

Future Conditions - see Appendix B

The 2(b) area drainage cost in this case was calculated within the spreadsheet (see Appendix B). The cost was calculated separately for each catchment area, A to Q. Each of these were then totalled to give an overall estimate of 2(b) area cost.

2(b) Area Cost = $12,484,000

Section 94 Contributions

The costs of drainage works in only the 2(b) areas were calculated for each of the two schemes above. The estimate of Section 94 Contributions is equal to the difference in cost of the two schemes, proportioned over the total area zoned 2(b).

[2(b) Cost difference / 2(b) Area] = (12,484,000 - 5,166,000) / 413 = $17,720 / ha

MINOR DRAINAGE

Typical 3 hectare residential area was selected and the 1 in 10 AEP drainage works estimated and costed for zoning 2(a) and 2(b). The results are shown below:

Residential 2(a)

Pipe Size	Length	Amount	
375	60	8 580	
450	95	15 865	
600	110	24 970	
		$49 415	
Equivalent to		$16 471	per hectare
Services Adjustment (say 3%)		494	
		$16 965	
	Say	$17 000	per hectare

Residential 2(b)

Pipe Size	Length	Amount	
450	90	15 030	
525	60	11 760	
675	95	24 415	
825	110	35 860	
		$87 065	
Equivalent to		$29 021	per hectare
Services Adjustment (say 3%)		870	
		$29 891	
	Say	$30 000	per hectare

Section 94 contribution is thus ($30 000 minus $17 000) $13 000 per hectare.

APPENDIX E

APPENDIX E

OPEN CHANNEL SURVEY CATCHMENT A

CROSS SECTION 1

CHAINAGE	R.L.	REMARKS
00.0	1.18	
10.0	1.33	TB
12.2	-0.22	EC
16.5	-0.30	IN
20.0	-0.24	EC
21.2	0.04	BOTT RW
21.4	0.96	TOP RW
23.9	1.03	FC
27.8	1.09	

CROSS SECTION 2

CHAINAGE	R.L.	REMARKS
00.0	1.18	FC
06.4	1.18	TB
08.8	-0.16	EC
11.1	-0.44	IN
13.3	-0.23	EC
15.8	1.42	TB
18.5	1.66	FC

CROSS SECTION 3

CHAINAGE	R.L.	REMARKS
00.0	1.62	
11.6	0.98	TB
12.4	0.00	EC
15.8	-0.44	IN
18.3	0.03	EC
18.7	0.69	TB
31.3	1.22	

CROSS SECTION 4

CHAINAGE	R.L.	REMARKS
00.0	1.58	FC
02.3	1.40	TB
05.4	0.47	
07.5	0.64	TB
08.3	0.09	EC
10.6	-0.10	IN
13.4	0.06	EC
14.0	0.54	TB
17.9	2.05	TB
26.7	1.78	

CROSS SECTION 5

CHAINAGE	R.L.	REMARKS
00.0	3.06	
09.8	2.90	TB
17.0	1.04	
21.3	0.64	TB
21.8	0.18	EC
24.7	0.15	IN
27.1	0.18	EC
29.3	1.78	TB
36.9	2.56	
47.4	2.15	

CROSS SECTION 6

CHAINAGE	R.L.	REMARKS
00.0	3.13	
11.5	2.48	TB
16.4	0.90	TB
17.3	0.36	EC
21.1	0.25	IN
26.3	0.66	EC
28.1	2.36	TB
43.8	3.29	

CROSS SECTION 7

CHAINAGE	R.L.	REMARKS
00.0	3.22	TK
10.1	1.93	TB
11.2	1.14	EC
12.8	0.27	IN
18.1	0.62	IN
21.2	1.08	EC
22.6	1.93	TB
30.3	3.29	TK

CROSS SECTION 8

CHAINAGE	R.L.	REMARKS
00.0	3.42	FC
02.6	3.40	
06.7	2.95	TB
10.5	1.90	TB
11.1	1.16	EC
14.1	0.48	IN
19.2	0.96	EC
19.4	1.47	TB
21.8	2.06	
26.7	3.27	FC

CROSS SECTION 9

CHAINAGE	R.L.	REMARKS
00.0	3.87	
09.1	3.74	TB
14.7	3.01	
17.6	2.78	TB
19.6	1.13	EC
22.9	0.51	IN
28.0	1.15	EC
30.3	1.53	
31.8	2.09	TB
34.4	2.24	
37.7	3.42	FC

CROSS SECTION 10

CHAINAGE	R.L.	REMARKS
00.0	3.44	
09.0	3.65	
11.2	3.48	TB
14.9	1.51	BB
18.0	1.17	EC
20.3	1.07	IN
23.0	1.18	EC
26.4	1.34	BB
33.0	3.25	FC

CROSS SECTION 11

CHAINAGE	R.L.	REMARKS
00.0	3.74	FC
04.7	3.50	TB
07.8	2.08	BB
12.8	2.00	TB
13.6	1.54	EC
16.3	1.28	IN
18.3	1.42	EC
20.9	3.42	TB
27.3	3.89	FC

CROSS SECTION 12

CHAINAGE	R.L.	REMARKS
00.0	3.78	FC
04.8	4.32	TB
08.0	1.81	BB
09.3	1.16	IN
11.3	1.50	IN
13.0	1.72	BB
16.1	4.32	TB
21.5	4.36	
27.6	3.71	

CROSS SECTION 13

CHAINAGE	R.L.	REMARKS
00.0	4.06	FC
02.7	3.81	TB
05.2	2.32	TB
05.8	1.68	EC
07.1	1.51	IN
08.3	1.65	EC
11.8	2.19	BB
13.4	3.64	TB
16.1	3.92	

CROSS SECTION 14

CHAINAGE	R.L.	REMARKS
00.0	4.04	FC
04.6	4.17	TB
06.8	2.51	BB
08.2	2.35	
08.8	1.94	EC
09.8	1.79	IN
12.3	1.95	EC
15.5	4.50	TB
26.4	3.86	FC

CROSS SECTION 15

CHAINAGE	R.L.	REMARKS
00.0	4.23	FC
01.7	3.87	TB
03.6	2.49	TB
03.9	2.07	EC
06.1	1.98	IN
10.1	2.39	BB
11.0	3.59	TB
14.0	4.15	
19.9	4.01	FC

CROSS SECTION 16

CHAINAGE	R.L.	REMARKS
00.0	5.52	
06.5	5.32	TB
11.9	2.56	BB
13.4	2.28	EC
15.4	2.12	IN
17.8	2.37	EC
19.6	3.76	TB
24.0	4.50	
31.7	4.04	

CROSS SECTION 17

CHAINAGE	R.L.	REMARKS
00.0	5.12	FC
06.0	5.05	
08.7	4.31	TB
09.7	2.95	BB
11.1	2.33	EC
13.8	2.11	IN
16.3	2.44	EC
17.5	2.85	BB
19.9	4.38	
24.9	5.33	TB
30.9	4.46	

CROSS SECTION 18

CHAINAGE	R.L.	REMARKS
00.0	5.03	FC
04.0	5.34	
09.3	5.35	TB
13.5	4.02	
14.7	2.70	EC
17.2	2.35	IN
20.0	2.62	EC
22.1	3.41	
23.8	4.65	TB
29.4	4.98	
30.6	5.43	
35.5	4.75	

CROSS SECTION 19

CHAINAGE	R.L.	REMARKS
00.0	5.08	FC
07.0	4.81	
08.8	4.14	TB
10.4	2.59	EC
13.4	2.26	IN
15.9	2.65	EC
17.3	4.12	TB
19.1	4.21	FC

CROSS SECTION 20

CHAINAGE	R.L.	REMARKS
00.0	5.33	FC
06.9	5.19	TB
09.0	3.83	
09.8	2.99	EC
12.6	2.83	IN
14.9	2.90	EC
16.6	3.90	TB
18.5	4.38	FC

CROSS SECTION 21

CHAINAGE	R.L.	REMARKS
00.0	5.83	
06.4	5.49	FC
08.1	5.27	TB
10.8	3.18	EC
14.1	2.66	IN
15.5	2.90	EC
17.9	4.36	TB
20.3	4.56	FC

CROSS SECTION 22

CHAINAGE	R.L.	REMARKS
00.0	4.82	EDGE SPOIL HEAP
10.2	5.07	FC / EDGE SPOIL HEAP
12.7	5.34	
15.7	4.80	TB
17.0	3.21	EC
18.9	3.21	IN
20.8	3.21	EC
21.9	4.62	TB
24.2	4.58	FC

CROSS SECTION 23

CHAINAGE	R.L.	REMARKS
00.0	5.10	FC
07.9	4.42	TB
09.0	2.93	EC
10.7	2.67	IN
12.8	3.12	EC
15.3	3.19	BB
18.0	5.06	TB
26.0	5.12	FC

CROSS SECTION 24

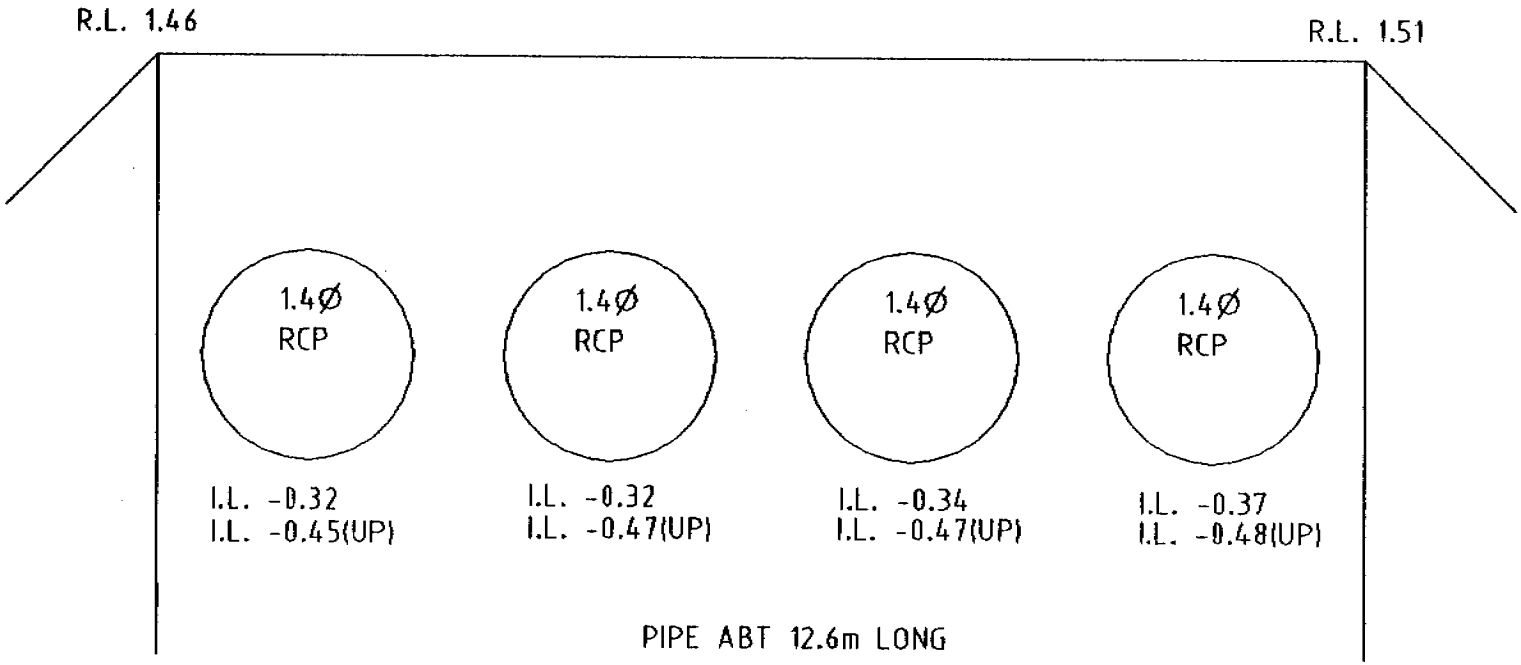
CHAINAGE	R.L.	REMARKS
00.0	3.59	
06.1	3.32	TB
07.0	2.81	EC
10.0	2.44	IN
11.8	2.79	EC
14.2	4.24	TB
20.7	4.36	
31.4	5.04	

