PLANNING PROPOSAL

PART LOT 2 DP 1101094
RANNOCH AVENUE
MACLEAN

APRIL 2015

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1. OBJECTIVES OR INTENDED OUTCOMES

To enable medium density residential development on Part Lot 2 DP 1101094 Rannoch Avenue, Maclean comprising 1.34ha.

2. EXPLANATION OF PROVISIONS

Amendment of the Clarence Valley Local Environmental Plan 2011 Land Zoning Map in accordance with the proposed zoning map shown in Annexure A.

3. BACKGROUND

Two adjoining properties on Rannoch Avenue and Hogues Lane have been the subject of several residential subdivision applications and approvals. The properties have subsequently been purchased and a new development application and modification to previous subdivision approvals have been lodged with Council.

Under the new ownership the properties have a potential for twenty four (24) residential flat building style units and twenty eight (28) residential lots on the Rannoch Avenue property and one hundred and fifteen (115) residential lots on the Hogues Lane property.

Approval was granted by Clarence Valley Council to stage 1 of a residential subdivision of Lot 2 DP 1101094 in Rannoch Avenue to create twenty three (23) residential lots, one (1) detention pond and a residue lot under SUB 2007/053. The subdivision approval has commenced. Stage 2 of the development would result in a further nine (9) residential lots adjoining a public reserve area known as Wherrett Park that provides for the sporting needs of Maclean township.

It is considered that this stage 2 location is better suited to residential flat building style housing to compliment existing medium density zoned land to the north currently proposed for twenty four (24) units and as a transition to low density housing to the east. The land is also located only 600m from the Maclean Hospital and 1.25 km from the Post Office and central business area of Maclean.

It is proposed to identify a triangular shaped area comprising the stage 2 residential subdivision land and some of the approved stage 1 lots (five (5) lots) with a total area of 1.34ha to be rezoned to R1 General Residential. This area could then accommodate some fifty five (55) three storey town houses on a community title or strata title subdivision. The area adjoins sporting fields, is close to the town centre and would provide for a more compact town.

The site is currently within Zone R2 Low Density Residential that is available to provide for a range of housing needs, however, in order to allow a design in the form of three (3) storey town houses it is necessary for the site to be rezoned to Zone R1 General Residential.

The R2 zone aims to limit housing design to a low density residential environment where the R1 zone will permit a variety of housing types and densities. It is considered that the town house style is better suited to this location close to the town centre and services.

Currently there are one hundred and sixty seven (167) dwellings proposed in the Rannoch Avenue and Hogues Lane area that are available for development. The Planning Proposal will allow an increase of forty one (41) dwellings in this location. The increase is considered to be only a minor increase in the total dwellings in Maclean township on flood prone lands.

A copy of the approved stage 1 subdivision, a plan showing the area requested for rezoning to R1 and concept plans for the proposed development of the site are included in Annexure B.

4. JUSTIFICATION

SECTION A –Need for the planning proposal

1. Is the planning proposal a result of any strategic study or report ?

No. The need for the Planning Proposal has arisen from the location of the site in proximity to existing town centre and services and adjoining sporting fields and other urban facilities as a logical transition to low density housing.

2. Is the planning proposal the best means of achieving the objectives or intended outcomes ?

The Planning Proposal is the only means of enabling medium density residential development on this infill location.

The only alternative is to withhold the proposal for inclusion in the next Council amendment to the Local Environmental Plan. However, there is no known timeframe for an amendment and as such the Planning Proposal is the only current option.

3. Is there a net community benefit ?

The community benefits are summarised as follows:-

- Additional housing opportunities in proximity to central business area.
- Provision of additional housing to support the economic viability of the area and local businesses.
- Maximising the use of urban infrastructure such as water and sewer services.
- Promotion of compact town to reduce the need for urban expansion.

SECTION B – Relationship to strategic planning framework

4. Is the planning proposal consistent with the objectives and actions contained within the applicable regional or sub-regional strategy?

The Planning Proposal is consistent with the objectives and strategic actions outlined in the Mid North Coast Regional Strategy as the land is included as a 'Growth Area' for Maclean that is identified as a Major Town.

Under the Mid North Coast Regional Strategy in respect to 'Natural Hazards' it is recommended that Council undertake flood investigations over land affected by sea level rises and inundation to ensure that risks to public and private assets are minimised. The Regional Strategy requires Council to not zone land or approve new development until the flood investigations are completed or redevelopment in potential hazard areas unless the location is assessed within a risk assessment framework adopted by the Council.

In this case, the site is located behind a flood levee for the protection of the public and private assets and flood investigation have been undertaken by de Groot & Benson Pty Ltd that found that with some site filling there will be no increase in flood impacts in this locality. The findings of the flood investigation report have been accepted by Council for the residential development approved on the adjoining lands.

5. Is the planning proposal consistent with the Local Council's Community Strategic Plan, or other local strategic plan ?

The proposal is also consistent with the Clarence Valley Settlement Strategy where Maclean is identified as a major district centre helping to serve the Lower Clarence community with secondary levels of sub-regional services. This Strategy acknowledges that residents access to services will be optimised by increased housing being encouraged closer to the Central Business District and is appropriate for the subject site.

6. Is the planning proposal consistent with applicable state environmental planning policies ?

The State Policies that have any relevance to the subject site are summarised as follows:

STATE POLICY (SEPP)	OBJECTIVE	CONSISTENCY
SEPP (Affordable Rental Housing) 2009	Provides incentives for new affordable rental housing	Complies. Provisions will apply.
SEPP (Exempt & Complying Development Codes) 2008	Streamlines assessment process for exempt and complying development	Complies. Provisions will apply.
SEPP (Infrastructure) 2007	Provide a regime for infrastructure and services across NSW.	Complies. Provisions will apply to development on this land.
SEPP(Temporary Structures) 2007.	Provides for erection of temporary structures and public entertainment.	Complies. Provisions will apply to development of this land.
SEPP (Major Developments) 2005	Defines projects to which the Minister is the consent authority.	Complies. Provisions will apply to development of this land.
SEPP (Building Sustainability Index) 2004.	Ensures the introduction of BASIX in NSW	Complies. BASIX will apply to new dwellings.
SEPP (Housing for Seniors or People with a Disability) 2004	Encourages accommodation for ageing population.	Complies. Provisions will apply to residential zone.
SEPP 71 Coastal Protection	To ensure appropriate development on the coast.	Complies. Provision will apply to this site. Generally replaced by clause 5.5 of LEP.
SEPP 55 – Remediation of Land	Controls remediation of contaminated Lands.	Complies. Assessment process applies to development of this site.
SEPP 36 Manufactured Home Estates.	Provides design criteria for manufactured home estates.	Complies. Provisions apply to this site and future development.
SEPP 14 – Coastal Wetlands.	Protects coastal wetlands.	Complies. No wetlands likely to be affected.
SEPP 1 – Development Standards	Provides flexibility in development standards.	Complies. Provisions apply to this site. Generally replaced by Clause 4.6 of LEP.

7. Is the proposal consistent with applicable Ministerial Directions ?

A summary of the current Section 117 Directions and their relevance to the residential rezoning is provided as follows:-

Direction	Objectives	Requirements	Consistency
1 Employment and Resources			
1.1 Business & Industrial Zone	To encourage and protect employment growth in business and industrial zones	To retain and not reduce business and industrial zones.	Complies Proposal will not impact on existing zones but will provide additional potential employees to support growth of employment lands. Not applicable.
1.2 Rural Zones	To protect agricultural production value of rural land	To not rezone rural zone to residential unless of minor significance.	Land is currently zoned residential.
1.3 Mining, Petroleum Production and Extractive Industries	To protect future reserves of extractive materials	To identify any extractive resources and land use conflicts	The site is an area of former alluvial floodplain with no likelihood of containing extractive material.
1.4 Oyster Aquaculture	To protect oyster aquaculture from impacts on water quality.	To consider likely impacts from incompatible uses and evaluate measures to avoid impact.	Reticulated sewerage services will be extended to each lot. Stormwater runoff controls can be provided by rainwater tanks, bioswales in roads and gross pollutant traps to ensure a nil or beneficial impact.
1.5 Rural Lands	To protect agricultural values	To retain rural lot sizes in accordance with rural planning principles and State Policy	Not applicable.
2 Environment and Heritage			
2.1 Environment Protection Zones	To protect and conserve environmentally sensitive areas	To include provisions to protect and conserve environmentally sensitive areas.	There are no aspects of this site that could be considered to be environmentally sensitive. Potential impacts can be controlled within the development of the land to ensure a nil or beneficial impact.
2.2 Coastal Protection	To implement the principles in the NSW Coastal Policy	To include coastal protection provisions in a planning proposal	The land to be developed is behind a levee along the river. Design guidelines can protect any visual impact. The site is removed from any ocean impacts.
2.3 Heritage Conservation	To conserve aspects of heritage significance	To ensure provisions to conserve heritage items are included.	There are no known heritage items to protect in this locality.

Direction	Objectives	Requirements	Consistency
2.4 Recreation Vehicle Access	To protect sensitive land and conservation areas from impacts from recreation vehicles.	To prevent land from being developed for recreation vehicle areas within environmental protection zones or beach and dune area.	Not applicable.
3 Housing, Infrastructure and Urban Development			
3.1 Residential Zones	To encourage variety in housing, make efficient use of infrastructure and minimise impacts.	To prevent residential development unless land is adequately serviced. To reduce consumption of land on the urban fringe. To broaden the choice of locations.	Complies The development of this land will make efficient use of the extension of services. The increased housing will reduce demand for urban land and provide wider choice of housing.
3.2 Caravan Parks and Manufactured Home Estates	To provide for a variety of housing choice and opportunities for caravan parks and manufactured home estates.	To retain provisions that permit caravan parks and identify locations for manufactured home estates.	Provisions will apply.
3.3 Home Occupations	To encourage low impact small businesses in dwelling houses.	To permit home occupations without development consent.	Future dwellings can include a home occupation.
3.4 Integrating Land Use and Transport	To ensure the subdivision and street layout improves access, walking, cycling and public transport choices and to reduce travel distances.	To locate zones for urban purposes to satisfy improved transport choices and in proximity to business and services.	Complies. The development will increase housing opportunities close to business and services.
3.5 Development Near Licensed Aerodromes	To ensure the effective and safe operation of aerodromes.	To control development in the vicinity of aerodromes.	Not relevant.
3.6 Shooting Ranges	To ensure safety and maintain amenity for rezoning for ranges.	To require consideration of issues prior to rezoning.	Not applicable. No shooting range in existence or proposed.
4 Hazard and Risk			
4.1 Acid Sulfate Soils	To avoid significant impacts from acid sulfate soils	To consider and regulate works in acid sulfate soils	An Acid Sulfate Soil Management Plan has been prepared for excavation activities involved in the construction of residential development on adjoining lands in the Rannoch Avenue and Hogues Lane properties. Site testing found acid soils of varying degrees of acidity and prepared management principles and guidelines. In addition, the site is to have fill placed on the development area. The Management Plan ensures that any impacts will be managed. A copy of the Plan is included in Annexure D.

Direction	Objectives	Requirements	Consistency
4.2 Mine Subsidence and Unstable Land	To prevent damage on land identified as unstable	To prevent development on unstable land.	Site comprises alluvial flood plain and has been compacted over many years. The topography of the development area is level and unlikely to be unstable.
4.3 Flood Prone Land	To ensure consideration of potential flood impacts.	Not rezone land within flood planning areas to increase development without adequate justification.	Land is zoned residential and is behind a flood levee. Buildings will be designed for flood protection. Justification report attached. The report includes filling the site to 1.7m AHD, considers evacuation routes and other matters in accordance with the Lower Clarence Valley Flood Plan 2012, Grafton and Lower Clarence Floodplain Risk Management Plan 2007 and matters for consideration under Direction 4.3. There is currently 167 dwellings proposed on the Rannoch Avenue & Hogues Lane sites. The Planning Proposal will allow an increase of forty one (41) dwellings that is 25% in this locality but only a very minor increase in the total dwellings in Maclean on flood prone land.
4.4 Planning for Bushfire Protection.	To protect life, property and environment from bushfire hazards.	To comply with Planning for Bushfire Protection 2006.	Site does not contain any vegetation likely to be a bushfire risk and is not in a bushfire risk location.
5 Regional Planning			
5.1 Implementation of Regional Strategies	To give legal effect to regional strategies.	To ensure consistency with Mid North Coast Regional Strategy	Maclean is identified as a Major Town. Subject site will support the growth of this town. The land is included as a 'Growth Area'.
5.2 Sydney Drinking Water Catchments	To protect water quality in Sydney water catchment.	Applies to certain council areas near Sydney.	Not applicable to Clarence Valley.
5.3 Farm land of State and Regional Significance on the NSW Far North Coast	To protect the best agricultural land in certain Council areas on north coast.	Applies to certain Council areas in north coast.	Land is already zoned for residential purposes.

Direction	Objectives	Requirements	Consistency
5.4 Commercial and Retail Development along the Pacific Highway North Coast.	To manage commercial and retail development along the Pacific Highway.	New commercial and retail development must be concentrated in district centres or 'within town' segments of the Pacific Highway and not in 'out of town' locations likely to impact on highway efficiency.	Not applicable.
5.5 Development in vicinity of Ettalong, Paxton and Millford.	To ensure consistency with Cessnock City Wide Settlement Strategy.	Prevent inconsistent rezoning.	Not applicable.
5.6 Sydney to Canberra Corridor	Revoked 10 July 2008		
5.7 Central Coast	Revoked 10 July 2008.		
5.8 Second Sydney Airport Badgerys Creek.	To avoid incompatible development near future airport site.	Prevent inconsistent rezoning.	Not applicable.
6 Local Plan Making			
6.1 Approval and Referral Requirements	To encourage efficient and appropriate assessment of development.	Minimise concurrence and referral of applications to Minister and public authority and not classify designated development unless significant impact is likely.	New LEP 2011 has addressed this issue. Subject land is included in residential zone under LEP.
6.2 Reserving land for Public Purposes.	To facilitate reserving land for public purposes and removal where no longer required.	Adhere to directions of Department of Planning, Minister or public authority when considering reserve land.	Land is included in residential zone and will not propose new reserves or alter existing reserves.
6.3 Site Specific Provisions.	To discourage unnecessarily restrictive site controls.	To rezone land to maintain existing zones and controls in principal LEP.	Land has adopted a standard residential zone.
7 Metropolitan Planning			
7.1 Implementation of Metropolitan Strategy	To give legal effect to the Metropolitan Strategy.	To require consistency from certain city Councils to Metropolitan Strategy	Not applicable

SECTION C – Environmental, Social and Economic Impact

8. Is there any likelihood that critical habitat or threatened species, populations or ecological communities or their habitats, will be adversely affected as a result of the proposal ?

The area has been retained as pasture land with no other vegetation and zoned for residential use . It is inconceivable that any flora or fauna could be adversely affected by the proposal. Impacts of development for residential flat building purposes can be contained with the site with services readily extended to future house sites.