CROSS SECTION 25

CHAINAGE	R.L.	REMARKS
00.0	4.18	FC
06.7	3.06	
09.1	2.69	TB
09.6	2.13	EC
11.0	2.06	IN
12.8	2.18	EC
14.8	3.51	TB
19.0	3.86	FC

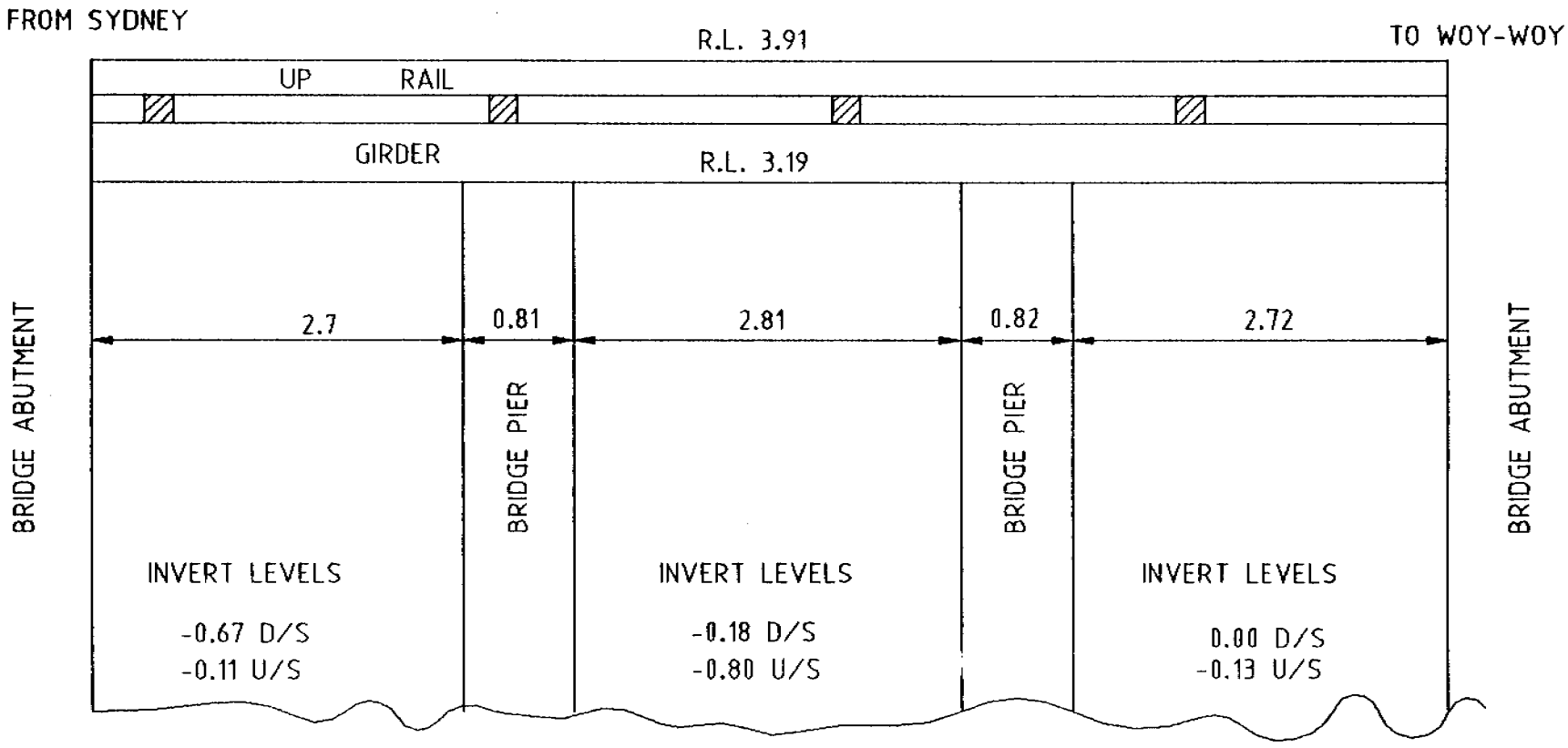
CULVERT UNDER WOY-WOY ROAD

LEVEL ON ROAD 1.68



LOOKING UPSTREAM

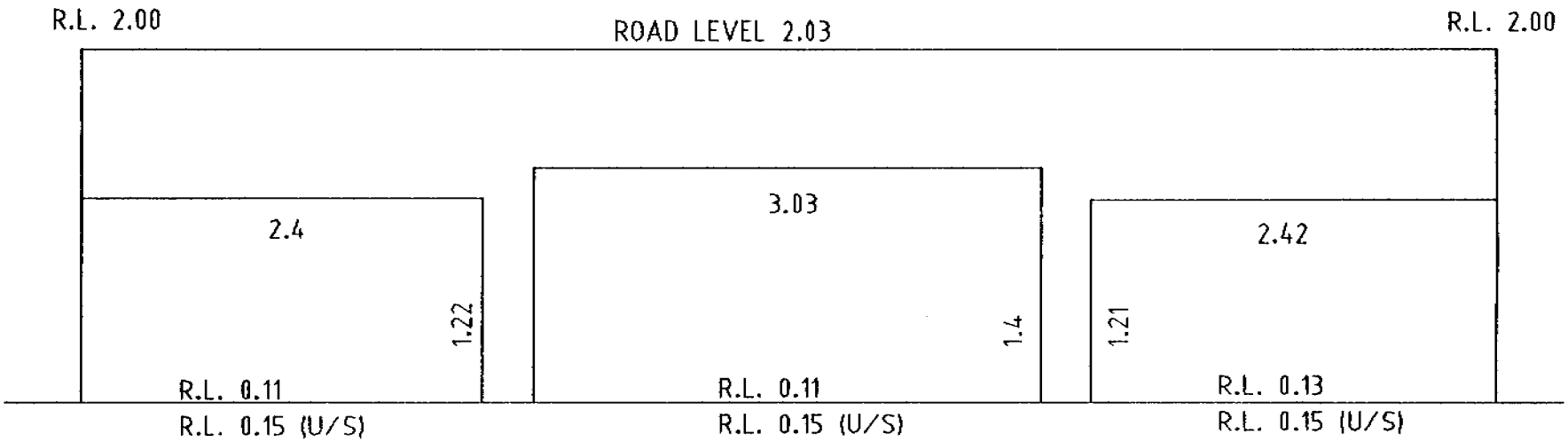
RAILWAY UNDERBRIDGE



D/S = DOWN STREAM
U/S = UP STREAM

LOOKING DOWNSTREAM

CULVERT UNDER RAILWAY STREET

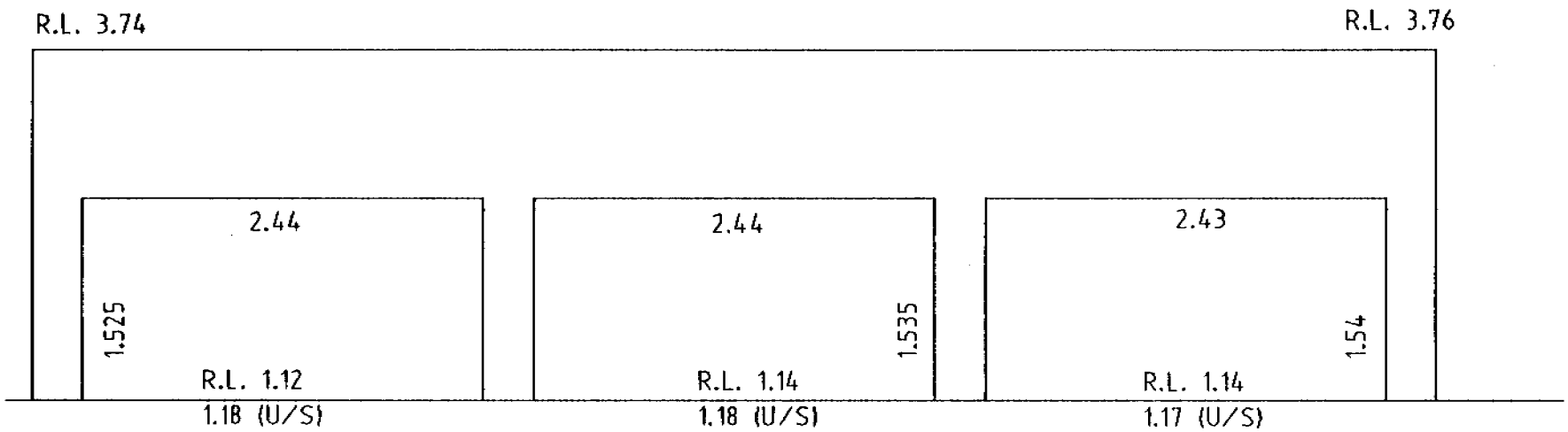


(CULVERT ABT 13.4m LONG)

LOOKING UPSTREAM

CULVERT UNDER NAMBUCCA DRIVE

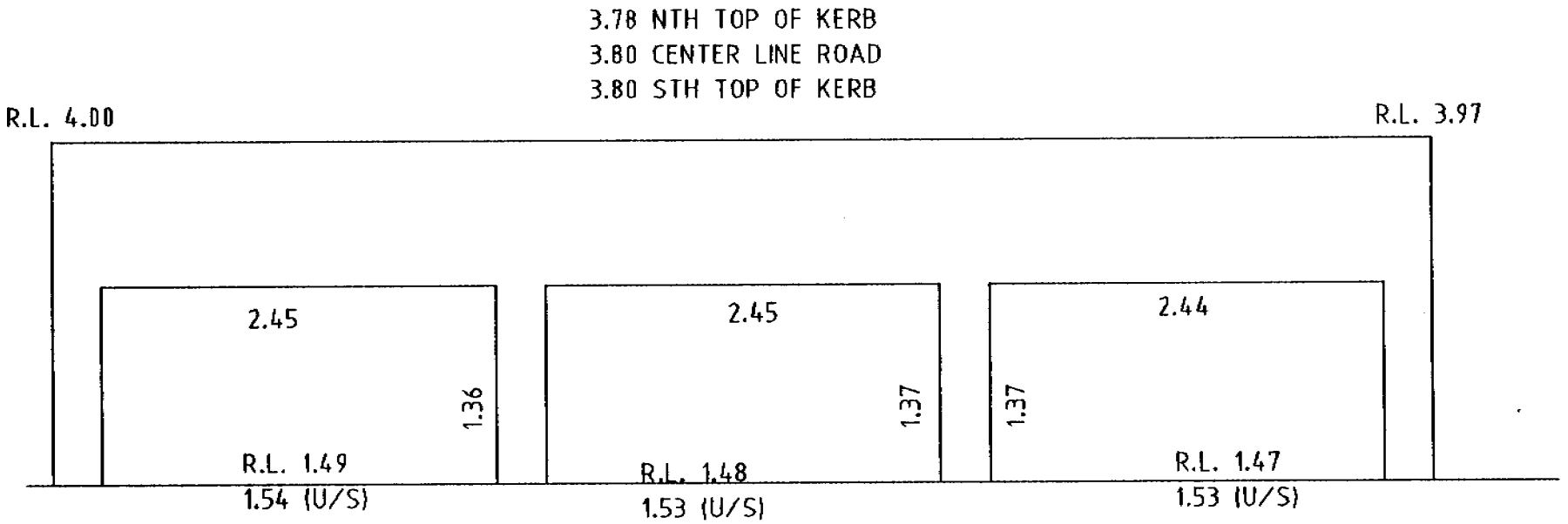
3.55 NTH TOP OF KERB (TK)
3.55 CENTER LINE ROAD
3.55 STH TOP OF KERB (TK)



(CULVERT ABT. 17.1m LONG)

LOOKING UPSTREAM

CULVERT UNDER DULKARA ROAD

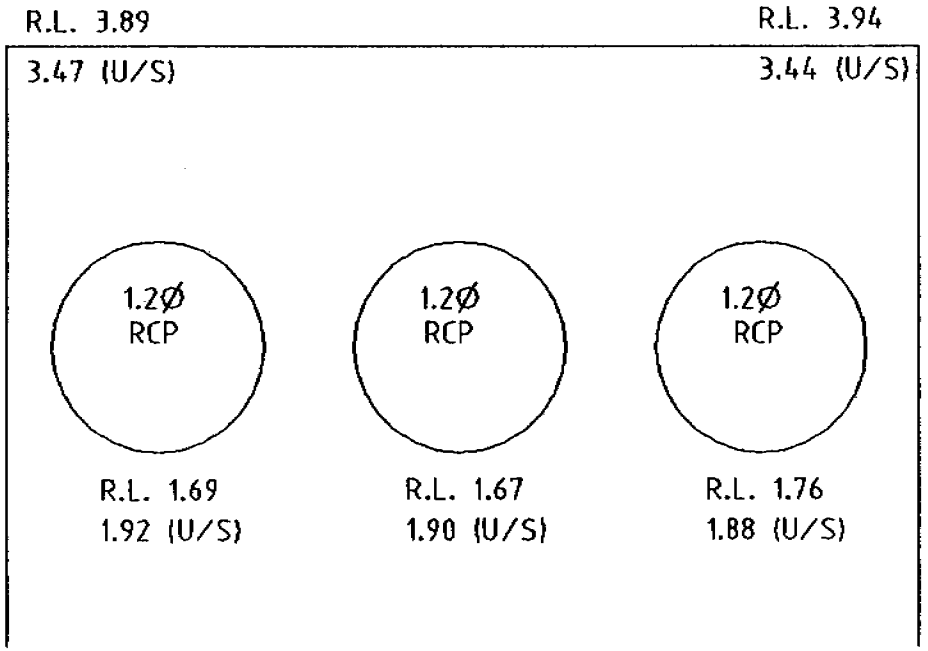


(CULVERT ABT. 17.1m LONG)