9. Are there any other likely environmental effects as a result of the planning proposal and how are they proposed to be managed ?

The site is identified as being floodprone and is protected by a levee. A Stormwater Management Study has been prepared by de Groot & Benson Pty Ltd to assess stormwater impacts for various development in this location. A copy of the study is attached in Annexure C. The study has found that there will be no increase in flood impacts.

Acid Sulfate soils can occur in this locality in varying degrees of acidity. Acid soils are not a prohibition to development and can be appropriately managed where exposed. Australian Soil & Concrete Testing Pty Ltd have prepared an Acid Sulfate Management Plan for adjoining lands and a copy is included in Annexure D.

10. How has the planning proposal adequately addressed any social and economic affects ?

The proposal will make a positive contribution to the economic stability of Maclean and the central business area and the provision of affordable housing opportunities.

The proximity to Maclean central business area and existing urban services and infrastructure will ensure that the proposal should have a positive social and economic effect. In addition, the proposal will complement the adjoining medium density zoned area.

SECTION D – State and Commonwealth Interests

11. Is there adequate public infrastructure for the planning proposal ?

The site is located 600m from the Maclean Hospital and 1.25km to the Post Office. The area is already serviced by Council. The proposal will result in a more efficient use of the services provided.

12. What are the views of State and Commonwealth public authorities consulted in accordance with the gateway determination ?

This consultation has yet to be undertaken, however, the Department of Planning has advised Councils that any residential rezoning must be in accordance with the Mid North Coast Regional Plan. This land is identified as a growth area in the Regional Plan and the proposal aims to increase housing opportunities in proximity to urban services.

5. COMMUNITY CONSULTATION

The proposal has not been exhibited for public consultation, however, the area has been zoned for residential use for many years.

Existing medium density housing is permitted on adjoining land. The proposal will provide additional housing opportunities adjoining public reserve land.

It is considered that the proposal is a 'low' impact planning proposal as it complies with the following criteria.

- It is consistent with the pattern of development proposed on the north side of Rannoch Avenue that is already zoned for medium density development.

- It is consistent with the strategic planning process of encouraging compact towns close to the town centre of a 'Growth Area' recognized as a Major Town in the Mid North Coast Regional Strategy and also recognized in the Clarence Valley Settlement Strategy.
- Presents no issues with regard to infrastructure servicing as all services are readily available to this residentially zoned area.
- The proposal is not a principal Local Environmental Plan but a change to an infill area of existing residentially zoned land.
- Does not reclassify any public land.

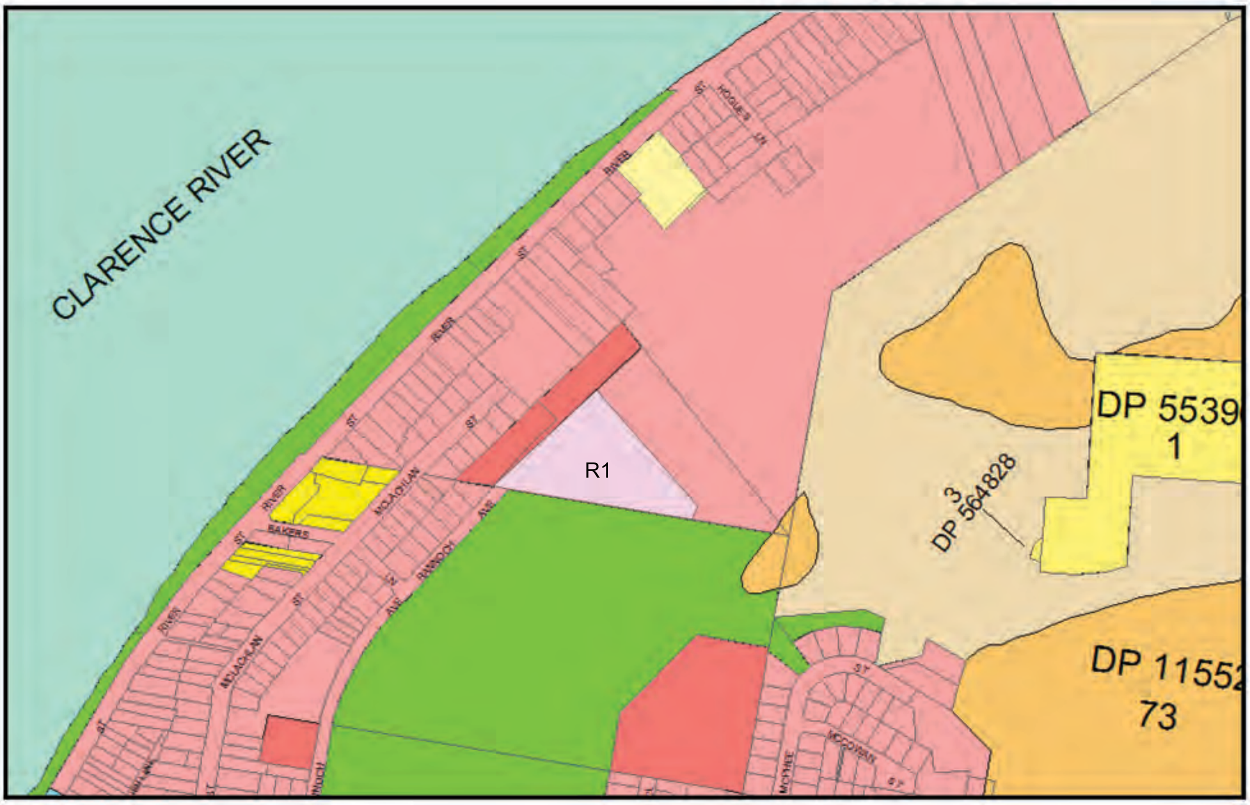
It is considered that exhibition for a fourteen (14) day period is adequate in the circumstances.

ANNEXURE A

Proposed Zoning Map

Clarence Valley Local Environmental Plan 2011

PROPOSED ZONING MAP



LEGEND

ZONE

B1	Neighbourhood Centre
B2	Local Centre
B3	Commercial Core
B5	Business Development
E1	National Parks and Nature Reserves
E2	Environmental Conservation
E3	Environmental Management
IN1	General Industrial
IN4	Working Waterfront
R1	General Residential
R2	Low Density Residential
R3	Medium Density Residential
R5	Large Lot Residential
RE1	Public Recreation
RE2	Private Recreation
RU1	Primary Production
RU2	Rural Landscape
RU3	Forestry
SP1	Special Activities
SP2	Infrastructure
SP3	Tourist
W1	Natural Waterways
W2	Recreational Waterways
W3	Working Waterways

N

on: GDA 1994
Zone 56

ANNEXURE B

Concept Plans by Mondo Architects

STAGING

1 : 500

PRELIMINARY not for construction

SITE RANNOCH AVENUE MACLEAN

CLIENT PIPERS GLEN HOLDINGS P/L

MONDOARCHITECTS

212 BOUNDARY STREET SPRING HILL QLD 4000
design@mondoarchitects.com.au T 07 3838 1638 F 07 3838 1688
MONDO ARCHITECTS PTY LTD ABN 64 085 992 990

DATE	DESCRIPTION	BY	REV
02.05.14	PRELIM CONCEPT	SK	A

SHEET P-002

A3

STAGES

PROJECT 4467

RANNOCH SOUTH

DEVELOPMENT SUMMARY
PART LOT 2 DP 1101094
PROPOSED SITE AREA APPROX 13458m2

PROPOSED DWELLING UNITS
TYPE A - 2
TYPE B - 4
TYPE C - 4
TYPE D - 2
TYPE E - 20
TYPE F - 15
TYPE G - 8

TOTAL - 55 UNITS

SITE COVER - 4560m2 (34%)

CARPARKING
TYPE A - DOUBLE GARAGE
TYPE B - DOUBLE GARAGE
TYPE C - SINGLE GARAGE + PRIVATE VISITOR ON DRIVEWAY
TYPE D - DOUBLE GARAGE
TYPE E - SINGLE GARAGE + CARPORT
TYPE F -DOUBLE GARAGE
TYPE G - TANDEM GARAGE
VISITOR CARPARKS - 25

REAR VEHICLE ACCESS 3 STOREY TOWNHOUSES WITH FRONT ENTRY TO ADDRESS RANNOCH AVENUE, THIS WILL PROVIDE VISUAL INTEREST TO THE STREETSCAPE AND ALSO PROVIDE INTERACTION WITH THE STREET

SITE PLAN

1 : 500

PRELIMINARY not for construction

SITE RANNOCH AVENUE MACLEAN

CLIENT PIPERS GLEN HOLDINGS P/L

MONDOARCHITECTS
212 BOUNDARY STREET SPRING HILL QLD 4000
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MONDO ARCHITECTS PTY LTD ABN 64 085 992 990

DATE	DESCRIPTION	BY	REV
02.05.14	PRELIM CONCEPT	SK	A

SHEET P-001

A3

SITE PLAN

PROJECT 4467

RANNOCH SOUTH

ANNEXURE C

Stormwater Management Strategy by de Groot & Benson Pty Ltd

Rannoch Ave & Hogues Lane Developments

Stormwater Management Strategy Amendment E

December 2014

de Groot & Benson Pty Ltd

Rannoch Ave & Hogues Lane Developments

Stormwater Management Strategy Amendment E

December 2014

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Job Number:	14007

1 INTRODUCTION

This report seeks to address stormwater management issues relating to development north of the Wherret Park detention basin and east of River Street.

The report has undergone numerous revisions in keeping with the changes in lot layouts and development proposals plus increas.es in the area considered and finally the consideration of additional matters at the request of Council.

The parcels of land specifically under consideration are:
- Lot 3 DP 1052069 Hogues Lane
- Lot 2 DP 1101094 Rannoch Ave

The amendment history is summarised below:

Initial Issue
The initial report sought to address concerns expressed by Council's engineering staff in July 2006 on a submission prepared by this firm. The submission dealt with stormwater generated from the site.

In particular, Council raised the following issues:
- The catchment boundary shown along the River Street side (western side) of the development appeared incorrect.
- No calculations were provided as to the size of the detention basins or the diverted open drains to the east of the development
- No overland flow path was shown for properties to the west of the development.
- No fill plan provided.

This report seeks to address these issues. It is noted that this report is does not represent the final design report for the stormwater drainage system, rather provides sufficient detail to for Council to complete its assessment of the Development Application.

Amendment A
In addition, following review of the report, Council raised several further issues. These have been incorporated into this report. Specifically:

1. the Stormwater Management Strategy does not fully address the impact of flood flows from the upstream catchments, on the land downstream of Wherret Park basin wall, due to the proposed filling for the subdivision and location of the detention basin

2. no consideration has been given to probable maximum flood flows (or wall failure) over the Wherret Park basin wall and the impact on the proposed downstream subdivision

3. no consideration has been given to the effect of flood / tidal flow in the Clarence River on the existing Essex Drain (outlet IL -0.3m)

4. The proposed stage 1 basin appears too deep (TWL 1.35m and 1.6m deep gives IL -0.25) with 1 in 3 slopes and the available area needs reviewing

5. The catchment areas shown need reviewing

Amendment B

Following further discussion with Council, Council stated a preference for the on-site detention basins to have a maximum side slope of 1 in 6 rather than the 1 in 3 previously modelled.

The net effect of this is that the effective available storage of the basins is decreased, with the possibility that additional land area is required to house the basins.

In addition, a conclusion has been added to the report to summarise the overall findings.

Amendment C

We have modelled additional backwater runs assuming different flow conditions down stream.

The Scenarios modelled included:

- Scenario 1 – Assume approx 50%of total flow discharge to River from Essex Drain
- Scenario 2 – Assume Full discharge to River from Essex Drain.

Refer Section 5.2 for details.

In addition Amendment C includes all results of the correspondence with Council since the release of Amendment B.

Amendment D

The report has been extended to reflect development on the proposed lot fronting Rannoch Ave

Minor modifications to the text to reflect the detailed design of bulk earthworks and the detention Basin.

Amendment E

Change in design of part of the Rannoch Avenue development to be medium density community title area required revision of the models used to design the Stormwater Management Strategy. The report has been amended to appropriately represent the latest design. The job reference number for the project has been changed from 04122 to 14007.

In addition, consideration of the Section 117 directions on Flood Prone Land has been added.

2 OVERALL DRAINAGE SYSTEM

2.1 Catchment Areas

The site falls within a large catchment approximately 129ha in size. The catchment is shown on Drawing 14007-10. We note the following:

- The northern section of the Maclean township forms a significant portion of the overall catchment. This area is divided into 2 portions, one that drains through Wherrit Park (approximately 32.4ha) and the sub catchment to the east of the park (approximately 70.6ha).
- These catchments are made up of a combination of developed areas, parkland and forested areas.
- The catchment draining to Wherrit Park is controlled by a detention basin. The outlet of the detention basin drains directly across the subject site. The basin is discussed in more detail in Section 2.2.
- The remaining sub catchments are predominated by the development site.
- Flow from the Wherrit Park area travels northwards in a large open drain. This drain has insufficient capacity for the 1 in 100 year flow and during storm events, stormwater spreads out over a wide area. This drain is referred to as "the main channel" in this report.
- The area eventually drains to the Clarence River through Essex Drain and other drains located further north of the site.
- That section of the catchment between the development site and River Street has a piped drainage system that directs runoff westwards to the river. However, their major storm flow path is to the east through the development site.
- The catchment boundary has been adjusted in accord with more detailed plans provided by Council.

2.2 Wherrit Park Detention Basin.

No information was available from Council as to the hydraulic design basis of the detention basin that has been constructed integrally with Wherrit Park. We carried out detailed survey of the detention basin walls and outlet, but it was beyond the scope of this report to carry out a full detailed survey of the detention basin area.

The outlet of the detention basin is a single 1050mm RCP. The invert level of the pipe is approximately RL-0.55m AHD. There is a small pump and associated pipework to pump water from the basin to the downstream drainage system in the event that high river levels prevent proper drainage of the water stored behind the basin walls.

From the information at hand we have been able to develop a stage versus discharge relationship for the Basin. It is detailed in the Table below:

Water level in Basin	Volume between different water levels	Cumulative Total Basin Storage	Outlet Flow
m AHD	m³	m³	L/s
-0.50		0	0
	295		
0		295	800
	1029		
0.25		1324	950
	5475		
0.5		6799	1600
	14646		

Water level in Basin	Volume between different water levels	Cumulative Total Basin Storage	Outlet Flow
m AHD	m³	m³	L/s
0.75		21445	1900
	25215		
1		46660	2600
	32379		
1.25		79039	2800
	6955		
1.3		85993	3400
	58090		
1.7		144083	30000

1. Flows have been derived assuming that the 1050mm pipe has fee discharge to the downstream area.
2. Water breaches the crest of the detention basin wall at approximately RL 1.7m AHD.

3 PROPOSED DEVELOPMENT

3.1 Overall Development

Plans of the overall development are contained in the plans accompanying the Development Application. The development is over 2 parcels of land:

- Lot 3 DP 1052069 Hogues Lane
- Lot 2 DP 1101094 Rannoch Ave

The development is shown on drawings 14007-1 and 2.

3.2 Drainage Proposal

The drainage proposal is shown on drawing 14007-3. It shows that the site will be graded generally eastwards towards the existing drainage channels. Two stormwater detention basins are proposed. Basin 1 basin is located on :

- proposed Lot 25 in Stage 1 of the development on Lot 3 DP 1052069, in the south eastern corner of the site.
- Proposed lot 15 in Stage 1 of development on Lot 2 DP 1101094

An additional basin, Basin 2, is proposed in later stages in the north eastern corner of the site of Lot 3 DP 1052069.

Water will be conveyed to the basins by a series of bioswales, drainage pipes and overland flow paths.

3.3 Bulk Earthworks and Road Grading

Earthworks are proposed as part of the development. A concept bulk earthworks plan is shown on Drawing 14007-6. The philosophy behind the earthworks is set out below:

- All lots will be filled to approximately "nuisance flood level". This is approximately RL 1.7m AHD.
- Roads will be filled but will be graded eastwards. They will act as surcharge paths for flows in excess on the minor drainage system

- No allotments will be filled to levels higher than the existing properties to the west of the development site. This will ensure that no water is "dammed" on these properties in high rainfall events.

The net effect of the development is that it will not adversely affect the local flow patterns of the existing properties between River Street and the development.

4 DRAINAGE SYSTEM ANALYSIS

4.1 Minor Drainage System

The minor drainage system will consist of a network of pipes, bioswales and drainage surcharge paths designed in accordance with Clarence Valley Council's subdivision guidelines. The drainage network will drain generally eastwards towards the proposed detention basins.

This system has not been analysed as part of this study as it will be fully analysed as part of the detailed design of the various stages of the development.

4.2 Major Drainage System

4.2.1 Ilsax Model

The major drainage system was modelled using ILSAX software. The system was modelled for three scenarios:

- the existing system (ie with the Hogues development site being vacant)
- The developed site with no on site detention
- The developed site with on-site detention.

Drawing 14007-11 shows the individual catchments modelled in ILSAX and their associated Catchment name.

Drawing 14007-12 shows the modelled schematic for the existing system

Drawing 14007-13 shows the modelled schematic for the developed site with on-site detention.

4.2.2 Detention Basins

The detention basins proposed for Stage 1 in the south eastern corner of the site and the Stage 2 basin in the north eastern corner of the site were modelled.

Key parameters for the basin are set out below:

Basin 1 – Stage 1 detention Basin.

- Surface areas when full — - 5,600 m² full development (ie development (lot 3) and western development (lot 2)
  - and 2,800 m² for Stage 1 only

- Side Slopes — 1 in 6

- Top Water Level — RL 1.35 m AHD

- Base RL 0.0m graded to RL -0.5m
- Outlet Pipe modelled 1050 mm RCP.
- Stage Storage and outlet characteristics for Nominal 5,600 m² basin.

Water level in Basin	Volume between different water levels	Cumulative Total Basin Storage	Outlet Flow
m AHD	m³	m³	L/s
0		0	0
0.3		50	950
	701.8		
0.5		701.8	1600
	772.5		
0.7		1474.3	1900
	846.9		
0.9		2321.2	2600
	924.4		
1.1		3245.6	2800
	1004.4		
1.3		4250	3400
	1086.9		
1.5		5336.9	

- Stage Storage and outlet characteristics for Nominal 2,800 m² basin.
-

Water level in Basin	Volume between different water levels	Cumulative Total Basin Storage	Outlet Flow
m AHD	m³	m³	L/s
0		0	0
0.3		50	950
	294		
0.5		344	1600
	340.2		
0.7		684.2	1900
	390		
0.9		1074.2	2600
	442.4		
1.1		1516.6	2800
	497		
1.3		2013.6	3400
	553.8		
1.5		2567.4	

Basin 2 – Future detention Basin in north eastern corner.

- Surface areas when full 1,500 m²
- Side Slopes 1 in 6
- Top Water Level RL 1.35 m AHD
- Depth 1.6m
- Outlet Pipe modelled 1050 mm RCP.
- Stage Storage and outlet characteristics:

Water level in Basin	Volume between different water levels	Cumulative Total Basin Storage	Outlet Flow
m AHD	m³	m³	L/s
0		0	0
0.3		0	950
	98.8		
0.5		98.8	1600
	130.2		
0.7		229	1900
	163.7		
0.9		392.7	2600
	199.2		
1.1		591.9	2800
	236.7		
1.3		828.6	3400
	276.2		
1.5		1104.8	

4.2.3 Other Key Data

The following key assumptions were made in setting up the model:

- The antecedent moisture conditions were set to 2.5. The site is wet prior to the rain event starting.
- Soil type – 2.5 – moderate to slow infiltration soils
- Depression storage, 1mm for paved areas and 5mm for grassed areas.

- Rainfall – 1 in 100 year rainfall for the Maclean area. The IFD tables are contained in Appendix A.
-
- The catchment was modelled for the following storm event 20mins, 30mins, 45mins, 60 mins, 90 mins, 120 mins and 180 mins The rainfall files are contained in Appendix D.

Impervious Areas
In order to produce an accurate representation of the developed situation, careful attention was given to evaluating the impervious area for the Rannoch Avenue and Hogues Lane developments. The impervious areas were taken from the latest architectural drawings available. For the medium density community title portion of the Rannoch Avenue development the exact values for impervious area was found, and used to determine the impervious fraction of catchment C1. For the Torrens title residential subdivision area of the Hogues Lane and Rannoch Avenue developments, the average impervious fractions of 52% for the road reserve and 57% for lot area were used.

The architectural drawings used to determine the new impervious area of the sub-catchments can be seen in Appendix G of this report.

The full data files are contained in Appendix D.

4.2.4 Results

The results of the analysis are contained in Appendix B to C and are summarised below:

Peak Flows				
Location	**ILSAX Link**	**Existing Development**	**Proposed Development**	
			No Attenuation	**Attenuation**
		Flow	**Flow**	**Flow**
		m^3/s	m^3/s	m^3/s
Downstream of Everett Park (Main Channel Flow)	A-2	8.244	8.414	6.282
Future development catchment south of proposed development	C-1	2.294	2.5	2.5
Part of Hogues Lane Development site plus existing development west of site which is connected to Basin 1.	D-1	1.007	1.183	1.183
	E-1	1.357	1.584	1.584
TOTAL		4.658	5.267	5.267
Main Channel Flow	A-6	12.540	12.982	10.982
Part of Hogues Lane Development site plus existing development west of site which is connected to Basin 2.	F-4	2.831	3.313	2.052

Main Channel flow (north of Development Site	A-7	15.251	15.973	12.576

The results show:

1) The development of the site will increase peak flows by approximately 11% for a 1 in 100 year local flood event if no on-site detention is provided.

2) For the whole catchment, the results show that there will only be an increase in flows of around 4.7%. This is because of the shorter time of concentration of the proposed development compared.

3) For the section of Channel immediately downstream of Wherrit Park, peak flows will decrease as flows from the developed areas are diverted to the detention basin No 1 and enter the main channel further downstream.

4) The detention Basins have maintained peak flows leaving the proposed development areas to pre-development levels.

5) Because of the different timing of the peaks, the peak flow in the main channel north of the site will not be greater than currently experienced by the channel.

4.2.5 Diverted Channel Downstream of Wherrit Park

As part of the works it is proposed to divert a section of the existing eastwards to create enough space to accommodate the detention Basin No 1.

The diverted channel is proposed to have the following cross section:

- base width – 4m
- side slopes – 1 vertical to 4 horizontal
- top of bank width – 12m
- approximate depth – 1m
- waterway area at top of bank – 8 m²

This is significantly greater the channel being diverted. This channel has the following approximate cross section

- base width – 1m
- side slopes – 1 vertical to 2.5 horizontal
- top of bank width – 6m
- approximate depth – 1m
- waterway area at top of bank – 3.5 m²

Given the increased waterway area and the lowering of peak flows in the diverted section of channel, the hydraulic gradient will be flatter.

The net result is the diverted channel will improve the flow characteristics in that section of the main channel compared to what exists at present.

5 ANALYSIS OF LOSS OF STORAGE OF FLOODPLAIN

5.1 Existing System

The existing drainage system essentially drains to the Clarence River. A major outlet is Essex Drain. In addition, stormwater can continue to flow easterly from the site and eventually rejoining the river at various locations downstream of Essex Drain.

The township of Maclean is protected by a levee. Flow from the catchment to the river may on occasions be prevented if the level in the river is high and the floodgates at Essex Drain and similar outlets are closed because the level of the river is higher than the level behind the levee (ie in the development area).

Obviously, in times of high River levels, water is ponded in the area behind the levee (this includes such areas as the development site, Wherrit Park and rural land to the south and east of the site). When water levels in the river drop, then flow from the ponded areas can be discharged to the river.

5.2 Effect of High River levels

As noted earlier, it is proposed to fill parts of the site. This has the effect of decreasing the existing available area for ponding of water in times when the river level is high.

We have modelled the situation to determine what the likely impacts of the filling will be.

For the purpose of the analysis we have assumed that:

- all water in the area draining through the development site is returned to the Clarence River through Essex drain. This means that for the analysis, we have conservatively assumed that no runoff proceeds easterly from the site.
- From analysis of storm hydrographs provided by Council, we have taken critical period of 48 hours ponding time. (ie a time when there is no flow from Essex Drain to the River.

We have analysed the performance of the catchment for different return period storms from a 1 in 10 year storm to a 1 in 100 year storm.

<u>Ponded Volumes</u>

Upstream of Essex Drain, we have determined the volume of water that can be impounded at different water levels in the catchment area.

The ponded area is essentially bounded by the following limits:

- the levee along the Clarence River to the north
- Central Avenue to the west
- Essex drain to the east
- The natural high ground to the south (eg Iona Street, McPhee Street, the treatment Plant)

The volume of impounded water is shown in the Table below. We estimate that approximately 26,000 m^3 of fill will be required to bring the development up to the levels shown on our Drawing 14007-06. This fill will generally be placed between RL0.5m AHD and RL 1.8m AHD. The net effect of this on the available storage is shown on the Table below:

Stage (RL m AHD)	Cumulative Storage EXISTING SITUATION (m³)	Cumulative Storage AFTER FILLING FOR DEVELOPMENT (m³)
0.00	295	295
0.25	30,871	30,871
0.50	90,382	90,382
0.75	178,006	178,006
1.00	291,825	291,825
1.25	425,700	417,700
1.50	548,783	532,783
1.75	735,074	711,074
2.00	918,062	892,062
2.25	1,188,816	1,162,816

The effect of the filling on ponding levels is shown on the table below:

Storm Event	Period (hrs)	Rainfall (mm/hr)	Total rainfall (mm)	Effective Runoff (mm)	Total Volume of Runoff (m³)	Ponding Depth- Existing development (RL m AHD)	Ponding Depth- With Proposed Development (RL m AHD)	Increase in ponding Levels (mm)
100 y	48	8.21	394.08	354.672	457526.9	1.315	1.337	22
50 y	48	7.27	348.96	314.064	405142.6	1.212	1.225	13
20 y	48	6.06	290.88	261.792	337711.7	1.086	1.091	5
10y	48	5.16	247.68	222.912	287556.5	0.991	0.991	0
5y	48	4.49	215.52	193.968	250218.7	0.909	0.909	0
Note: Overall catchment Area – 129 ha Volumetric coefficient of runoff of 0.90 assumed.								

The table shows that the increase in ponding levels due to filling of the development could be upto 22mm for a 1 in 100 year 48 hour storm. For a 20 year storm, the increase is only 5mm,

The above analysis is considered conservative as:

- no flows are assumed to travel eastwards from the site. This is an obvious flow path for stormwater should outlets to the river from Essex Drain be blocked.
- Minimal allowance has been made for the gradient in the ponded area. The calculations assume zero gradient across the ponded area when in fact there should be some gradient.

Nevertheless, it is our opinion that the effect of loss of storage for ponding of water is not significant and does not lead to any increased risk of flooding of surrounding properties.

6 ANALYSIS OF LOSS OF FLOW AREA OF FLOODPLAIN

6.1 Existing System

Water from the Wherrit Park areas flows overland to the Essex Drain. The floodplain in this area is 300m to 400m wide. Filling of the development will reduce the available flow area and could lead to increased flood levels.

We carried out an analysis using HEC RAS. Drawing 14007-14 shows the locations of the cross sections used in the analysis. We essentially modelled 5 cross sections from Essex drain upstream to the downstream side of the detention basin wall at Wherrit Park.

The 1 in 100 year flows estimated in Section 4.2.4 of the report were used in the analysis. Two scenarios were modelled:

- existing situation
- situation after filling of the development area.

Copies of the cross sections used are contained in Appendix E – HEC-RAS Modelling

The results are shown in the Table below:

HEC-RAS River: Hogues Reach: Main Profile: PF 1								
River Station	Plan	Q Total	W.S. Elev	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width
		(m3/s)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)
422	Developed	8.5	1.88	1.88	0.000066	0.02	371.52	232
422	Existing	8.5	1.80	1.80	0.000041	0.02	524.62	408
325	Developed	12.5	1.86	1.86	0.000642	0.07	194.98	142
325	Existing	12.5	1.80	1.80	0.000125	0.03	477.6	398
258	Developed	15.5	1.81	1.81	0.000897	0.08	216.4	170
258	Existing	15.5	1.78	1.78	0.000288	0.04	415.39	377
102	Developed	15.5	1.76	1.76	0.000146	0.03	477.38	307
102	Existing	15.5	1.76	1.76	0.000107	0.03	610.02	474
0	Developed	15.5	1.75	1.75	0.000092	0.03	587.88	364
0	Existing	15.5	1.75	1.75	0.000068	0.02	749.06	554

The results show that the maximum afflux caused by filling of the development is 80mm based on a starting water level of RL 1.75 at Essex Drain. This increase decreases to 60mm if the starting water level is RL 1.90m AHD.

These increases in flood level are not significant as they do not increase the risk on inundation of any properties adjacent to the development. Obviously the filling has no effect on flood levels downstream of Essex Drain.

6.2 Effect of Essex Drain

In addition to the above, Two outlet conditions were modelled:

- Scenario 1 – Assume approx 50%of total flow discharge to River from Essex Drain
- Scenario 2 – Assume Full discharge to River from Essex Drain.

The flow in Essex Drain is controlled by box culverts under River Street which discharge into the Clarence River. Key data for the culverts are:

- Size – 2 culverts, one 1500mm by 1500mm high; the other 2100mm by 2100mm high
- Invert Level – RL -0.3 m AHD

A Stage discharge relationship was developed for the culverts assuming free discharge into the Clarence River. The Stage Discharge relationship is included in Table 6.2.

For both Scenarios we have modelled 2 cases, one with the River level at MHWS (RL 0.39m AHD) and the other at MLWS (RL -0.18 m AHD).