LOOKING UPSTREAM

CULVERT UNDER VERON ROAD

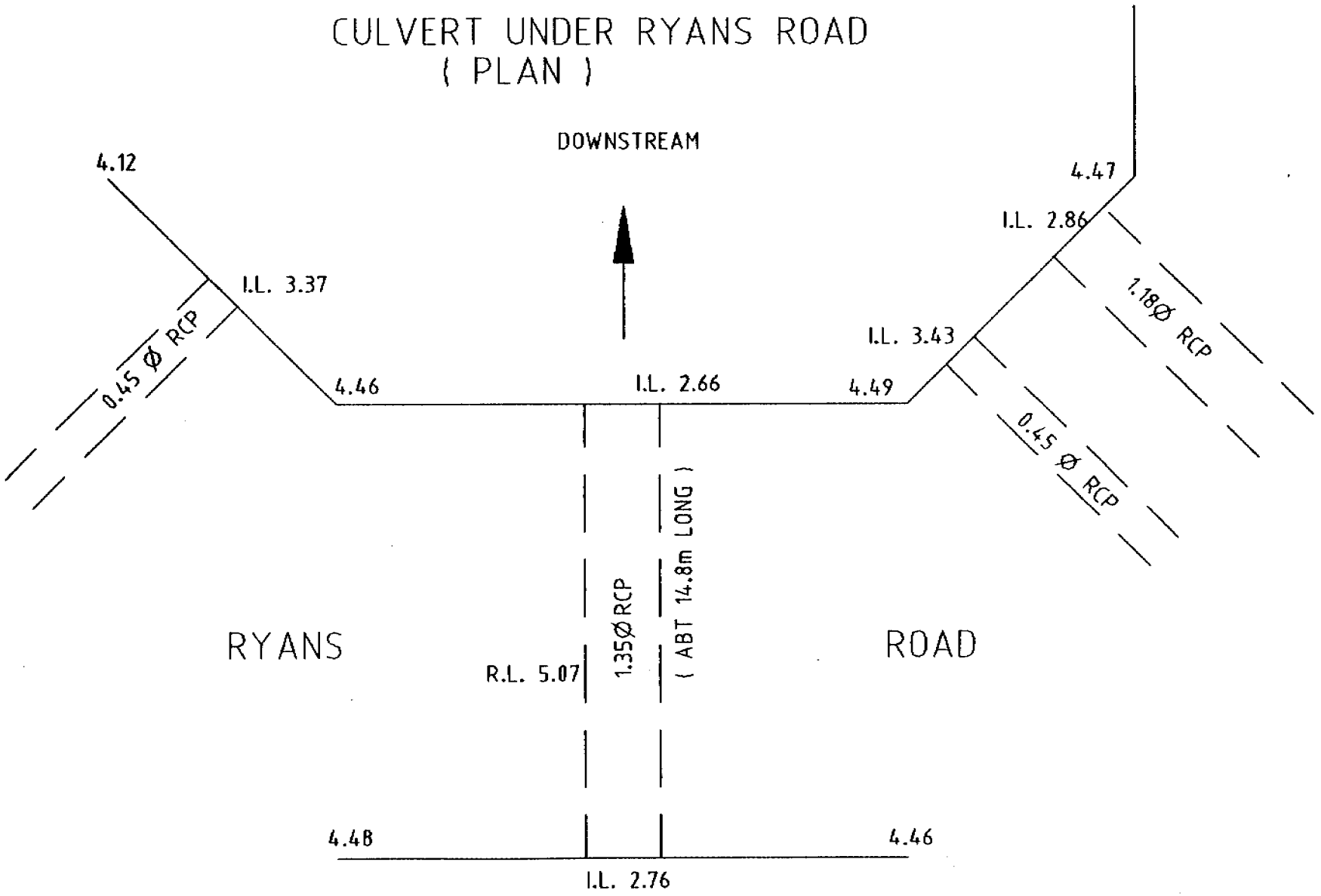
3.84 NTH TOP OF KERB
3.89 CENTER LINE ROAD
3.89 STH TOP OF KERB



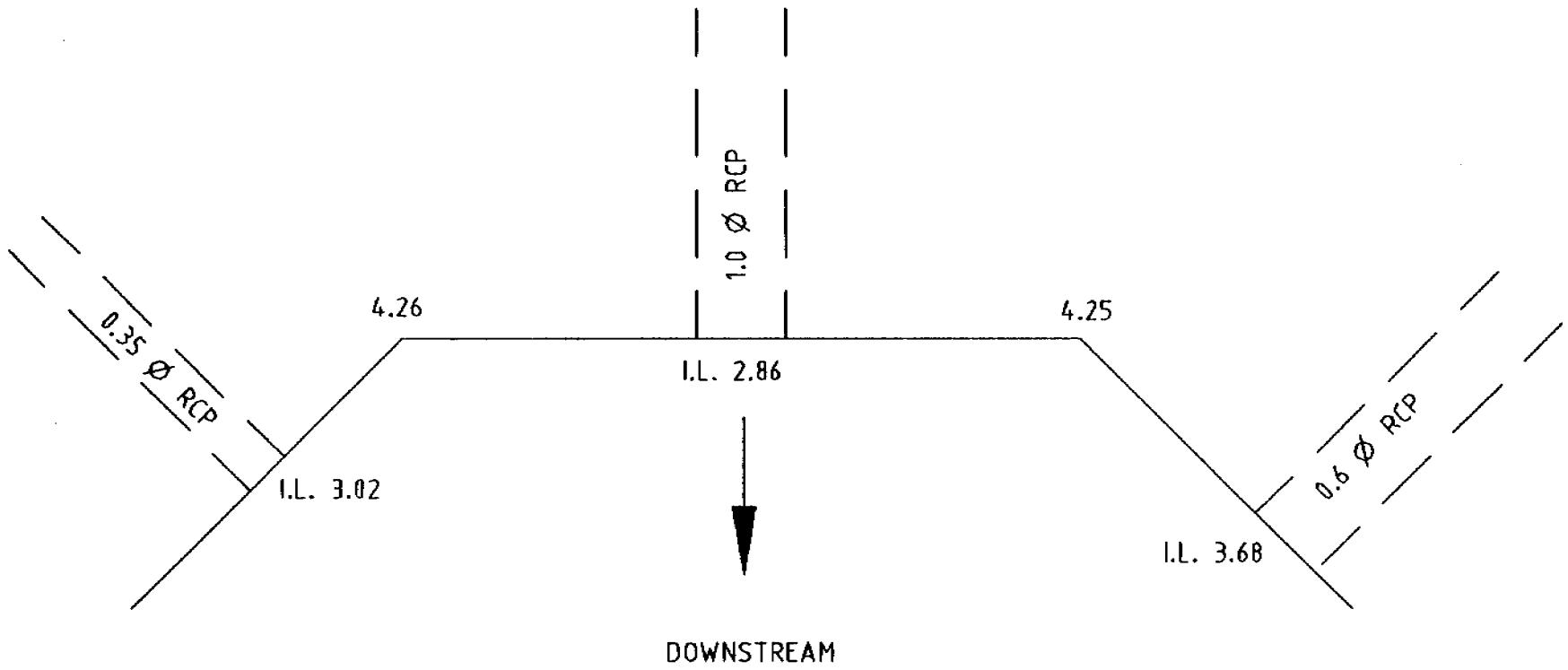
(CULVERT ABT 22.0m LONG)

LOOKING UPSTREAM

CULVERT UNDER RYANS ROAD
(PLAN)

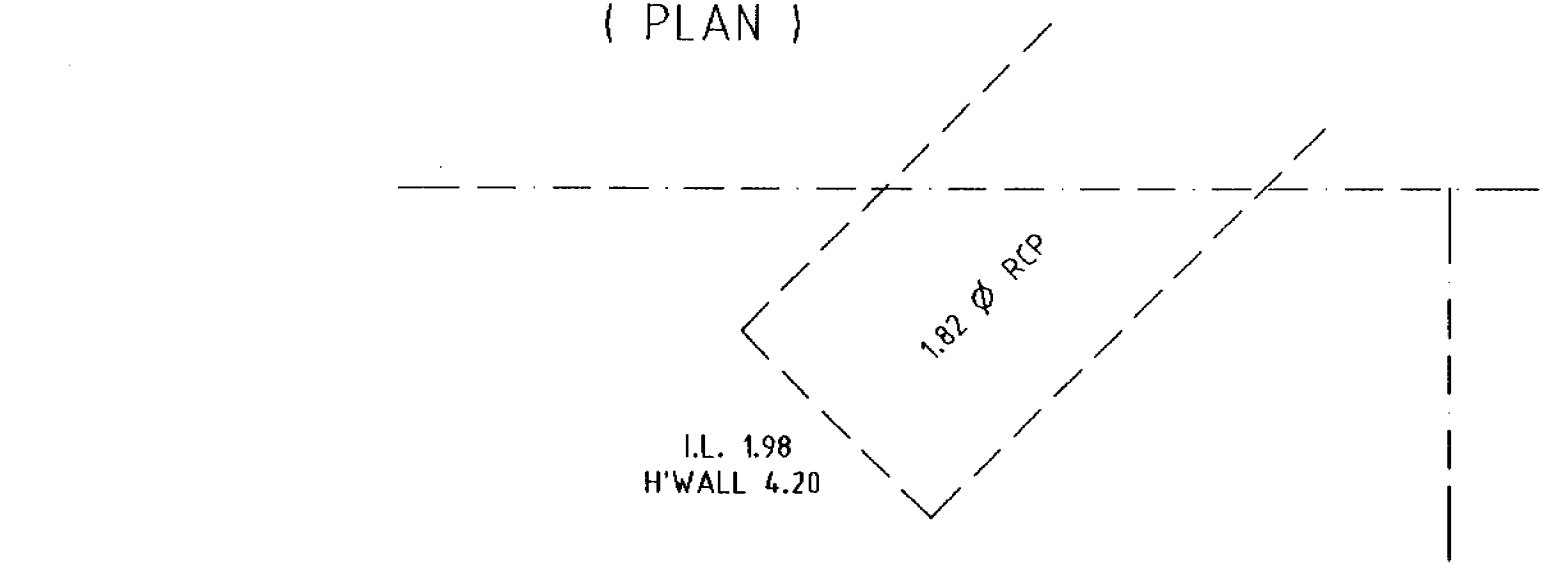


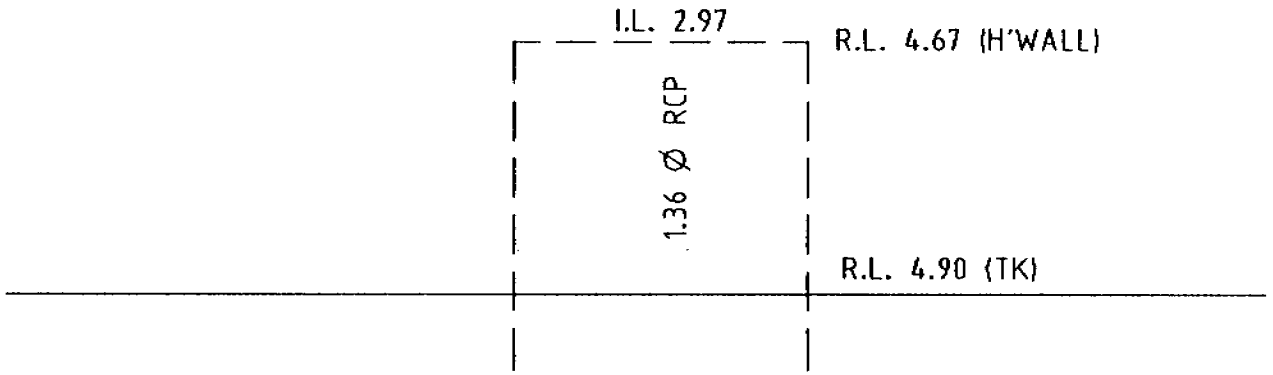
END OF EAST CHANNEL
(PLAN)



WESTERN CHANNEL

(PLAN)





VERON ROAD

APPENDIX F

GOSFORD CITY COUNCIL

49 MANN STREET, GOSFORD, N.S.W. 2250

P.O. BOX 21, GOSFORD. DX 7211 GOSFORD

Telephone: (043) 25 8857 Please Quote: Mr C Slater:sw 109547 & 920.30.01

20 December 1991

Webb, McKeown & Associates Pty Ltd
117 York Street
SYDNEY NSW 2000

Attention: Mr I.J. Tye

Woy Woy, Umina, Ettalong, Peninsula Drainage Strategy Study - Determination of Council's Future Expenditure

Dear Sir

Following the project meeting called to discuss Council's likely works program and standards of work for the future in the study area if no further development occurred we wish to advise as follows:-

- The criteria for developing a program of works in the study area should be primarily to remove flood waters from buildings. This strategy is applied across the city area to determine the highest priorities for drainage and flood mitigation works. Works proposals in this area would compete for available funding with other similarly affected areas of the city. Works to the same standards as new proposals are not an achievable short term goal within available funding. However wherever possible, the element of the works in the proposed program should be able to be readily incorporated in a suitable long term scheme. Applicable standards are set out below.

- Residential streets with overflow to reserves or pathways, or bypass along the street - 10 year design flood average recurrence interval (DFARI).

- Set minimum floor levels for low blocks of land, low points and low areas where surface flow may enter houses.

- Major System Problems - rectification by staged works in problem areas using 50 year DFARI and minimum floor levels to achieve a standard where new buildings will have ½ metre free board over a 100 year DFARI. Proposals should be curtailed where benefits are low or marginal.

- Current undrained areas without extensive problems of buildings flooding may be managed with minor drainage works and minimum floor levels.

Please apply these criteria in determining the estimated cost of the works required for the case with no further development.

Yours faithfully

M G Alsop
Program Manager - Environment

AA 1	AD 1	AG 1	AI 1	AK 1	BA 1	DA 2	GA 1	IA 2	JA 1	JA 6	JB 3
no existing	750mm pipe	600mm pipe	2 x 375mm pipes	open channel	no existing	no existing	no existing	2x900	no existing	750mm pipe	900mm pipe
1500mm pipe	525mm pipe	450mm pipe	750mm pipe	825mm pipe	1200mm pipe	2 x 1500mm pipes	1200mm pipe	no upgrade required	1350mm pipe	2 x 1800mm pipes	1500mm pipe
1500mm pipe	900mm pipe	750mm pipe	900mm pipe	825mm pipe	1200mm pipe	2 x 1500mm pipes	1200mm pipe	1200mm pipe	1350mm pipe	2 x 1800mm pipes	1650mm pipe
1.7m wide channel	1.2m wide channel	1.2m wide channel	1.2m wide channel	1.2m wide channel	1.2m wide channel	2.8m wide channel	1.2m wide channel	1.2m wide channel	1.4m wide channel	4.8m wide channel	2.0m wide channel
AA 2	**AE 1**	**AH 1**	**AC 9**	**AA 9**	**BA 2**	**DA 3**	**GA 2**	**IA 3**	**JA 2**	**JB 1**	**JB 4**
no existing	825mm pipe	825mm pipe	2x1050 + 825mm	open channel	no existing	no existing	750mm pipe	open channel	no existing	no existing	1200mm pipe
2 x 1500mm pipes	675mm pipe	675mm pipe	1050mm pipe	6 x 1800mm pipes	1500mm pipe	2 x 1500mm pipes	1200mm pipe	2 x 1500mm pipes	1650mm pipe	900mm pipe	1200mm pipe
2 x 1500mm pipes	1050mm pipe	1050mm pipe	2 x 1500mm pipes	6 x 1800mm pipes	1500mm pipe	2 x 1500mm pipes	1350mm pipe	2 x 1500mm pipes	1650mm pipe	1200mm pipe	1650mm pipe
3.6m wide channel	1.2m wide channel	1.2m wide channel	1.2m wide channel	18.6m wide channel	1.9m wide channel	3.2m wide channel	1.3m wide channel	3.0m wide channel	2.2m wide channel	1.2m wide channel	2.3m wide channel
AA 3	**AF 1**	**AC 3**	**AA 6**	**AL 1**	**BA 3**	**EA 1**	**GA 3**	**IA 4**	**JA 3**	**JB 2**	**JB 5**
open channel	1275mm pipe	3 x 1350mm pipes	open channel	750mm pipe	no existing	no existing	no existing	1200mm pipe	no existing	no existing	1350mm pipe
3 x 1650mm pipes	no upgrade required	no upgrade required	4 x 1650mm pipes	1050mm pipe	1800mm pipe	1200mm pipe	1350mm pipe	1650mm pipe	1800mm pipe	1500mm pipe	1200mm pipe
3 x 1650mm pipes	1200mm pipe	1200mm pipe	4 x 1650mm pipes	1200mm pipe	1800mm pipe	1200mm pipe	1350mm pipe	2 x 1500mm pipes	1800mm pipe	1500mm pipe	1800mm pipe
5.6m wide channel	1.2m wide channel	1.2m wide channel	9.7m wide channel	1.2m wide channel	2.7m wide channel	1.2m wide channel	1.2m wide channel	2.5m wide channel	2.6m wide channel	1.7m wide channel	2.5m wide channel
AB 1	**AF 2**	**AC 4**	**AA 7**	**AL 2**	**BA 4**	**EA 2**	**HA 1**	**IA 5**	**JA 4**		
2 x 900mm pipes	1500mm pipe	3 x 1350mm pipes	open channel	900mm pipe	no existing	open channel	no existing	1050+1200mm pipes	no existing		
825mm pipe	no upgrade required	no upgrade required	4 x 1650mm pipes	1350mm pipe	2 x 1500mm pipes	1500mm pipe	1350mm pipe	1200mm pipe	2 x 1500mm pipes		
1500mm pipe	1500mm pipe	1200mm pipe	4 x 1650mm pipes	1500mm pipe	2 x 1500mm pipes	1500mm pipe	1350mm pipe	2 x 1500mm pipes	2 x 1500mm pipes		
1.9m wide channel	1.9m wide channel	1.2m wide channel	9.8m wide channel	1.9m wide channel	3.0m wide channel	1.7m wide channel	1.5m wide channel	2.7m wide channel	3.4m wide channel		
AB 2	**AF 3**	**AC 5**	**AJ 1**	**AL 3**	**CA 1**	**EA 3**	**HA 2**	**QA 1**	**JA 5**		
2 x 900mm pipes	1950mm pipe	3 x 1350mm pipes	900mm pipe	1050mm pipe	750mm pipe	open channel	no existing	750mm pipe	no existing		
1500mm pipe	no upgrade required	no upgrade required	825mm pipe	1500mm pipe	1200mm pipe	2 x 1500mm pipes	1500mm pipe	750mm pipe	2 x 1800mm pipes		
2 x 1500mm pipes	1800mm pipe	1200mm pipe	1200mm pipe	1800mm pipe	1350mm pipe	2 x 1500mm pipes	1500mm pipe	1050mm pipe	2 x 1800mm pipes		
3.1m wide channel	2.4m wide channel	1.2m wide channel	1.2m wide channel	2.4m wide channel	1.4m wide channel	3.0m wide channel	1.6m wide channel	1.2m wide channel	4.4m wide channel		
AA 4	**AF 4**	**AC 6**	**AJ 2**	**AL 4**	**CA 2**	**FA 1**	**HA 3**	**QA 2**			
open channel	1800mm pipe	3 x 1350mm pipes	open channel	open channel	no existing	no existing	no existing	900mm pipe			
3 x 1800mm pipes	750mm pipe	no upgrade required	2 x 1500mm pipes	2 x 1500mm pipes	1350mm pipe	1350mm pipe	1500mm pipe	600mm pipe			
3 x 1800mm pipes	2 x 1500mm pipes	1200mm pipe	2 x 1500mm pipes	2 x 1500mm pipes	1350mm pipe	1350mm pipe	1500mm pipe	1050mm pipe			
7.2m wide channel	3.0m wide channel	1.2m wide channel	3.2m wide channel	3.0m wide channel	1.4m wide channel	1.6m wide channel	1.9m wide channel	1.2m wide channel			
AA 5	**AF 5**	**AC 7**	**AJ 3**	**AL 5**	**CA 3**	**FA 2**	**IA 1**				
open channel	1800mm pipe	3 x 1350mm pipes	no existing	open channel	1050mm pipe	no existing	no existing				
3 x 1800mm pipes	750mm pipe	no upgrade required	3 x 1800mm pipes	2 x 1500mm pipes	900mm pipe	1650mm pipe	825mm pipe				
3 x 1800mm pipes	2 x 1500mm pipes	1200mm pipe	3 x 1800mm pipes	2 x 1500mm pipes	1350mm pipe	1650mm pipe	825mm pipe				
7.8m wide channel	3.1m wide channel	1.2m wide channel	7.1m wide channel	3.1m wide channel	1.6m wide channel	2.0m wide channel	1.2m wide channel				
AC 1	**AC 2**	**AC 8**	**AA 8**	**AA 10**	**DA 1**						
750mm pipe	2 x 1350mm pipes	2x1050 + 825mm	open channel	open channel	900mm pipe						
no upgrade required	450mm pipe	no upgrade required	6 x 1800mm pipes	7 x 1800mm pipes	825mm pipe						
675mm pipe	2 x 1500mm pipes	1200mm pipe	6 x 1800mm pipes	7 x 1800mm pipes	1200mm pipe						
1.2m wide channel	1.2m wide channel	1.2m wide channel	16.6m wide channel	21.1m wide channel	1.2m wide channel						

JB 6	KA 3	LA 1	LB 3
1800mm pipe	no existing	1350mm pipe	1050mm pipe
no upgrade required	2 x 1500mm pipes	no upgrade required	1350mm pipe
1800mm pipe	2 x 1500mm pipes	1350mm pipe	1650mm pipe
2.4m wide channel	3.3m wide channel	1.5m wide channel	2.1m wide channel
JA 7	**KB 1**	**LA 2**	**LA 4**
1800mm pipe	no existing	1500mm pipe	2x1200 + 1050mm
2 x 1500mm pipes	1500mm pipe	750mm pipe	no upgrade required
3 x 1650mm pipes	1500mm pipe	1650mm pipe	2 x 1500mm pipes
5.8m wide channel	1.7m wide channel	2.1m wide channel	3.0m wide channel
JA 8	**KB 2**	**LA 3**	
1800mm pipe	600mm pipe	1500mm pipe	
2 x 1500mm pipes	1800mm pipe	750mm pipe	
3 x 1650mm pipes	1800mm pipe	1650mm pipe	
5.9m wide channel	2.5m wide channel	2.1m wide channel	
KA 1	**KA 4**	**LB 1**	
1200mm pipe	600mm pipe	750mm pipe	
1200mm pipe	2 x 1800mm pipes	1050mm pipe	
1650mm pipe	2 x 1800mm pipes	1200mm pipe	
2.2m wide channel	4.8m wide channel	1.2m wide channel	
KA 2	**KA 5**	**LB 2**	
1350mm pipe	no existing	900mm pipe	
1500mm pipe	3 x 1650mm pipes	1050mm pipe	
2 x 1500mm pipes	3 x 1650mm pipes	1350mm pipe	
2.9m wide channel	5.2m wide channel	1.6m wide channel	

LEGEND

	1% AEP Upgrade Options
AC 2	Branch and Reach
2 x 1350mm pipes	Existing Pipe Size
450mm pipe	Option 1 - Additional Pipes
2 x 1500mm pipes	Option 2 - New Pipes
1.2m wide channel	Option 3 - Open Channel

"Black Spot" locations (Source: Council Maps)

Natural depression (Source: 1: 2 000 Orthophotomaps)