The results are summarised in the table 6.1 below. The table shows that the increase in flood extents on the southern side of the flow path is of the order of 4m for a 1 in 100 year storm event for Scenario 1 and slightly less for Scenario 2. Copies of the HEC-RAS output is also attached in Appendix F Tables 1 and 2. The approximate flood line has been plotted on Drawing 14007-14 Revision A attached.

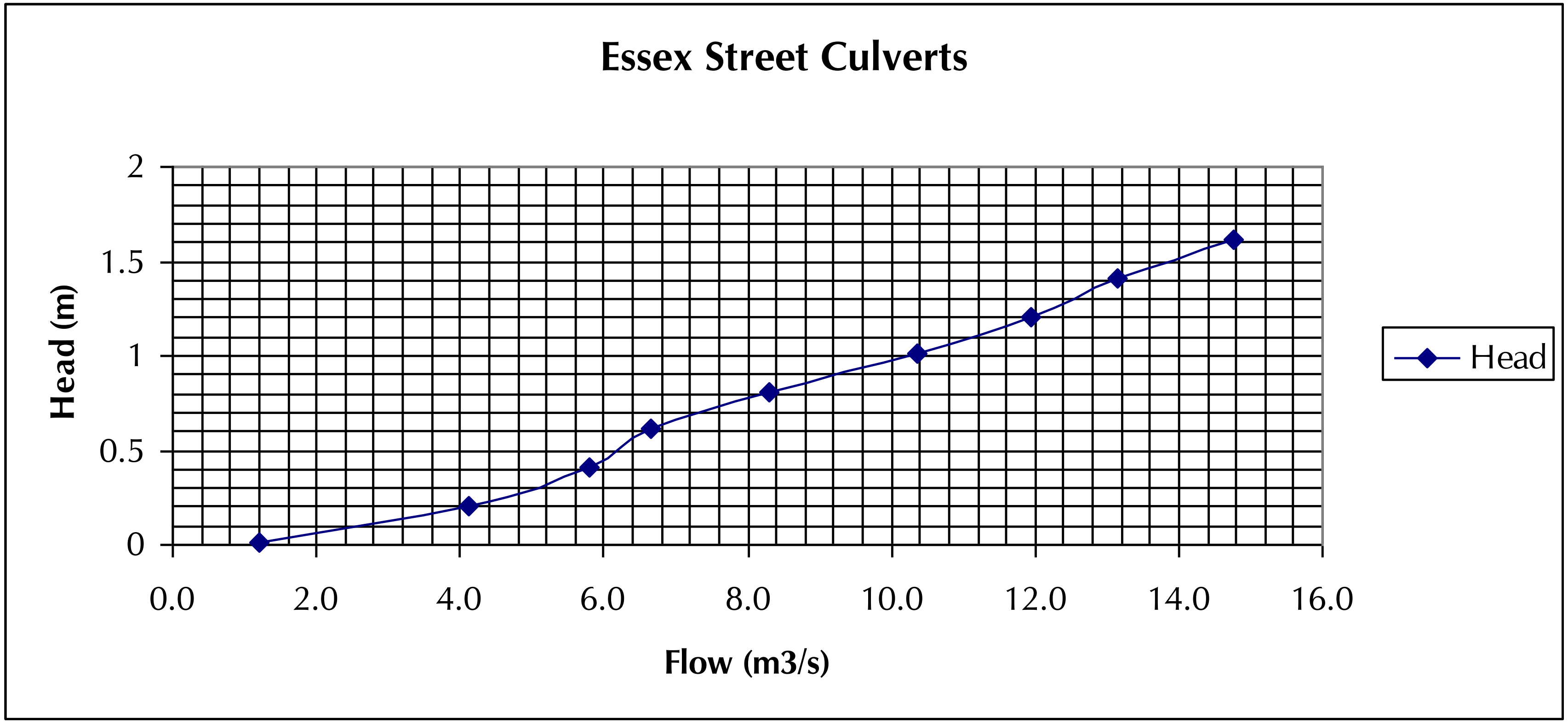
TABLE 6.1 – Effect of Development on Flood Flows and Extent of Inundation

Water Level in Clarence River (RL m AHD)	Headloss across Culverts in Essex Drain at River Street (m)	Water Level upstream of Culverts in Essex Drain at River Street (RL m AHD)	Starting Water Level at XS-1 CH 0.0 (downstream extent of development) (RL m AHD)	Existing Development Level D/S of Wherrit Park (RL m AHD)	Proposed Development Level D/S of Wherrit Park (RL m AHD)	Difference in flood level height at XS-5 CH 422 (near Wherrit Park) (m)	Difference "on the ground" on southern side near Wherrit Park (m)
Scenario 1 – 50% discharge to River from Essex Drain and to rural land eastwards							
			0.50	1.33	1.54	0.21	4
-0.18 *(Note 1)*	0.7 *(Note 3)*	0.52	0.82 *(normal depth)*	1.34	1.54	0.20	4
0.39 *(Note 2)*	0.7 *(Note 3)*	1.09	1.20	1.56	1.68	0.12	4
Scenario 2 – Free discharge to River from Essex Drain and minimal discharge to rural land eastwards.							
-0.18 *(Note 1)*	1.5 *(Note 4)*	1.32	1.50	1.60	1.71	0.11	3
			1.70 *(nuisance flood level)*	1.76	1.84	0.08	3
0.39 *(Note 2)*	1.5 *(Note 4)*	1.90	2.00	2.03	2.05	0.02	3

Notes:
1. MLWS in Clarence River RL -0.18 m AHD
2. MHWS in Clarence River 0.39 m AHD
3. Assumes that culverts are freely discharging approximately 6 m^3/s into Clarence River (based on calculations with CULVERT software)
4. Assumes that culverts are freely discharging approximately 13.5 m^3/s into Clarence River (based on calculations with CULVERT software)

Table 6.2 – Stage Discharge Relationship for Culverts at Essex Drain

Head	Flow
m	m³/s
0.01	1.2
0.21	4.1
0.41	5.8
0.61	6.7
0.81	8.3
1.01	10.4
1.21	11.9
1.41	13.2
1.61	14.8



7 OTHER CONSIDERATIONS

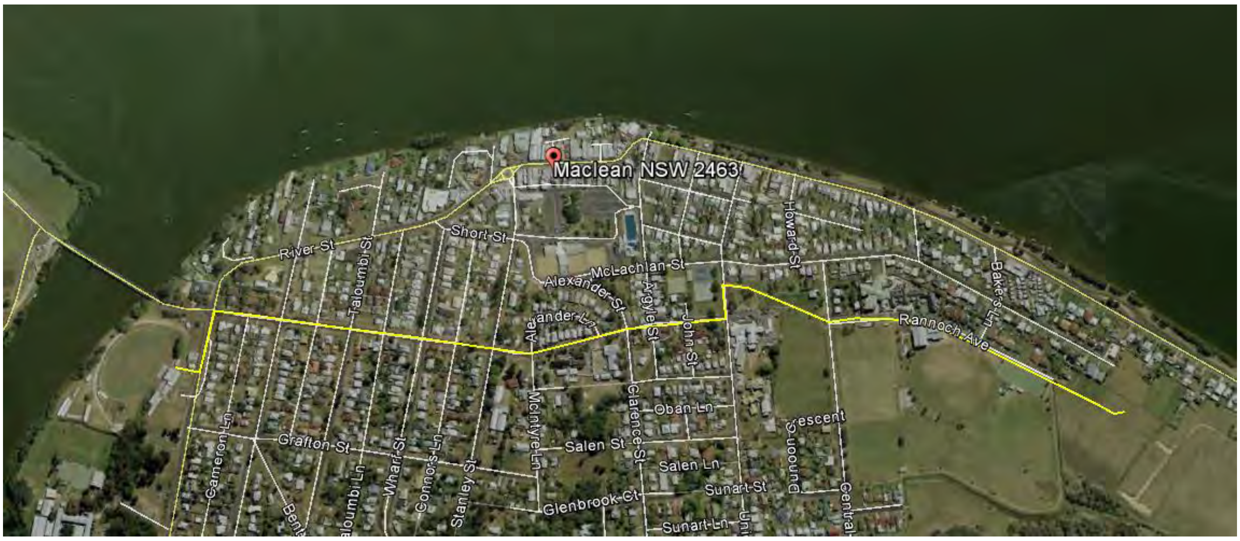
7.1 Flood Emergency Response

The forms part of the lower Clarence Valley flood plain. As noted previously, the site will be protected by the levee along the river bank to the wets of the site. Notwithstanding this, flood events will overtop the levee in large flood events that will require an emergency response.

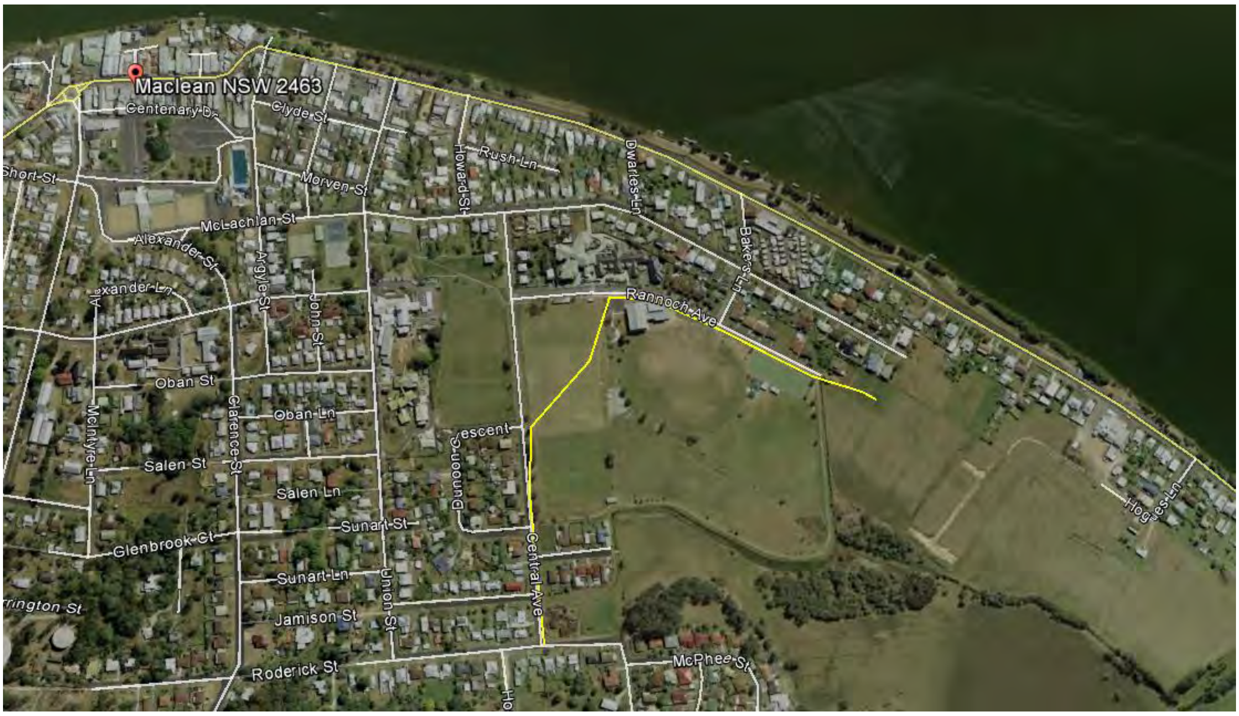
The SES and Clarence Valley Council have developed a Flood Plan for the whole valley, including Maclean. The latest version of the plan entitled "Lower Clarence Valley Flood Plan" 2012 prepared by the SES and Clarence Valley Council. The section of the Plan relating to Maclean is copied as Appendix H.

As a result of this development, the plan will require revision, mainly relating to the number of dwellings that may be affected by a breach of the levee and the targeted evacuation order for the township. The main advantage of this development over many existing dwellings in the the area is that all residences will have their habitable floor area well above the 1 in 100 year flood level and as such if persons do not evacuate their residences, they can still be safe – above the flood level – but will be just isolated.

The plan identifies evacuation routes, all leading to the Showground at Cameron Street. The distance from the site to Cameron Street is approximately 2km as shown below:



The distance from the site to the nearest flood free ground is around 1km as shown below:



7.2 Grafton and Lower Clarence FRMP

The Grafton and Lower Clarence Floodplain Risk Management Plan, 2007 prepared by Bewsher Consulting examined options to manage the flooding risk on the floodplain of the Clarence River. It came up with a series of recommendations.

The recommended floodplain management measures for Maclean (Section 6.2.3) include:

Section 6.2.3 Recommendations	DGB Response
a) Undertake a detailed survey of the full length of the Maclean Levee. Any deficiencies in the integrity of the structure, or areas where settlement has occurred below the original design specifications, should be rectified as part of on-going maintenance operations.	Not Applicable to the proposed development
b) Further review of the internal drainage strategy within the town, including the capacity and maintenance of the existing levee pumps.	This report examines the impact of the development on local drainage and concludes that it has minimal impact compared.
c) Application of appropriate development controls for new development and redevelopment as this occurs. The primary control for residential development is the use of minimum floor levels based on the 100 year flood level (WBM, 2004) in the river with 0.5m freeboard. Other flood-	The development complies with all the relevant development controls

proofing initiatives are recommended for commercial development.	
d) Improved emergency management planning, including the development of a standard flood warning template for Maclean, updating flood intelligence cards and the Local Flood Plan, based on the latest flood results.	Not specifically applicable to this development. In emergency situations, flood emergency management falls under the "Lower Clarence Valley Flood Plan" 2012 prepared by the SES and Clarence Valley Council. Refer Section 7.1.
e) Implementation of a measured education campaign to dispel the perception that the town enjoys full protection from flooding as a result of the levee. Residents and owners need to be reminded of the risk of levee overtopping and the consequent flood behaviour.	Not Applicable to the proposed development. This recommendation relates to Council and SES actions.

7.3 SECTION 117 CONSIDERATIONS

Clause 4.3 of Section 117(2) of the Environmental Planning and Assessment Act 1979 sets out considerations for Flood Probe Land. The compliance of the proposed site with these directions is discussed below.

Clause 4.3 Consideration	**DGB Response**
What a council must do if this direction applies	
(4) A draft LEP shall include provisions that give effect to and are consistent with the NSW Flood Prone Land Policy and the principles of the Floodplain Development Manual 2005 (including the Guideline on Development Controls on Low Flood Risk Areas).	The proposed area is protected by a levee which also protects the rest of the Maclean township. It provides approximately 1 in 70 year protection.
(5) A draft LEP shall not rezone land within the flood planning areas from Special Use, Special Purpose, Recreation, Rural or Environmental Protection Zones to a Residential, Business, Industrial, Special Use or Special Purpose Zone.	Land is currently zoned residential.
(6) A draft LEP shall not contain provisions that apply to the flood planning areas which:	
(a) permit development in floodway areas,	The site is not in a floodway
(b) permit development that will result in significant flood impacts to other properties,	All properties are protected by a levee bank. In addition, minimum floor level requirements apply so that the minimum floor level of any habitable dwelling is at least 0.5m above the 1% AEP flood event.
(c) permit a significant increase in the development of that land,	When the site is considered in the whole Maclean township area that is protected by the levee bank, the additional density on this site will not significantly increase the number of dwellings protected by the levee.

Clause 4.3 Consideration	DGB Response
(d) are likely to result in a substantially increased requirement for government spending on flood mitigation measures, infrastructure or services, or	No additional expenditure on flood mitigation measures are required.
(e) permit development to be carried out without development consent except for the purposes of agriculture (not including dams, drainage canals, levees, buildings or structures in floodways or high hazard areas), roads or exempt development.	Development Consent will be required for the possible residential development
(7) A draft LEP must not impose flood related development controls above the residential flood planning level for residential development on land, unless a council provides adequate justification for those controls to the satisfaction of the Director-General (or an officer of the Department nominated by the Director-General).	No controls proposed above the Flood Planning Level.
(8) For the purposes of a draft LEP, a council must not determine a flood planning level that is inconsistent with the Floodplain Development Manual 2005 (including the Guideline on Development Controls on Low Flood Risk Areas) unless a council provides adequate justification for the proposed departure from that Manual to the satisfaction of the Director-General (or an officer of the Department nominated by the Director-General).	The Flood Planning Level that applies to the site is consistent with the surrounding Maclean township areas.

7.4 CVC Specific Information Requests

In a meeting between Council and the Developer, Council highlighted several specific matters that they indicated needed addresses in this report. The matters and our response is detailed below:

CVC Comment	DGB Response
1. Obtain accurate levels of the land and consider filling the site to reduce flood levels.	There is a survey of the site. However, this is a bit irrelevant as it is proposed to fill the site. The fill levels are shown on the architectural drawings.

CVC Comment	DGB Response
2. Undertake a flood assessment to address impacts of filling, the potential impacts from flood waters and an evacuation strategy in the event of a flood	a) This report addresses the impacts of filling. b) The evacuation strategy for the site forms part of the "Lower Clarence Valley Flood Plan" 2012 prepared by the SES and Clarence Valley Council. Refer Section 7.1 This Plan fully details the procedures, responsibilities and actions during times of flooding. It identifies flood safe areas and evacuation routes. The main evacuation route highlighted in the plan, relevant to this site is southwards to Central Ave and thence higher ground further south.
3. Discuss flooding impacts and evacuation issues with local SES members and nearest evacuation point.	The consultant has not specifically discussed the evacuation issues with SES as the Flood Plan is considered to address the issue. It is acknowledged that the plan will require revision to accommodate the development – mainly in relation to the number of dwellings affected should the levee overtop.
4. Review 'Grafton and Lower Clarence Floodplain Risk Management Plan' and any implications for this site.	Refer Section 7.2 of this report,
5. Address the matters under the Ministers direction number 4.3 for Flood Prone Land.	Refer Section 7.3 of this report
Other issues raised at the meeting to be considered are as follows:-	
o Consideration should be given to rezoning the land R1 rather than R3 to not reflect an increase in housing density	This is a planning issue
o Ensure that the proposed detention ponds can accommodate the runoff from 55 units and	This is covered in my report
o It is likely that a pump station will be required for reticulated sewerage services.	No it is not – it all can be gravity fed as per the various subdivision concepts.

8 CONCLUSION

8.1 Impacts on Adjoining Properties

The impact of the development on adjoining properties can be summarised as follows:

Item	Property to the south of proposed development (ie between Treatment Plant and Wherrit Park)	Properties to the east of proposed development (ie east of Essex drain)
Flows in Main Drainage Channels	Because of on-site detention, the peak flows from the development do not exceed that which left the site prior to the development. Thus the flows in the Main drainage channel will be similar following the completion of the development. Total Flows at Essex Drain are the same pre and post development.	No change from current flows crossing these properties as a result of the filling in the development. This means that flows pre and post development down stream of Essex drain are the same.
Flood Inundation Depth when Clarence River Levels are High	Modelling shows that water levels on adjacent property could increase by up to 22mm for a 1 in 100 year 48 hour storm. For a 1 in 20 year 48 hour storm, the increase is approximately 5mm. These depths are effectively not measurable given the likely wave heights that usually occur with winds associated with large storm events.	No extra inundation over what occurs at present
Flood Inundation depth when Essex Drain is open and flowing	Modelling shows that the increase in water levels varies along the southern boundary of the site. At Essex Drain, the increase due to the filling on the development site is 0mm. Immediately downstream of Wherrit Park, the increase is between 60 and 80mm.	No change from the current inundation depths of this area as a result of the development.
Peak Velocities during storm events.	We have estimated that the peak velocity of flow over the adjoining property prior to filling on the site is 0.04 m/s for a 1 in 100 flood event. Following the development, these velocities are likely to increase to about 0.07m/s. These velocities are extremely low and will not lead to any additional erosion or other such issues.	No change in flow velocities as a result of the development.
Time of Inundation (ie length of time	No change in time the land is inundated as a result of the development.	No change in time the land is inundated as a result of the development

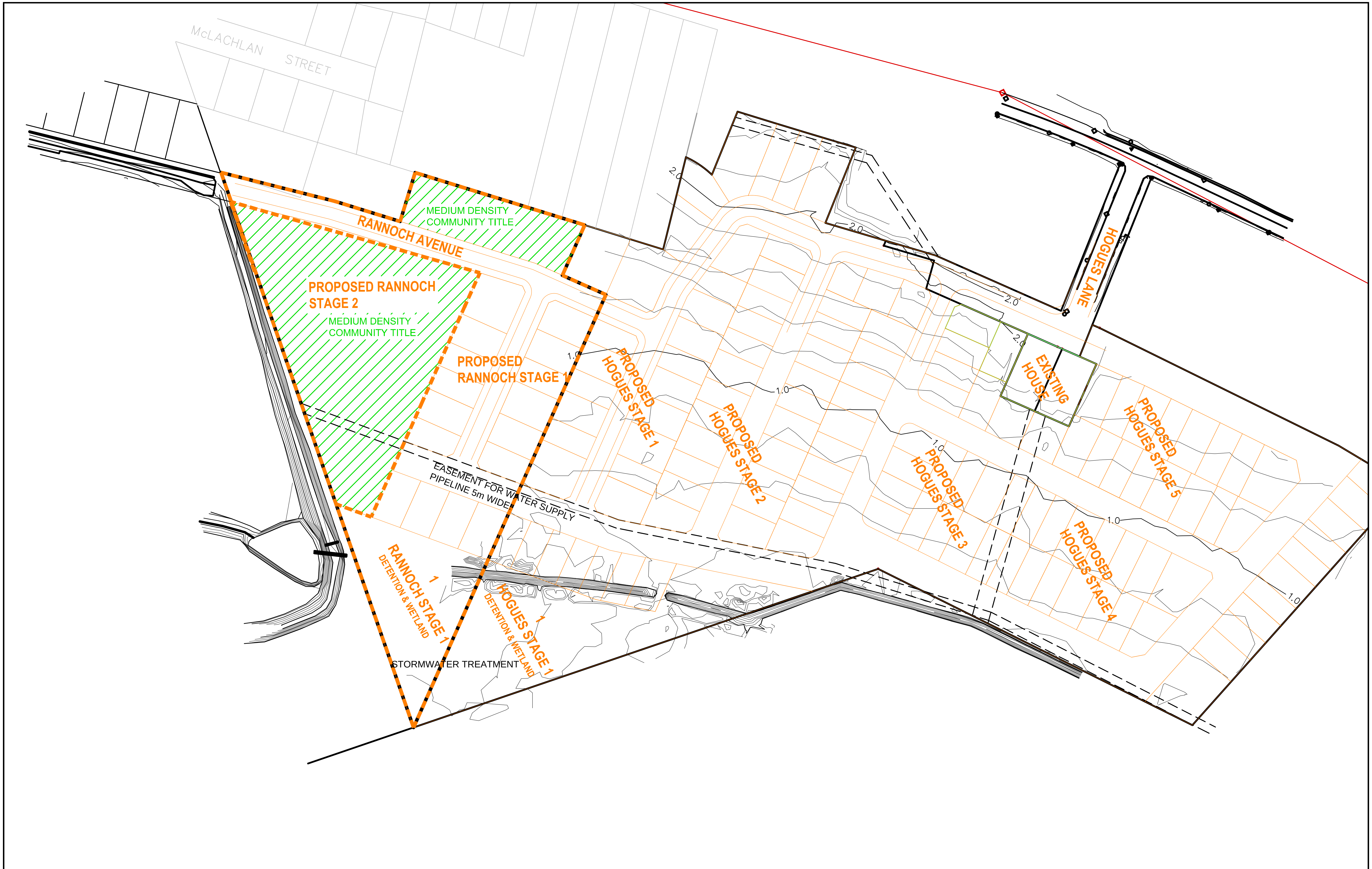
Item	Property to the south of proposed development (ie between Treatment Plant and Wherrit Park)	Properties to the east of proposed development (ie east of Essex drain)
water sits around on the land following a storm event)	This is because the control of the time is the ability of Essex Drain to cater for the flows (which is also associated with river levels in the Clarence River).	
Frequency of Inundation	Given the levels of the adjoining land, and the size of the local catchments drain through the property, the frequency of inundation will not be increased by the development.	No effect on these properties.
Overall	Overall, the net effect of filling for the development on these adjoining property will be a slightly greater depth of ponding. However, the time that the water is present on the property will not change	Overall, there is no effect on flood behaviour on these properties following the development.

8.2 General Conclusions

In our opinion, the results of this investigation show that the proposed development of the Hogues Lane and Rannoch Ave areas will not adversely affect flooding in and around the development area.

The dwellings proposed will be constructed above the 1 in 100 year flood level and so offer a very high level of flood protection.

Emergency flood plans are in place for the Maclean area and this development would "slot" into this overall plan with minimal change.



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PROPOSED RESDENTIAL DEVELOPMENT
RANNOCH AVE & HOGUES LANE, MACLEAN NSW

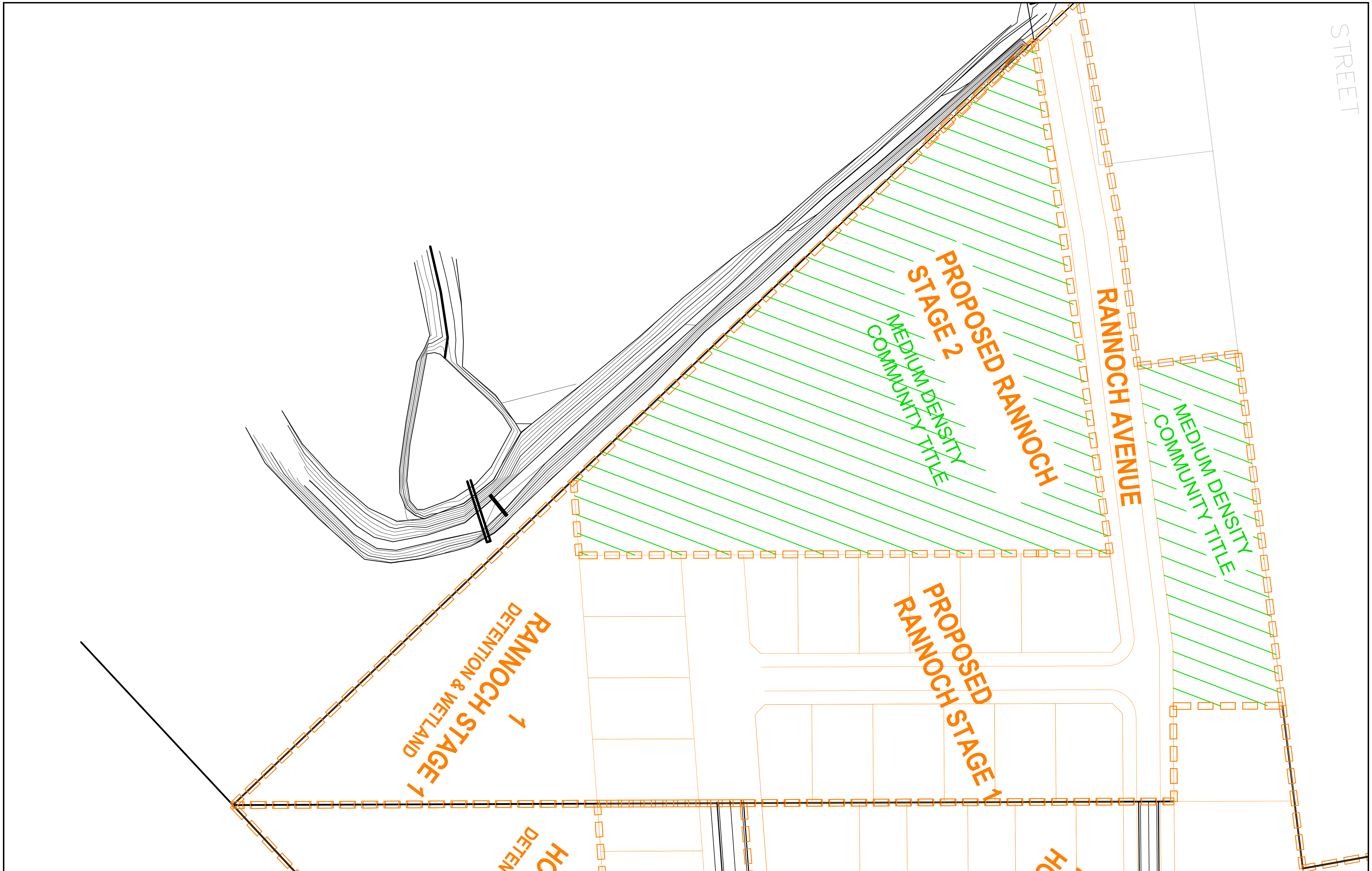
OVERALL CONCEPT PLAN

0 40 80 120m
SCALE OF METRES 1:2000

May 2007 RDG

14007-01

Amendment No.