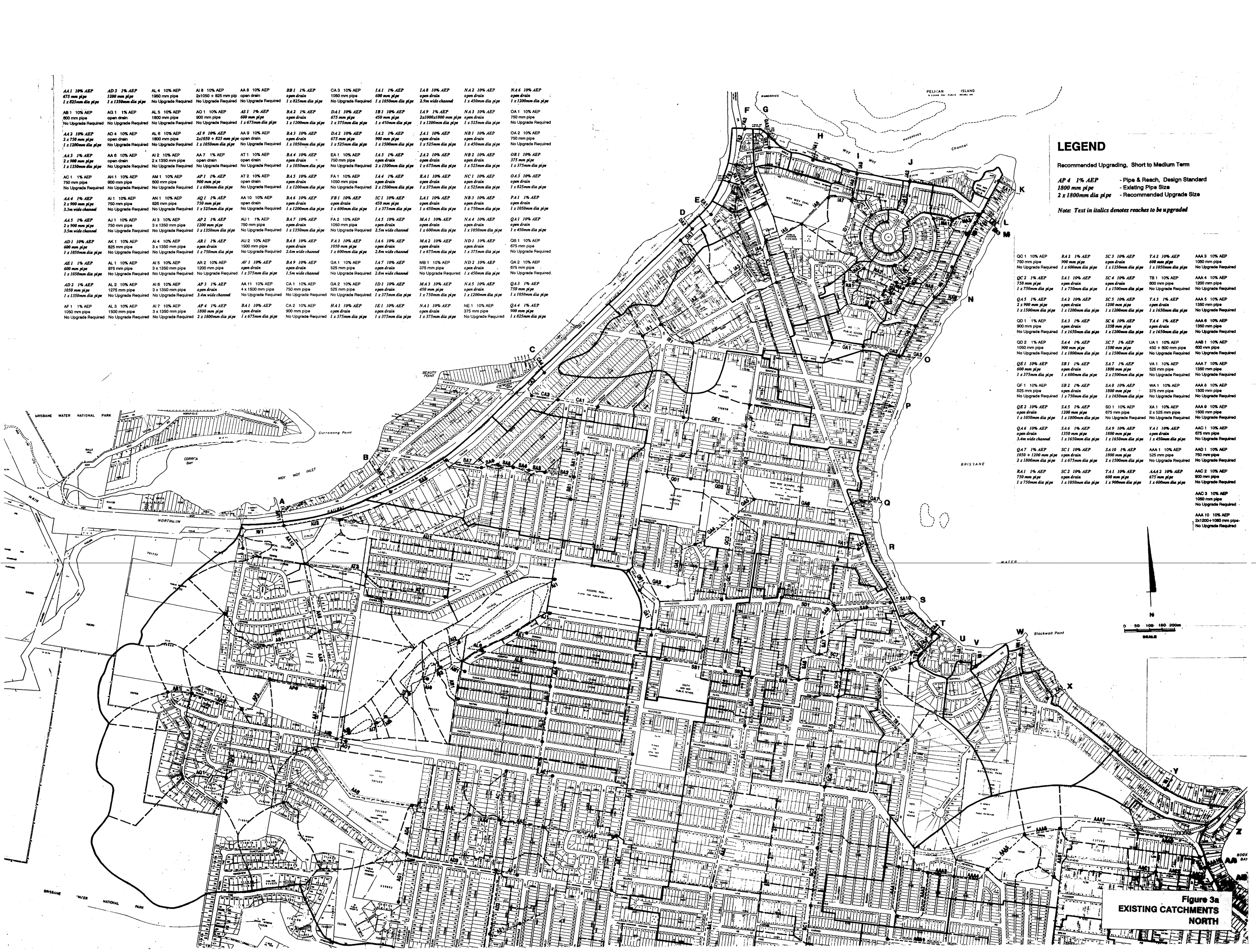
Proposed Catchment Boundary

Proposed drainage reserve

SCALE 40 0 40 80 120 160 200m

Figure 4a
PROPOSED CATCHMENTS NORTH

AA1 10% AEP *675 mm pipe* *1 x 825mm dia pipe*	*AD3 1% AEP* *1200 mm pipe* *1 x 1350mm dia pipe*	AL4 10% AEP 1950 mm pipe No Upgrade Required	AI8 10% AEP 2x1050 + 825 mm pipe No Upgrade Required	AA8 10% AEP open drain No Upgrade Required	*BB1 1% AEP* *open drain* *1 x 825mm dia pipe*	CA3 10% AEP 1050 mm pipe No Upgrade Required	*IA1 1% AEP* *600 mm pipe* *1 x 1050mm dia pipe*	*IA8 10% AEP* *open drain* *2.9m wide channel*	*NA2 10% AEP* *open drain* *1 x 450mm dia pipe*	*NA6 10% AEP* *open drain* *1 x 1200mm dia pipe*
AB1 10% AEP 600 mm pipe No Upgrade Required	AG1 1% AEP open drain No Upgrade Required	AL5 10% AEP 1800 mm pipe No Upgrade Required	AO1 10% AEP 900 mm pipe No Upgrade Required	*AS1 1% AEP* *600 mm pipe* *1 x 675mm dia pipe*	*BA2 1% AEP* *open drain* *1 x 1200mm dia pipe*	*DA1 10% AEP* *675 mm pipe* *1 x 375mm dia pipe*	*IB1 10% AEP* *450 mm pipe* *1 x 450mm dia pipe*	*IA9 1% AEP* *2x1000x1800 mm pipe* *1 x 1200mm dia pipe*	*NA3 10% AEP* *open drain* *1 x 525mm dia pipe*	OA1 10% AEP 750 mm pipe No Upgrade Required
AA2 10% AEP *2 x 750 mm pipe* *1 x 1200mm dia pipe*	AD4 10% AEP open drain No Upgrade Required	AL6 10% AEP 1800 mm pipe No Upgrade Required	*AI9 10% AEP* *2x1050 + 825 mm pipe* *1 x 1050mm dia pipe*	AA9 10% AEP open drain No Upgrade Required	*BA3 10% AEP* *open drain* *1 x 1050mm dia pipe*	*DA2 10% AEP* *675 mm pipe* *1 x 525mm dia pipe*	*IA2 1% AEP* *900 mm pipe* *1 x 1500mm dia pipe*	*JA1 10% AEP* *open drain* *1 x 525mm dia pipe*	*NB1 10% AEP* *open drain* *1 x 450mm dia pipe*	OA2 10% AEP 750 mm pipe No Upgrade Required
AA3 1% AEP *2 x 900 mm pipe* *1 x 1350mm dia pipe*	AA6 10% AEP open drain No Upgrade Required	AI2 10% AEP 2 x 1350 mm pipe No Upgrade Required	AA7 1% AEP open drain No Upgrade Required	AT1 10% AEP open drain No Upgrade Required	*BA4 10% AEP* *open drain* *1 x 1050mm dia pipe*	EA1 10% AEP 750 mm pipe No Upgrade Required	*IA3 1% AEP* *open drain* *2 x 1500mm dia pipe*	*JA2 10% AEP* *open drain* *1 x 675mm dia pipe*	*NB2 10% AEP* *open drain* *1 x 525mm dia pipe*	*OB1 10% AEP* *375 mm pipe* *1 x 375mm dia pipe*
AC1 1% AEP 750 mm pipe No Upgrade Required	AH1 10% AEP 900 mm pipe No Upgrade Required	AM1 10% AEP 600 mm pipe No Upgrade Required	*AP1 1% AEP* *900 mm pipe* *1 x 600mm dia pipe*	AT2 10% AEP open drain No Upgrade Required	*BA5 10% AEP* *open drain* *1 x 1200mm dia pipe*	FA1 10% AEP 1050 mm pipe No Upgrade Required	*IA4 1% AEP* *open drain* *2 x 1500mm dia pipe*	*KA1 10% AEP* *open drain* *1 x 375mm dia pipe*	*NC1 10% AEP* *open drain* *1 x 525mm dia pipe*	*OA3 10% AEP* *open drain* *1 x 825mm dia pipe*
AA4 1% AEP *2 x 900 mm pipe* *3.3m wide channel*	AI1 10% AEP 750 mm pipe No Upgrade Required	AN1 10% AEP 825 mm pipe No Upgrade Required	*AQ1 1% AEP* *750 mm pipe* *1 x 525mm dia pipe*	AA10 10% AEP open drain No Upgrade Required	*BA6 10% AEP* *open drain* *1 x 1200mm dia pipe*	*FB1 10% AEP* *open drain* *1 x 600mm dia pipe*	*IC1 10% AEP* *450 mm pipe* *1 x 375mm dia pipe*	*LA1 10% AEP* *open drain* *1 x 450mm dia pipe*	*NB3 10% AEP* *open drain* *1 x 750mm dia pipe*	*PA1 1% AEP* *open drain* *1 x 1050mm dia pipe*
AA5 1% AEP *2 x 900 mm pipe* *3.5m wide channel*	AJ1 10% AEP 750 mm pipe No Upgrade Required	AI3 10% AEP 3 x 1350 mm pipe No Upgrade Required	*AP2 1% AEP* *1200 mm pipe* *1 x 1350mm dia pipe*	AU1 1% AEP 750 mm pipe No Upgrade Required	*BA7 10% AEP* *open drain* *1 x 1350mm dia pipe*	FA2 10% AEP 1050 mm pipe No Upgrade Required	*IA5 10% AEP* *open drain* *2.5m wide channel*	*MA1 10% AEP* *open drain* *1 x 600mm dia pipe*	*NA4 10% AEP* *open drain* *1 x 1050mm dia pipe*	*QA1 10% AEP* *open drain* *1 x 450mm dia pipe*
AD1 10% AEP *600 mm pipe* *1 x 1050mm dia pipe*	AK1 10% AEP 825 mm pipe No Upgrade Required	AI4 10% AEP 3 x 1350 mm pipe No Upgrade Required	*AR1 1% AEP* *open drain* *1 x 750mm dia pipe*	AU2 10% AEP 1500 mm pipe No Upgrade Required	*BA8 10% AEP* *open drain* *2.6m wide channel*	*FA3 10% AEP* *1050 mm pipe* *1 x 600mm dia pipe*	*IA6 10% AEP* *open drain* *2.8m wide channel*	*MA2 10% AEP* *open drain* *1 x 675mm dia pipe*	*ND1 10% AEP* *open drain* *1 x 375mm dia pipe*	QB1 10% AEP 675 mm pipe No Upgrade Required
AE1 1% AEP *600 mm pipe* *1 x 1050mm dia pipe*	AL1 10% AEP 975 mm pipe No Upgrade Required	AI5 10% AEP 3 x 1350 mm pipe No Upgrade Required	AR2 10% AEP 1200 mm pipe No Upgrade Required	*AV1 10% AEP* *open drain* *1 x 375mm dia pipe*	*BA9 10% AEP* *open drain* *1.5m wide channel*	GA1 10% AEP 525 mm pipe No Upgrade Required	*IA7 10% AEP* *open drain* *2.8m wide channel*	MB1 10% AEP 375 mm pipe No Upgrade Required	*ND2 10% AEP* *open drain* *1 x 450mm dia pipe*	QA2 10% AEP 675 mm pipe No Upgrade Required
AD2 1% AEP *1050 mm pipe* *1 x 1350mm dia pipe*	AL2 10% AEP 1275 mm pipe No Upgrade Required	AI6 10% AEP 3 x 1350 mm pipe No Upgrade Required	*AP3 1% AEP* *open drain* *3.4m wide channel*	AA11 10% AEP 4 x 1500 mm pipe No Upgrade Required	CA1 10% AEP 750 mm pipe No Upgrade Required	GA2 10% AEP 525 mm pipe No Upgrade Required	*ID1 10% AEP* *open drain* *1 x 375mm dia pipe*	*MA3 10% AEP* *450 mm pipe* *1 x 750mm dia pipe*	*NA5 10% AEP* *open drain* *1 x 1200mm dia pipe*	*QA3 1% AEP* *750 mm pipe* *1 x 1050mm dia pipe*
AF1 1% AEP 1050 mm pipe No Upgrade Required	AL3 10% AEP 1500 mm pipe No Upgrade Required	AI7 10% AEP 3 x 1350 mm pipe No Upgrade Required	*AP4 1% AEP* *1800 mm pipe* *2 x 1800mm dia pipe*	*BA1 10% AEP* *open drain* *1 x 675mm dia pipe*	CA2 10% AEP 900 mm pipe No Upgrade Required	*HA1 10% AEP* *open drain* *1 x 375mm dia pipe*	*IE1 10% AEP* *open drain* *1 x 375mm dia pipe*	*NA1 10% AEP* *open drain* *1 x 375mm dia pipe*	NE1 10% AEP 375 mm pipe No Upgrade Required	*QA4 1% AEP* *900 mm pipe* *1 x 825mm dia pipe*



LEGEND

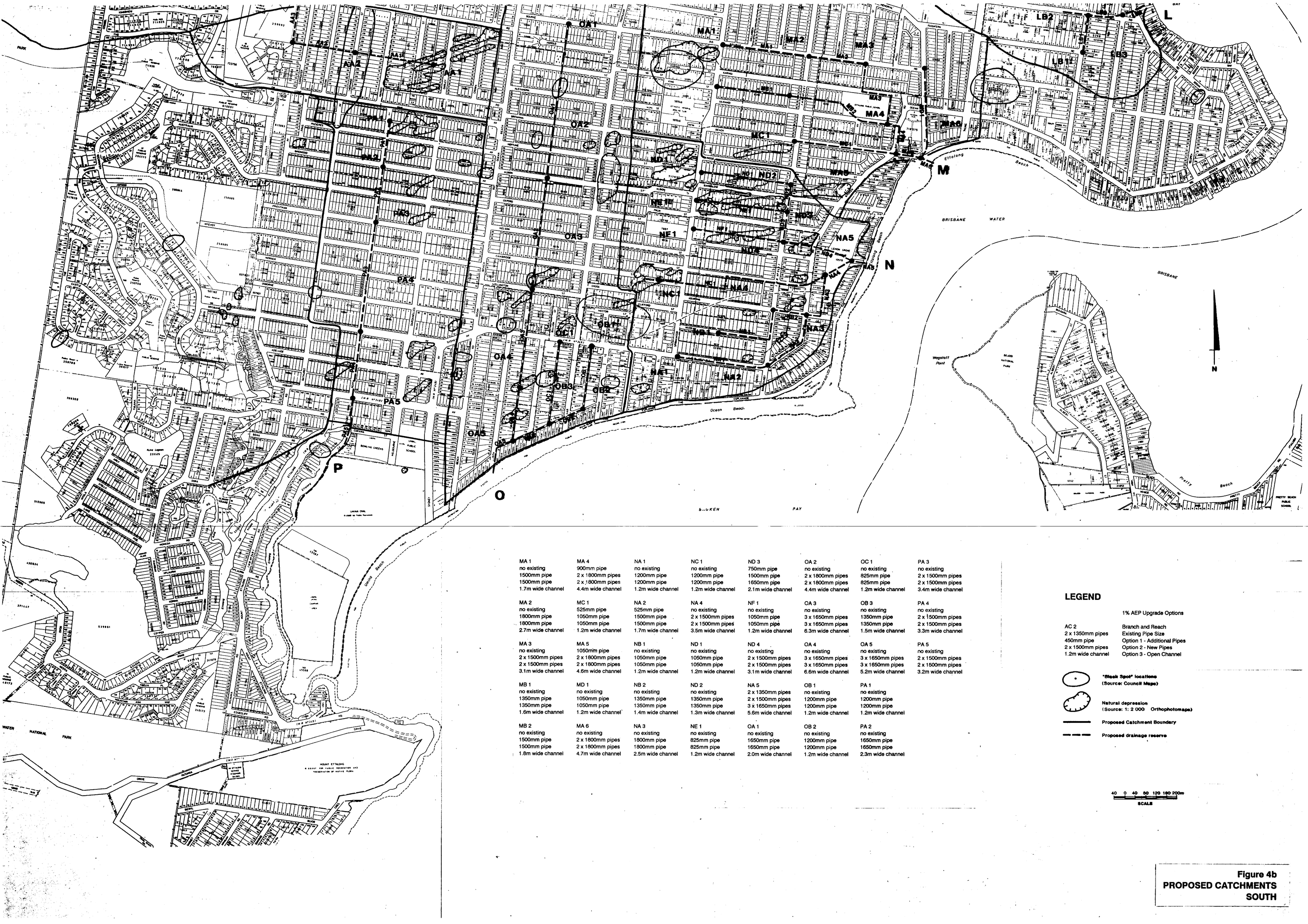
Recommended Upgrading, Short to Medium Term

AP 4 1% AEP	- Pipe & Reach, Design Standard
1800 mm pipe	- Existing Pipe Size
2 x 1800mm dia pipe	- Recommended Upgrade Size

Note: *Text in italics denotes reaches to be upgraded*

QC 1 10% AEP 750 mm pipe No Upgrade Required	*RA2 1% AEP* *900 mm pipe* *1 x 600mm dia pipe*	*SC3 10% AEP* *open drain* *1 x 1350mm dia pipe*	*TA2 10% AEP* *600 mm pipe* *1 x 1050mm dia pipe*	AAA3 10% AEP 1050 mm pipe No Upgrade Required
QC 2 1% AEP *750 mm pipe* *1 x 750mm dia pipe*	*SA1 10% AEP* *open drain* *1 x 750mm dia pipe*	*SC4 10% AEP* *open drain* *1 x 1500mm dia pipe*	TB 1 10% AEP 600 mm pipe No Upgrade Required	AAA4 10% AEP 1200 mm pipe No Upgrade Required
QA5 1% AEP *2 x 900 mm pipe* *1 x 1500mm dia pipe*	*SA2 10% AEP* *open drain* *1 x 1200mm dia pipe*	*SC5 10% AEP* *1200 mm pipe* *1 x 1200mm dia pipe*	*TA3 1% AEP* *open drain* *1 x 1650mm dia pipe*	AAA5 10% AEP 1350 mm pipe No Upgrade Required
QD 1 1% AEP 900 mm pipe No Upgrade Required	*SA3 1% AEP* *open drain* *1 x 1650mm dia pipe*	*SC6 10% AEP* *1350 mm pipe* *1 x 1200mm dia pipe*	*TA4 1% AEP* *open drain* *1 x 1650mm dia pipe*	AAA6 10% AEP 1350 mm pipe No Upgrade Required
QD 2 1% AEP 1050 mm pipe No Upgrade Required	*SA4 1% AEP* *900 mm pipe* *1 x 1800mm dia pipe*	*SC7 1% AEP* *1500 mm pipe* *1 x 1500mm dia pipe*	UA 1 10% AEP 450 + 600 mm pipe No Upgrade Required	AAB 1 10% AEP 600 mm pipe No Upgrade Required
QE 1 10% AEP *600 mm pipe* *1 x 375mm dia pipe*	*SB1 1% AEP* *open drain* *1 x 600mm dia pipe*	*SA7 1% AEP* *1800 mm pipe* *2 x 1500mm dia pipe*	VA 1 10% AEP 525 mm pipe No Upgrade Required	AAA 7 10% AEP 1350 mm pipe No Upgrade Required
QF 1 10% AEP 525 mm pipe No Upgrade Required	*SB 2 1% AEP* *open drain* *1 x 750mm dia pipe*	*SA8 10% AEP* *1800 mm pipe* *1 x 1650mm dia pipe*	WA 1 10% AEP 375 mm pipe No Upgrade Required	AAA 8 10% AEP 1500 mm pipe No Upgrade Required
QE 2 10% AEP *open drain* *1 x 1050mm dia pipe*	*SA5 1% AEP* *1200 mm pipe* *1 x 1800mm dia pipe*	SD 1 10% AEP 675 mm pipe No Upgrade Required	XA 1 10% AEP 2 x 525 mm pipe No Upgrade Required	AAA 9 10% AEP 1500 mm pipe No Upgrade Required
QA 6 10% AEP *open drain* *3.4m wide channel*	*SA6 1% AEP* *1350 mm pipe* *1 x 1650mm dia pipe*	*SA9 10% AEP* *1800 mm pipe* *1 x 1650mm dia pipe*	*YA1 10% AEP* *open drain* *1 x 450mm dia pipe*	AAC 1 10% AEP 675 mm pipe No Upgrade Required
QA7 1% AEP *1050 + 1200 mm pipe* *2 x 1800mm dia pipe*	*SC1 10% AEP* *open drain* *1 x 675mm dia pipe*	*SA10 1% AEP* *1800 mm pipe* *2 x 1500mm dia pipe*	AAA 1 10% AEP 525 mm pipe No Upgrade Required	AAD 1 10% AEP 750 mm pipe No Upgrade Required
RA1 1% AEP *750 mm pipe* *1 x 750mm dia pipe*	*SC2 10% AEP* *open drain* *1 x 1050mm dia pipe*	*TA1 10% AEP* *600 mm pipe* *1 x 900mm dia pipe*	*AAA2 10% AEP* *675 mm pipe* *1 x 600mm dia pipe*	AAC 2 10% AEP 900 mm pipe No Upgrade Required
				AAC 3 10% AEP 1050 mm pipe No Upgrade Required
				AAA 10 10% AEP 2x1200+1050 mm pipe No Upgrade Required

Figure 3a
EXISTING CATCHMENTS NORTH



MA 1	MA 4	NA 1	NC 1	ND 3	OA 2	OC 1	PA 3
no existing	900mm pipe	no existing	no existing	750mm pipe	no existing	no existing	no existing
1500mm pipe	2 x 1800mm pipes	1200mm pipe	1200mm pipe	1500mm pipe	2 x 1800mm pipes	825mm pipe	2 x 1500mm pipes
1500mm pipe	2 x 1800mm pipes	1200mm pipe	1200mm pipe	1650mm pipe	2 x 1800mm pipes	825mm pipe	2 x 1500mm pipes
1.7m wide channel	4.4m wide channel	1.2m wide channel	1.2m wide channel	2.1m wide channel	4.4m wide channel	1.2m wide channel	3.4m wide channel
MA 2	**MC 1**	**NA 2**	**NA 4**	**NF 1**	**OA 3**	**OB 3**	**PA 4**
no existing	525mm pipe	525mm pipe	no existing	no existing	no existing	no existing	no existing
1800mm pipe	1050mm pipe	1500mm pipe	2 x 1500mm pipes	1050mm pipe	3 x 1650mm pipes	1350mm pipe	2 x 1500mm pipes
1800mm pipe	1050mm pipe	1500mm pipe	2 x 1500mm pipes	1050mm pipe	3 x 1650mm pipes	1350mm pipe	2 x 1500mm pipes
2.7m wide channel	1.2m wide channel	1.7m wide channel	3.5m wide channel	1.2m wide channel	6.3m wide channel	1.5m wide channel	3.3m wide channel
MA 3	**MA 5**	**NB 1**	**ND 1**	**ND 4**	**OA 4**	**OA 5**	**PA 5**
no existing	1050mm pipe	no existing	no existing	no existing	no existing	no existing	no existing
2 x 1500mm pipes	2 x 1800mm pipes	1050mm pipe	1050mm pipe	2 x 1500mm pipes	3 x 1650mm pipes	3 x 1650mm pipes	2 x 1500mm pipes
2 x 1500mm pipes	2 x 1800mm pipes	1050mm pipe	1050mm pipe	2 x 1500mm pipes	3 x 1650mm pipes	3 x 1650mm pipes	2 x 1500mm pipes
3.1m wide channel	4.6m wide channel	1.2m wide channel	1.2m wide channel	3.1m wide channel	6.6m wide channel	5.2m wide channel	3.2m wide channel
MB 1	**MD 1**	**NB 2**	**ND 2**	**NA 5**	**OB 1**	**PA 1**	
no existing	no existing	no existing	no existing	2 x 1350mm pipes	no existing	no existing	
1350mm pipe	1050mm pipe	1350mm pipe	1350mm pipe	2 x 1500mm pipes	1200mm pipe	1200mm pipe	
1350mm pipe	1050mm pipe	1350mm pipe	1350mm pipe	3 x 1650mm pipes	1200mm pipe	1200mm pipe	
1.6m wide channel	1.2m wide channel	1.4m wide channel	1.3m wide channel	5.6m wide channel	1.2m wide channel	1.2m wide channel	
MB 2	**MA 6**	**NA 3**	**NE 1**	**OA 1**	**OB 2**	**PA 2**	
no existing	no existing	no existing	no existing	no existing	no existing	no existing	
1500mm pipe	2 x 1800mm pipes	1800mm pipe	825mm pipe	1650mm pipe	1200mm pipe	1650mm pipe	
1500mm pipe	2 x 1800mm pipes	1800mm pipe	825mm pipe	1650mm pipe	1200mm pipe	1650mm pipe	
1.8m wide channel	4.7m wide channel	2.5m wide channel	1.2m wide channel	2.0m wide channel	1.2m wide channel	2.3m wide channel	