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PROPOSED RESDENTIAL DEVELOPMENT
RANNOCH AVE & HOGUES LANE, MACLEAN NSW

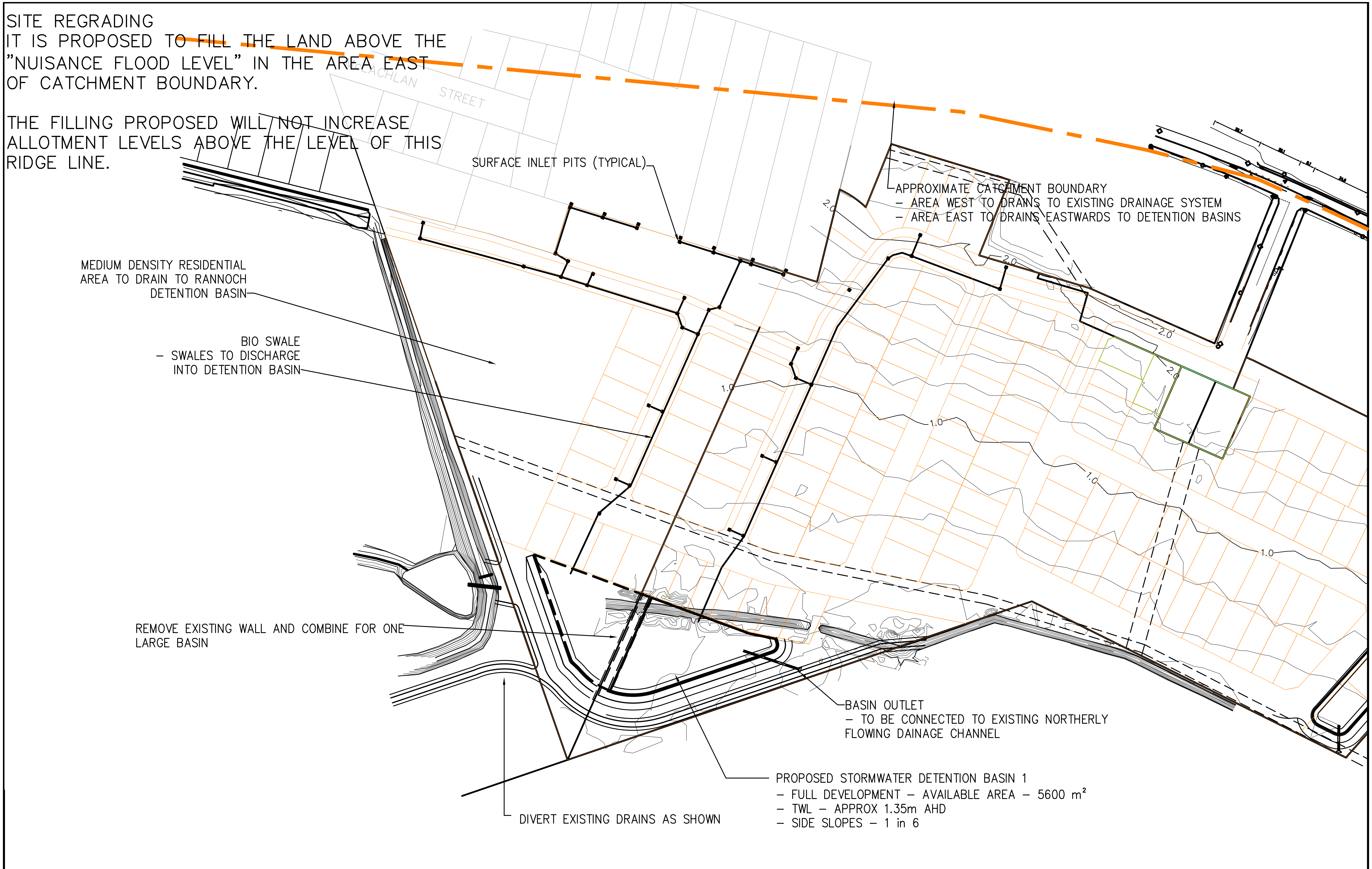
STAGE 1 DEVELOPMENT

MAY 2006

JMK

14007-02

Amendment No.



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PROPOSED RESDENTIAL DEVELOPMENT
RANNOCH AVE & HOGUES LANE, MACLEAN NSW

STAGE 1 DRAINAGE PLAN

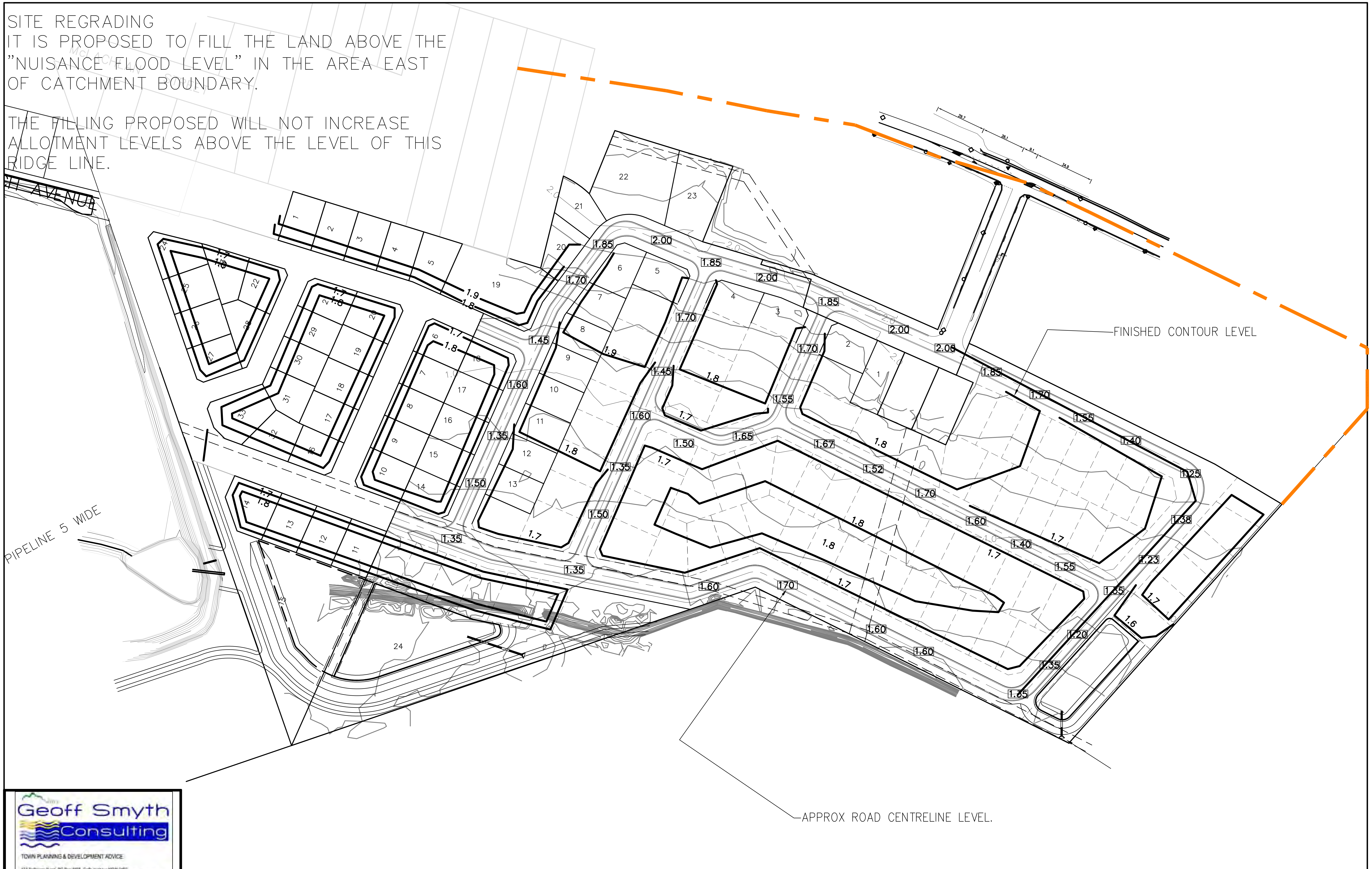
0 40 80 120m

SCALE OF METRES 1:2000

OCT 2006 RDG

14007-03

Amendment No.



Geoff Smyth Consulting
TOWN PLANNING & DEVELOPMENT ADVICE

de Groot & Benson Pty Ltd
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PROPOSED RESDENTIAL DEVELOPMENT
RANNOCH AVE & HOGUES LANE, MACLEAN NSW

BULK EARTHWORKS CONCEPT PLAN

0 40 80 120m
SCALE OF METRES 1:2000

AUG 2006 RDG

14007-06

Amendment No.
A

de Groot & Benson

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PROPOSED RESDENTIAL DEVELOPMENT
RANNOCH AVE & HOGUES LANE, MACLEAN NSW

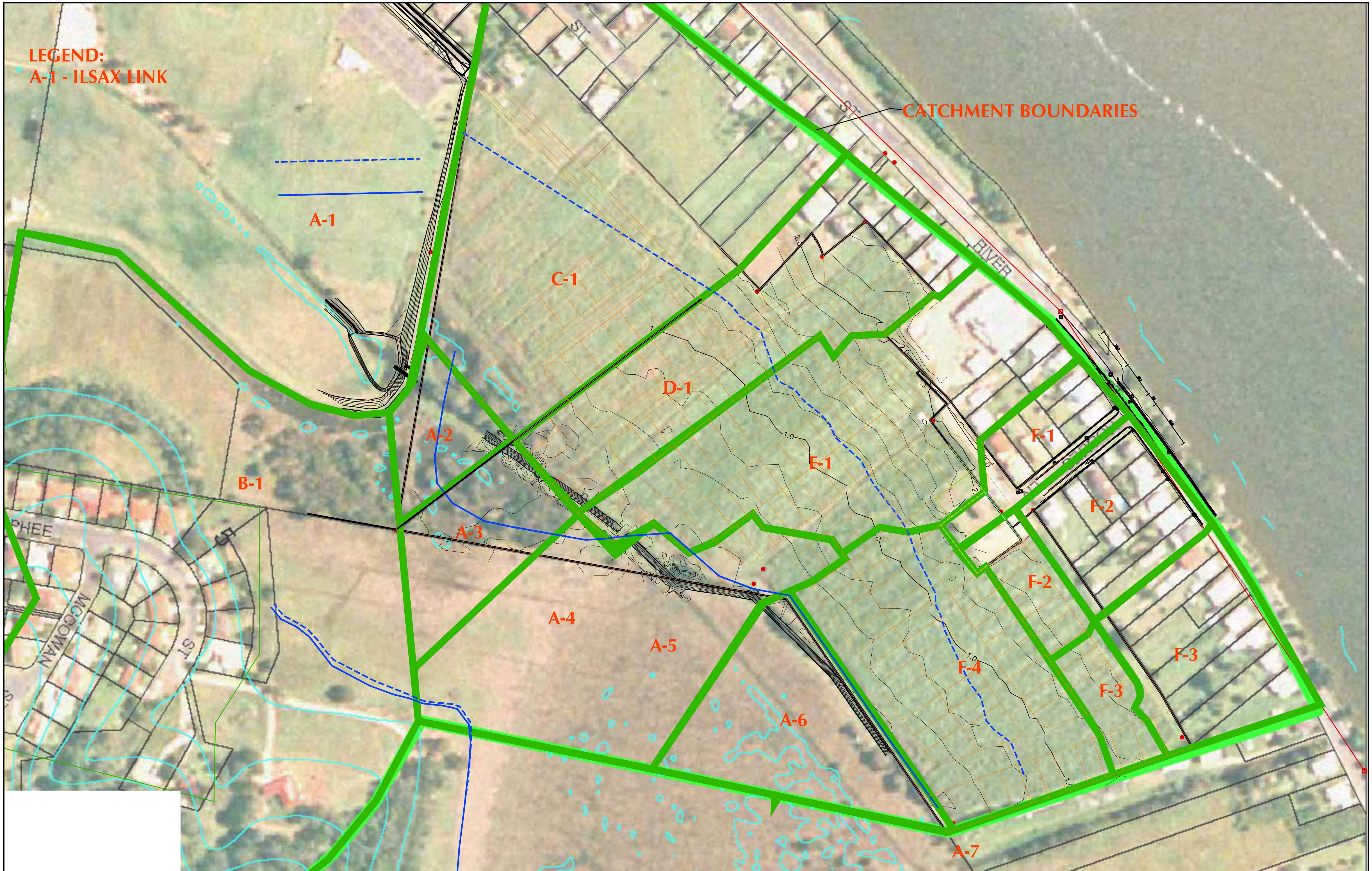
OVERALL CATCHMENT PLAN

100 0 100 200
SCALE OF METRES 1:5000

AUG 2006 RDG

14007-10

Amendment No. A



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PROPOSED RESDENTIAL DEVELOPMENT
RANNOCH AVE & HOGUES LANE, MACLEAN NSW

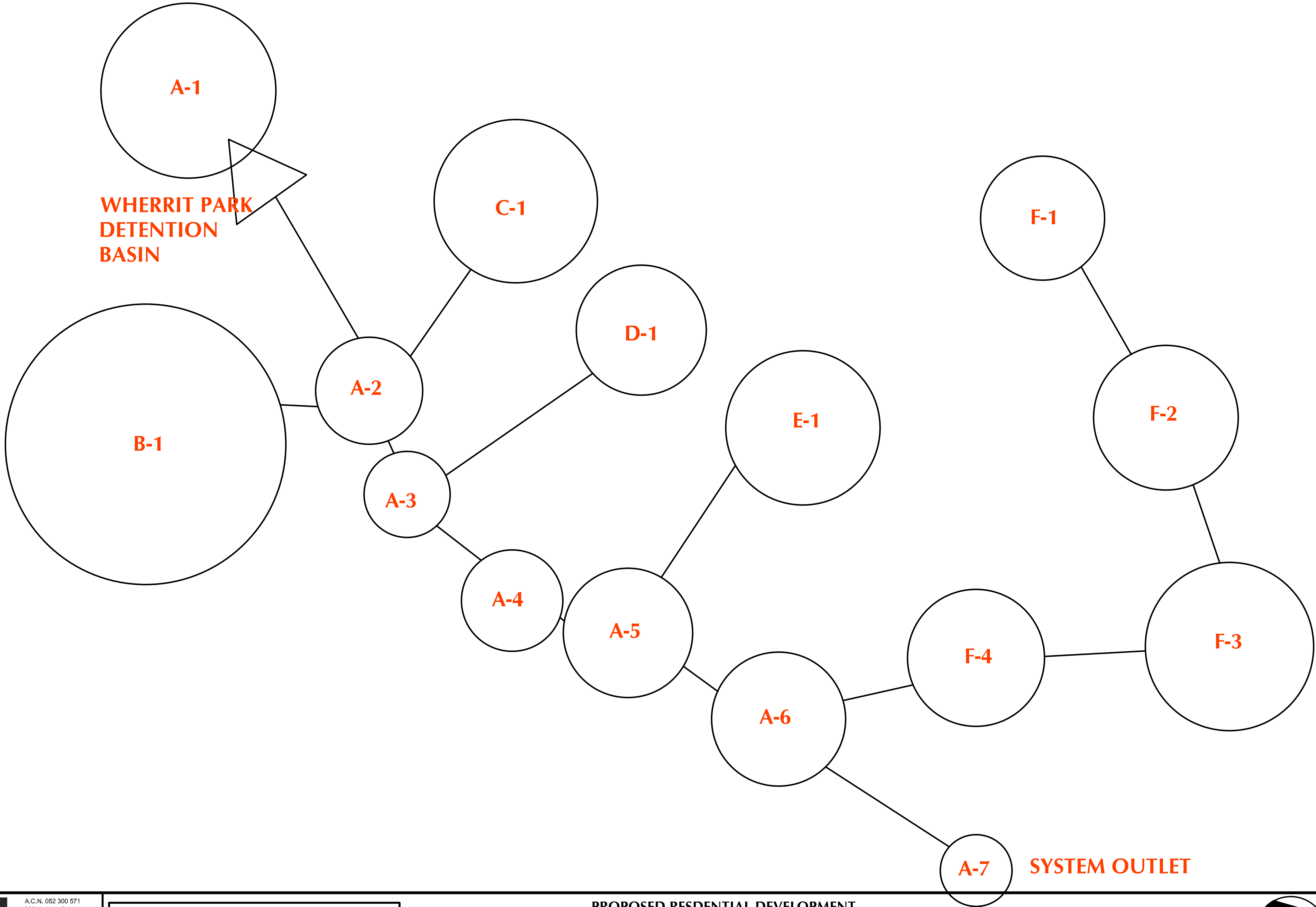
ILSAX MODEL

MAY 2006 JMK

14007-11

Amendment No.