LEGEND

1% AEP Upgrade Options

AC 2	Branch and Reach
2 x 1350mm pipes	Existing Pipe Size
450mm pipe	Option 1 - Additional Pipes
2 x 1500mm pipes	Option 2 - New Pipes
1.2m wide channel	Option 3 - Open Channel

"Black Spot" locations (Source: Council Maps)

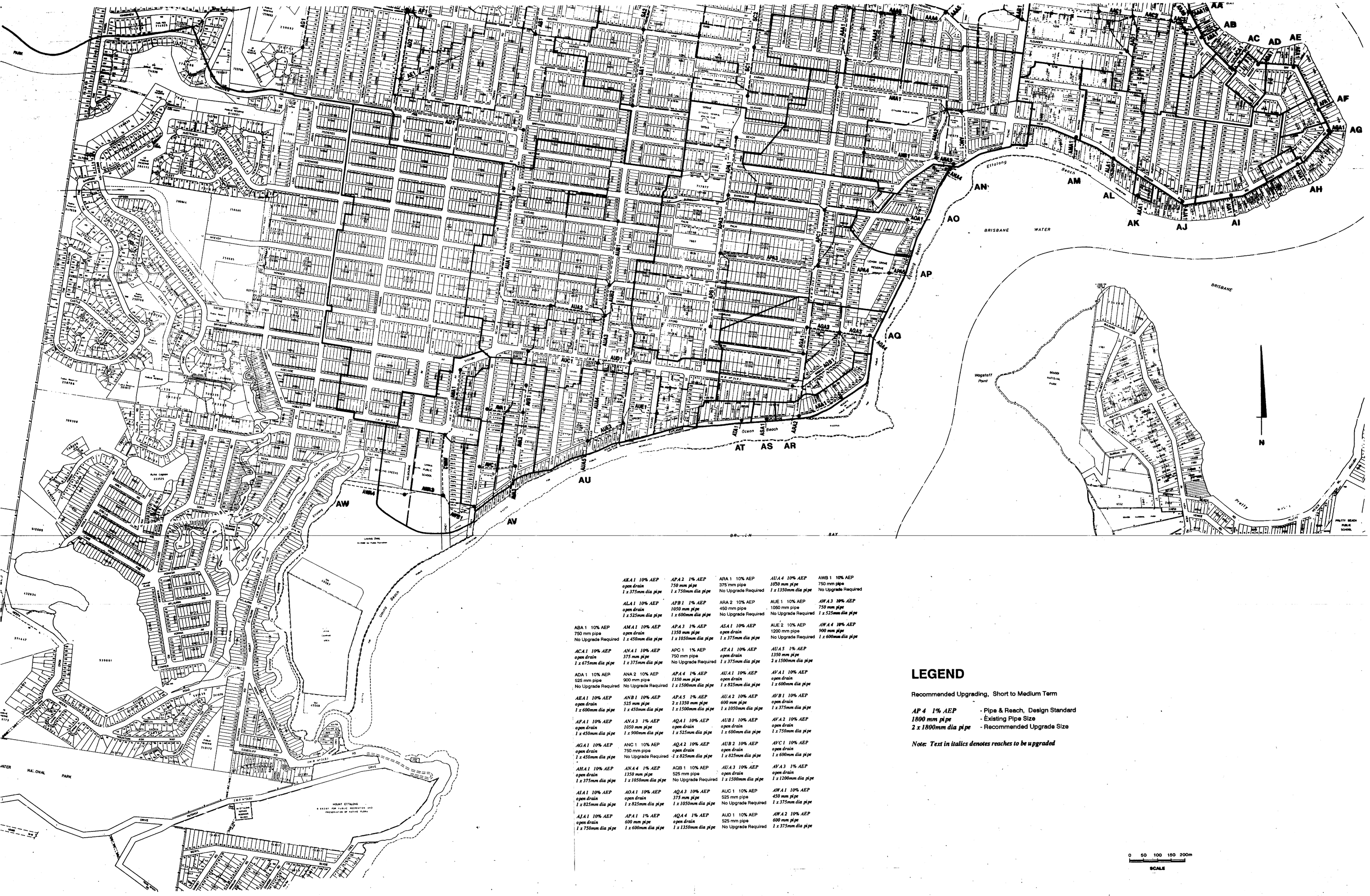
Natural depression (Source: 1: 2 000 Orthophotomaps)

Proposed Catchment Boundary

Proposed drainage reserve

40 0 40 80 120 160 200m
SCALE

Figure 4b
PROPOSED CATCHMENTS SOUTH



	AKA1 10% AEP *open drain* *1 x 375mm dia pipe*	*APA2 1% AEP* *750 mm pipe* *1 x 750mm dia pipe*	ARA 1 10% AEP 375 mm pipe No Upgrade Required	*AUA4 10% AEP* *1050 mm pipe* *1 x 1350mm dia pipe*	AWB 1 10% AEP 750 mm pipe No Upgrade Required
	ALA1 10% AEP *open drain* *1 x 525mm dia pipe*	*APB1 1% AEP* *1050 mm pipe* *1 x 600mm dia pipe*	ARA 2 10% AEP 450 mm pipe No Upgrade Required	AUE 1 10% AEP 1050 mm pipe No Upgrade Required	*AWA 3 10% AEP* *750 mm pipe* *1 x 525mm dia pipe*
ABA 1 10% AEP 750 mm pipe No Upgrade Required	*AMA1 10% AEP* *open drain* *1 x 450mm dia pipe*	*APA3 1% AEP* *1350 mm pipe* *1 x 1050mm dia pipe*	*ASA1 10% AEP* *open drain* *1 x 375mm dia pipe*	AUE 2 10% AEP 1200 mm pipe No Upgrade Required	*AWA 4 10% AEP* *900 mm pipe* *1 x 600mm dia pipe*
ACA1 10% AEP *open drain* *1 x 675mm dia pipe*	*ANA1 10% AEP* *375 mm pipe* *1 x 375mm dia pipe*	APC 1 1% AEP 750 mm pipe No Upgrade Required	*ATA1 10% AEP* *open drain* *1 x 375mm dia pipe*	*AUA5 1% AEP* *1350 mm pipe* *2 x 1500mm dia pipe*	
ADA 1 10% AEP 525 mm pipe No Upgrade Required	ANA 2 10% AEP 900 mm pipe No Upgrade Required	*APA4 1% AEP* *1350 mm pipe* *1 x 1500mm dia pipe*	*AUA1 10% AEP* *open drain* *1 x 825mm dia pipe*	*AVA1 10% AEP* *open drain* *1 x 600mm dia pipe*	
AEA1 10% AEP *open drain* *1 x 600mm dia pipe*	*ANB1 10% AEP* *525 mm pipe* *1 x 450mm dia pipe*	*APA5 1% AEP* *2 x 1350 mm pipe* *1 x 1500mm dia pipe*	*AUA2 10% AEP* *600 mm pipe* *1 x 1050mm dia pipe*	*AVB1 10% AEP* *open drain* *1 x 375mm dia pipe*	
AFA1 10% AEP *open drain* *1 x 450mm dia pipe*	*ANA3 1% AEP* *1050 mm pipe* *1 x 900mm dia pipe*	*AQA1 10% AEP* *open drain* *1 x 525mm dia pipe*	*AUB1 10% AEP* *open drain* *1 x 600mm dia pipe*	*AVA2 10% AEP* *open drain* *1 x 750mm dia pipe*	
AGA1 10% AEP *open drain* *1 x 450mm dia pipe*	ANC 1 10% AEP 750 mm pipe No Upgrade Required	*AQA2 10% AEP* *open drain* *1 x 825mm dia pipe*	*AUB2 10% AEP* *open drain* *1 x 825mm dia pipe*	*AVC1 10% AEP* *open drain* *1 x 600mm dia pipe*	
AHA1 10% AEP *open drain* *1 x 375mm dia pipe*	*ANA4 1% AEP* *1350 mm pipe* *1 x 1050mm dia pipe*	AQB 1 10% AEP 525 mm pipe No Upgrade Required	*AUA3 10% AEP* *open drain* *1 x 1500mm dia pipe*	*AVA3 1% AEP* *open drain* *1 x 1200mm dia pipe*	
AIA1 10% AEP *open drain* *1 x 825mm dia pipe*	*AOA1 10% AEP* *open drain* *1 x 825mm dia pipe*	*AQA3 10% AEP* *375 mm pipe* *1 x 1050mm dia pipe*	AUC 1 10% AEP 525 mm pipe No Upgrade Required	*AWA1 10% AEP* *450 mm pipe* *1 x 375mm dia pipe*	
AJA1 10% AEP *open drain* *1 x 750mm dia pipe*	*APA1 1% AEP* *600 mm pipe* *1 x 600mm dia pipe*	*AQA4 1% AEP* *open drain* *1 x 1350mm dia pipe*	AUD 1 10% AEP 525 mm pipe No Upgrade Required	*AWA2 10% AEP* *600 mm pipe* *1 x 375mm dia pipe*	

LEGEND

Recommended Upgrading, Short to Medium Term

AP 4 1% AEP - Pipe & Reach, Design Standard
1800 mm pipe - Existing Pipe Size
2 x 1800mm dia pipe - Recommended Upgrade Size

Note: Text in italics denotes reaches to be upgraded

0 50 100 150 200m
SCALE

Figure 3b
EXISTING CATCHMENTS SOUTH

End of Report