LEGEND:
A-1 - ILSAX LINK



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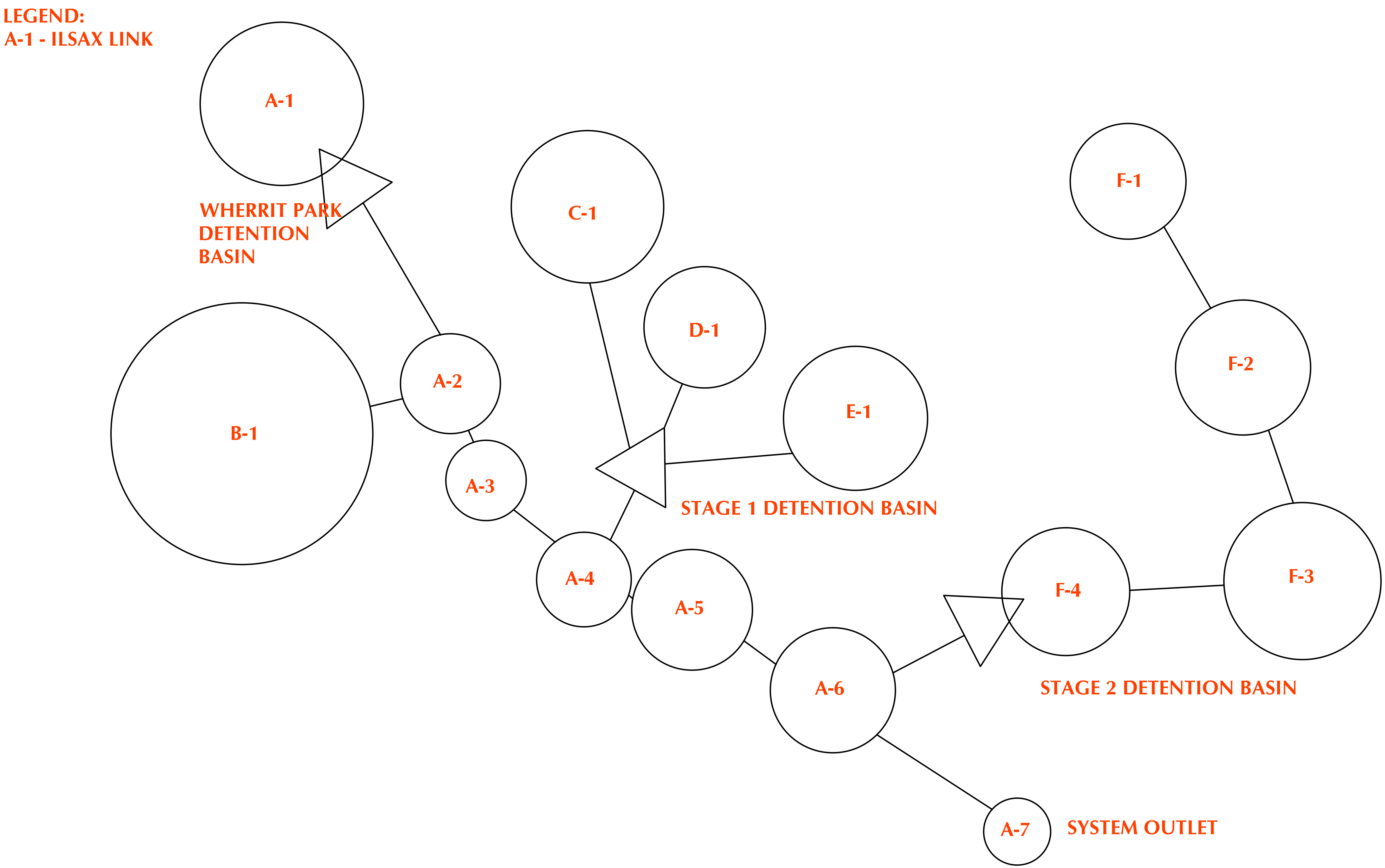
PROPOSED RESDENTIAL DEVELOPMENT
RANNOCH AVE & HOGUES LANE, MACLEAN NSW

ILSAX SCHEMATIC - EXISTING SYSTEM (PRE DEVELOPMENT)

MAY 2006 JMK

14007-12

Amendment No.



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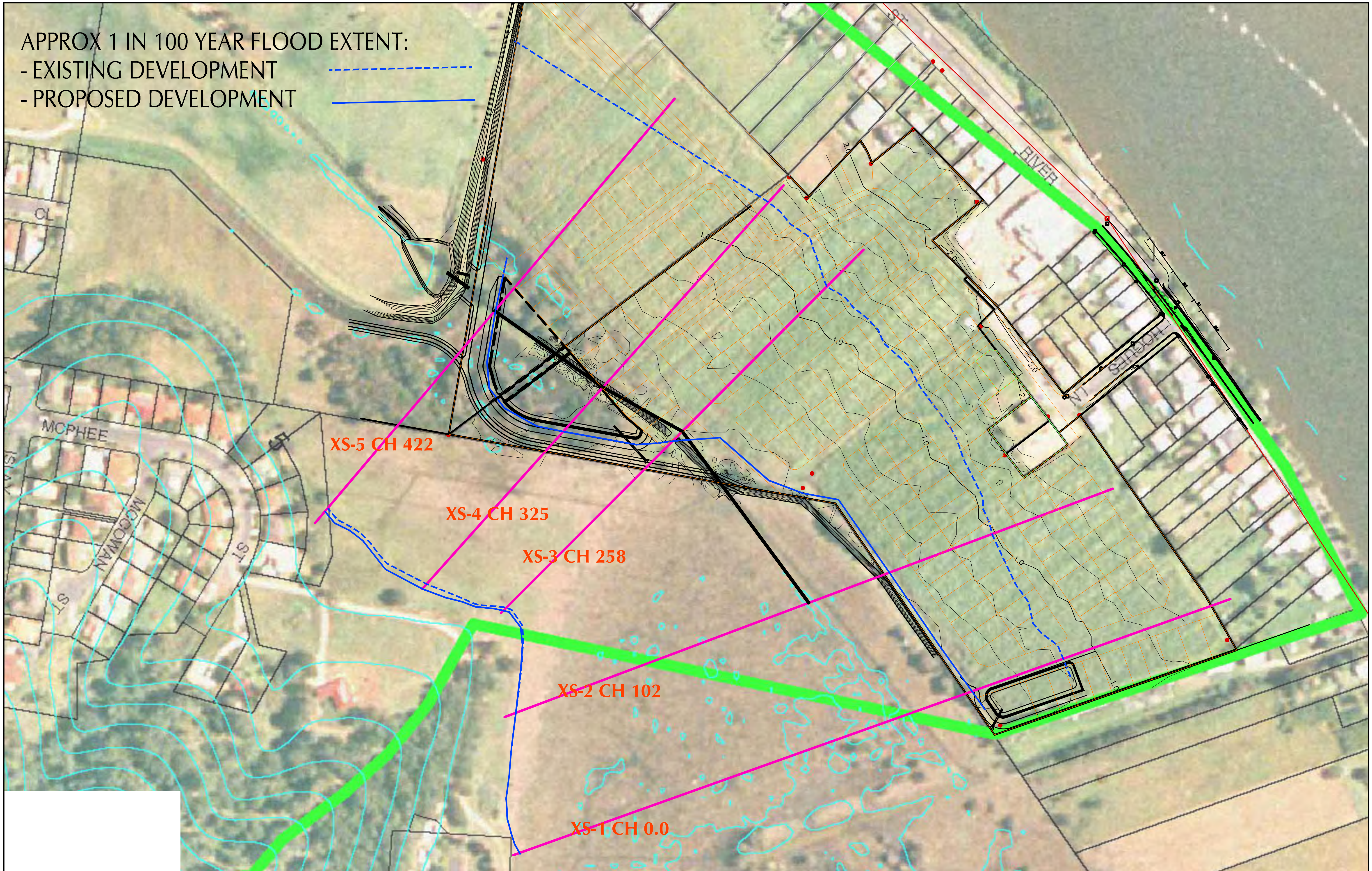
PROPOSED RESDENTIAL DEVELOPMENT
RANNOCH AVE & HOGUES LANE, MACLEAN NSW

ILSAX SCHEMATIC - FULL DEVELOPMENT (WITH DETENTION BASINS)

MAY 2006 JMK

14007-13

Amendment No.



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PROPOSED RESDENTIAL DEVELOPMENT
RANNOCH AVE & HOGUES LANE, MACLEAN NSW

HEC-RAS MODEL

OCT 2006 RDG

14007-14

Amendment No.
A

Appendix A – IFD Tables for Maclean

```
***********************************************************
*                    I F D                     *
*                                              *
*  Intensity - Frequency - Duration Design Rainfall Program  *
*                  (Version 2.0)                  *
*                                              *
*     This software determines IFD design rainfall in       *
*    accordance  with the algebraic procedures presented     *
*        in Chapter 2 (Author : R.P. Canterford) of        *
*            Australian Rainfall & Runoff(1987)           *
*                                              *
*           ***************************                 *
*                                              *
*     This software is supplied as is and without any       *
*    warranties as to performance or any other warranties    *
*                expressed or implied.               *
*                                              *
*                 (C) WP SOFTWARE 1988                 *
*                   Ph. (062) 815811                *
***********************************************************
```

*** INPUT DATA ECHO ***

Maclean
 2 year, 1 hour intensity: 43.00 mm/hr
 2 year, 12 hour intensity: 8.10 mm/hr
 2 year, 72 hour intensity: 2.50 mm/hr
50 year, 1 hour intensity: 81.00 mm/hr
50 year, 12 hour intensity: 16.10 mm/hr
50 year, 72 hour intensity: 5.50 mm/hr
Skewness: .05
Geographical factor for 6 minute, 2 yr storm: 4.39
Geographical factor for 6 minute, 50 yr storm: 16.70
Latitude :   .0000
Longitude: .0000

*** OUTPUT IFD TABLE ***

Rainfall Intensity (mm/h) for Maclean

Duration	Average Storm Recurrence Interval (years) 1	2	5	10	20	50	100
5m	108.15	137.68	172.33	190.47	216.57	250.47	276.12
6	101.35	129.07	161.74	178.86	203.47	235.44	259.64
7	95.68	121.89	152.88	169.15	192.51	222.87	245.85
8	90.83	115.76	145.32	160.85	183.13	212.10	234.04
9	86.62	110.43	138.74	153.63	174.97	202.73	223.76
10	82.92	105.74	132.94	147.27	167.77	194.46	214.69
11	79.62	101.56	127.77	141.59	161.36	187.08	206.59
12	76.66	97.81	123.12	136.49	155.58	180.45	199.30
13	73.98	94.41	118.91	131.87	150.35	174.43	192.69
14	71.54	91.31	115.08	127.65	145.58	168.94	186.66
15	69.30	88.47	111.56	123.78	141.20	163.91	181.13
16	67.24	85.86	108.32	120.22	137.17	159.26	176.03
17	65.34	83.45	105.33	116.92	133.43	154.96	171.30
18	63.57	81.20	102.54	113.86	129.96	150.97	166.91
20	60.39	77.16	97.52	108.33	123.70	143.75	158.98
25	53.97	69.01	87.38	97.17	111.04	129.16	142.93
30	49.08	62.79	79.63	88.62	101.35	117.98	130.62
35	45.19	57.85	73.46	81.82	93.62	109.05	120.80
40	42.01	53.80	68.41	76.24	87.28	101.73	112.73
45	39.35	50.42	64.18	71.56	81.97	95.59	105.96
50	37.09	47.54	60.57	67.57	77.43	90.34	100.18
55	35.13	45.05	57.44	64.12	73.50	85.80	95.17
60	33.42	42.87	54.71	61.09	70.06	81.81	90.77
75	28.89	37.08	47.41	53.00	60.83	71.10	78.94
90	25.60	32.88	42.11	47.11	54.11	63.29	70.31
2.0h	21.11	27.13	34.84	39.02	44.87	52.56	58.43
3.0	16.03	20.63	26.59	29.84	34.37	40.33	44.89
4.0	13.17	16.97	21.93	24.65	28.42	33.39	37.20
5.0	11.31	14.59	18.88	21.25	24.52	28.84	32.15
6.0	9.99	12.89	16.72	18.83	21.74	25.59	28.54
8.0	8.22	10.61	13.80	15.56	17.99	21.20	23.67
10.0	7.06	9.13	11.89	13.43	15.54	18.33	20.48
12.0	6.24	8.07	10.53	11.90	13.78	16.27	18.19
14.0	5.67	7.34	9.61	10.88	12.62	14.92	16.70
16.0	5.22	6.76	8.88	10.07	11.69	13.85	15.51
18.0	4.85	6.29	8.28	9.40	10.92	12.95	14.52
20.0	4.53	5.89	7.77	8.83	10.28	12.20	13.69
22.0	4.27	5.55	7.34	8.35	9.72	11.56	12.98
24.0	4.04	5.25	6.96	7.93	9.24	11.00	12.35
36.0	3.10	4.05	5.41	6.20	7.25	8.67	9.77
48.0	2.55	3.34	4.49	5.16	6.06	7.27	8.21
60.0	2.17	2.85	3.86	4.45	5.23	6.29	7.12
72.0	1.90	2.49	3.39	3.91	4.62	5.57	6.31

Appendix B – Existing development

```
                  * * *  I L S A X  * * *

                   Version V2.13 January 1993
              Produced at University of Technology, Sydney
               for IBM-PC and compatible microcomputers

* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
*                                                                          *
*  HOGUES LANE                                                             *
*                                                                          *
*  20 MINUTE, 100 YEAR DESIGN STORM - MACLEAN                              *
*                                                                          *
*  RUN NUMBER :  10           NO. OF RAINFALL PATTERNS IS  7               *
*  HYDROGRAPHS ARE FORMED USING TIME-AREA METHOD APPLIED TO RAINFALLS      *
*  GRASSED AREA LOSSES ARE SUBTRACTED FROM FLOW DEPTH DISTRIBUTION         *
*  DEFAULT MODE IS UPGRADE                                                 *
*  TIME SHIFT ROUTING                                                      *
*  LIMITED OUTPUT                                                          *
*  DIAMETER AND UNIT COST SET USED IS :                                    *
*   EXACT DIAMETERS 152 TO 2134 mm, COSTS AT AUGUST 1988                   *
*  MINIMUM DIAMETER IS  375 mm                                             *
*  MANNING'S EQUATION IS USED FOR PIPES                                    *
*  OLD AND NEW DEFAULT PIPE ROUGHNESSES ARE  .012 AND  .012                 *
*                                                                          *
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *

RUN & RAINFALL FILE :    rain100.mac
SYSTEM PIPE FILE :       04122ex.dat
OUTPUT DATA FILE :       04122ex.out
INTERMEDIATE DATA FILE : 04122ex.int


USER ...............................................    DATE ................

REFERENCE ....................................................................

..............................................................................


CATCHMENT PARAMETERS
********************
                                                  INFILTRATION
        DEPRESSION STORAGE (mm)   SOIL TYPE    AMC      PARAMETERS
          PAVED AREA   GRASSED    1234=ABCD            FI =    47.0 mm
                                  5=NEW              F0 =  162.5 mm/h
                                                     FC =    9.5 mm/h
             1.0        6.0        2.50      2.50    K =    2.0 /h
                                                    FID =   43.1 mm
                                           INITIAL RATE =   76.4 mm/h
RAINFALL PARAMETERS AND DATA
****************************

   DURATION      TIME INCREMENT       NUMBER OF       TOTAL RAINFALL
   (minutes)       (minutes)     RAINFALL INCREMENTS      (mm)

     20.0            1.0              4             53.0

STANDARD AUSTRALIAN RAINFALL PATTERN FOR ZONE  1
WITH AVERAGE INTENSITY  158.98 mm/h                ( MULTIPLIER =  1.000 )

 127.2   127.2   127.2   127.2   127.2   254.4   254.4   254.4   254.4   254.4
 190.8   190.8   190.8   190.8   190.8    63.6    63.6    63.6    63.6    63.6


COMPUTATIONAL TIME STEP =  1.0 minutes
```

PIPE SYSTEM DETAILS
****

```
BCH RCH      AREAS (ha)     PAVED     GRASSED     C    VOL SURFACE PIT  PIPE
        PAV  SUP GRAS TOTAL TIME  Q   TIME    Q              Q     Q     Q

LEN SLOPE         ORIGINAL          DESIGNED      CAP  VEL    VOLUMES  OFLOW
         H    B    SS  NO DIA nORk NO DIA nORk PAT  Q        BYP UPW OFL  Q

DETENTION BASIN ROUTING

     HEIGHT-STORAGE-OUTFLOW RELATIONSHIP
HEIGHT (m)      STORAGE (m3)     OUTFLOW (m3/s)

  -.500            .0          .000
   .000          295.0          .800
   .250         1324.0          .950
   .500         6799.0         1.600
   .750        21445.0         1.900
  1.000        46660.0         2.600
  1.250        79039.0         2.800
  1.300        85993.0         3.400
  1.700      1442083.0         5.000
  1.750      1500000.0        30.000


STARTING STORAGE IS     0. m3

VOLUMES OF INFLOW AND OUTFLOW HYDROGRAPHS ARE    27939. AND     27939. m3
AND RESPECTIVE PEAKS ARE    19.057 AND     1.971 m3/s
PEAK HEIGHT IN BASIN IS    .775 m, AND TIME OF PONDING IS  346.0 minutes

                                              DETENTION BASIN
  A_  125.03  .0064.37 89.40 30 7.231  0-2511.826  .5902793919.05719.057 1.971

CIRCULAR PIPE,       UNRESTRICTED, NO-OVERFLOW INLET              UPGRADING
  B_  1 2.38  .0012.52 14.90 20 1.033  0-25 2.300  .525 4141 3.332 3.332 3.315
 70  .50  .00  .00  .00      0 .000   1295 .012  1 3.659 2.8   0   0   0  .000

CIRCULAR PIPE,       UNRESTRICTED, NO-OVERFLOW INLET              UPGRADING
  C_  1  .95  .00 5.36  6.30 15  .490  0-15 1.640  .554 1851 2.085 2.085 2.083
 30  .50  .00  .00  .00      0 .000   1067 .012  1 2.183 2.4   0   0   0  .000

CIRCULAR PIPE,       UNRESTRICTED, NO-OVERFLOW INLET              UPGRADING
  A_  2  .00  .00  .60   .60  6  .000  0-12  .222  .491  156  .222 7.236 7.222
 60  .50  .00  .00  .00      0 .000   1676 .012  1 7.279 3.3   0   0   0  .000

CIRCULAR PIPE,       UNRESTRICTED, NO-OVERFLOW INLET              UPGRADING
  D_  1  .28  .00 2.52  2.80 15  .145  0-15  .772  .529  785  .904  .904  .902
 50  .50  .00  .00  .00      0 .000    838 .012  1 1.146 2.1   0   0   0  .000

CIRCULAR PIPE,       UNRESTRICTED, NO-OVERFLOW INLET              UPGRADING
  A_  3  .00  .00 1.10  1.10  6  .000  0-10  .480  .499  291  .480 8.359 8.358
 80  .50  .00  .00  .00      0 .000   1829 .012  1 9.189 3.5   0   0   0  .000

CIRCULAR PIPE,       UNRESTRICTED, NO-OVERFLOW INLET              UPGRADING
  A_  4  .00  .00 3.20  3.20  6  .000  0-10 1.395  .499  845 1.395 9.456 9.440
130  .50  .00  .00  .00      0 .000   1981 .012  111.369 3.7   0   0   0  .000

CIRCULAR PIPE,       UNRESTRICTED, NO-OVERFLOW INLET              UPGRADING
  E_  1  .74  .00 2.94  3.68 15  .382  0-15  .901  .579 1130 1.248 1.248 1.248
 50  .50  .00  .00  .00      0 .000    914 .012  1 1.445 2.2   0   0   0  .000

CIRCULAR PIPE,       UNRESTRICTED, NO-OVERFLOW INLET              UPGRADING
  A_  5  .00  .00 1.01  1.01  6  .000  0-15  .309  .479  256  .30910.98410.977
200  .50  .00  .00  .00      0 .000   1981 .012  111.369 3.7   0   0   0  .000

CIRCULAR PIPE,       UNRESTRICTED, NO-OVERFLOW INLET              UPGRADING
  A_  6  .00  .00  .70   .70  6  .000  0-15  .214  .479  178  .21411.18711.154
 50  .50  .00  .00  .00      0 .000   1981 .012  111.369 3.7   0   0   0  .000
```

CIRCULAR PIPE, UNRESTRICTED, NO-OVERFLOW INLET UPGRADING
F_ 1 .34 .00 .34 .69 10 .213 0-10 .150 .740 271 .364 .364 .364
110 .50 .00 .00 .00 0 .000 610 .012 1 .492 1.7 0 0 0 .000

CIRCULAR PIPE, UNRESTRICTED, NO-OVERFLOW INLET UPGRADING
F_ 2 .80 .00 .80 1.60 6 .542 0-10 .349 .740 627 .796 1.141 1.124
90 .50 .00 .00 .00 0 .000 838 .012 1 1.146 2.1 0 0 0 .000

CIRCULAR PIPE, UNRESTRICTED, NO-OVERFLOW INLET UPGRADING
F_ 3 .94 .00 .94 1.88 10 .581 0-15 .288 .730 727 .854 1.978 1.974
175 .50 .00 .00 .00 0 .000 1067 .012 1 2.183 2.4 0 0 0 .000

CIRCULAR PIPE, UNRESTRICTED, NO-OVERFLOW INLET UPGRADING
F_ 4 .00 .00 2.75 2.75 10 .000 0-15 .842 .479 698 .842 2.781 2.769
30 .50 .00 .00 .00 0 .000 1219 .012 1 3.114 2.7 0 0 0 .000

CIRCULAR PIPE, UNRESTRICTED, NO-OVERFLOW INLET UPGRADING
A_ 7 .00 .00 .10 .10 6 .000 0 -6 .048 .508 27 .04813.81213.770
350 .50 .00 .00 .00 0 .000 2134 .012 113.863 3.9 0 0 0 .000

OUTFALL HYDROGRAPH (m3/s)
****
(349 VALUES AT 1.0 minute INTERVALS)

.000	.000	.002	.030	.124	.294	.526	.868	1.501	2.553
3.935	5.456	6.976	8.385	9.629	10.743	11.808	12.791	13.493	13.770
13.704	13.467	13.086	12.475	11.586	10.487	9.284	8.117	7.111	6.256
5.545	4.997	4.600	4.316	4.061	3.770	3.426	3.055	2.694	2.391
2.181	2.066	2.013	1.989	1.977	1.972	1.971	1.970	1.968	1.967
1.964	1.962	1.959	1.956	1.953	1.950	1.946	1.943	1.940	1.937
1.933	1.930	1.927	1.924	1.921	1.917	1.914	1.911	1.908	1.905
1.902	1.899	1.897	1.894	1.892	1.890	1.887	1.885	1.883	1.880
1.878	1.876	1.873	1.871	1.869	1.866	1.864	1.862	1.860	1.857
1.855	1.853	1.850	1.848	1.846	1.844	1.841	1.839	1.837	1.835
1.832	1.830	1.828	1.826	1.823	1.821	1.819	1.817	1.814	1.812
1.810	1.808	1.806	1.803	1.801	1.799	1.797	1.794	1.792	1.790
1.788	1.786	1.783	1.781	1.779	1.777	1.775	1.773	1.770	1.768
1.766	1.764	1.762	1.760	1.757	1.755	1.753	1.751	1.749	1.747
1.744	1.742	1.740	1.738	1.736	1.734	1.732	1.729	1.727	1.725
1.723	1.721	1.719	1.717	1.715	1.713	1.710	1.708	1.706	1.704
1.702	1.700	1.698	1.696	1.694	1.692	1.690	1.687	1.685	1.683
1.681	1.679	1.677	1.675	1.673	1.671	1.669	1.667	1.665	1.663
1.661	1.659	1.657	1.655	1.653	1.651	1.649	1.647	1.644	1.642
1.640	1.638	1.636	1.634	1.632	1.630	1.628	1.626	1.624	1.622
1.620	1.618	1.616	1.614	1.612	1.610	1.609	1.607	1.605	1.602
1.598	1.591	1.581	1.570	1.559	1.548	1.537	1.526	1.515	1.504
1.493	1.483	1.472	1.462	1.451	1.441	1.431	1.421	1.411	1.401
1.391	1.381	1.371	1.361	1.352	1.342	1.333	1.323	1.314	1.304
1.295	1.286	1.277	1.268	1.259	1.250	1.241	1.232	1.223	1.215
1.206	1.198	1.189	1.181	1.172	1.164	1.156	1.147	1.139	1.131
1.123	1.115	1.107	1.099	1.092	1.084	1.076	1.069	1.061	1.053
1.046	1.039	1.031	1.024	1.017	1.009	1.002	.995	.988	.981
.974	.967	.960	.953	.946	.938	.930	.921	.913	.905
.898	.890	.882	.874	.867	.859	.852	.844	.837	.830
.822	.814	.799	.760	.689	.600	.512	.435	.370	.314
.267	.227	.193	.164	.139	.118	.100	.085	.072	.061
.052	.044	.038	.032	.027	.023	.020	.017	.014	.012
.010	.009	.007	.006	.005	.005	.004	.003	.003	.002
.002	.002	.001	.001	.001	.001	.001	.001	.000	

TOTAL AREA = 130.71 ha (31.46 ha PAVED, .00 ha SUPPLEMENTARY
99.25 ha GRASSED AND .00 ha UNDRAINED)
ACCUMULATED RUNOFF = 39923 m3
INCLUDING BASEFLOW = 0 m3
& USER HYDROGRAPHS = 0 m3
VOLUME DIVERTED OUT = 0 m3
OVERFLOWS IN TRANSIT = 0 m3 (NET)
RUNOFF COEFFICIENTS = .576 (VOLUMETRIC) BASED ONLY ON RAINFALL INPUTS
.239 (PEAK/AVERAGE) AND .149 (PEAK/PEAK)
INCL. USER-PROVIDED HYDROGRAPHS, BUT NOT BASEFLOWS

NO. OF PIPES = 15
PEAK FLOWRATE = 13.770 m3/s 20.0 minutes AFTER START OF STORM
TOTAL BASEFLOW = .000 m3/s
GRASSED RUNOFF = 59.0 %

RERUN WITH NEW RAINFALL PATTERN NO. 2
****

30 MINUTE, 100 YEAR DESIGN STORM - MACLEAN
(ANTECEDENT MOISTURE CONDITION = 2.50)

CATCHMENT PARAMETERS
****

```
                                          INFILTRATION
     DEPRESSION STORAGE (mm)   SOIL TYPE     AMC       PARAMETERS
      PAVED AREA   GRASSED    1234=ABCD              FI =   47.0 mm
                        5=NEW              F0 =  162.5 mm/h
                                         FC =    9.5 mm/h
        1.0        6.0        2.50       2.50     K =    2.0 /h
                                         FID =   43.1 mm
                                   INITIAL RATE =   76.4 mm/h
```

RAINFALL PARAMETERS AND DATA
****

DURATION (minutes)	TIME INCREMENT (minutes)	NUMBER OF RAINFALL INCREMENTS	TOTAL RAINFALL (mm)
30.0	1.0	6	65.3

STANDARD AUSTRALIAN RAINFALL PATTERN FOR ZONE 1
WITH AVERAGE INTENSITY 130.62 mm/h (MULTIPLIER = 1.000)

```
 125.4   125.4   125.4   125.4   125.4   188.1   188.1   188.1   188.1   188.1
 235.1   235.1   235.1   235.1   235.1    78.4    78.4    78.4    78.4    78.4
  94.0    94.0    94.0    94.0    94.0    62.7    62.7    62.7    62.7    62.7
```

COMPUTATIONAL TIME STEP = 1.0 minutes

PIPE SYSTEM DETAILS
****

```
BCH RCH      AREAS (ha)     PAVED     GRASSED     C    VOL SURFACE PIT  PIPE
        PAV  SUP GRAS TOTAL TIME  Q   TIME    Q              Q     Q     Q

LEN SLOPE         ORIGINAL           DESIGNED       CAP  VEL    VOLUMES  OFLOW
        H    B    SS  NO DIA nORk NO DIA nORk PAT  Q        BYP UPW OFL  Q
```

DETENTION BASIN ROUTING

HEIGHT-STORAGE-OUTFLOW RELATIONSHIP

HEIGHT (m)	STORAGE (m3)	OUTFLOW (m3/s)
-.500	.0	.000
.000	295.0	.800
.250	1324.0	.950
.500	6799.0	1.600
.750	21445.0	1.900
1.000	46660.0	2.600
1.250	79039.0	2.800
1.300	85993.0	3.400
1.700	1442083.0	5.000
1.750	1500000.0	30.000

STARTING STORAGE IS 0. m3

VOLUMES OF INFLOW AND OUTFLOW HYDROGRAPHS ARE 35434. AND 35434. m3
AND RESPECTIVE PEAKS ARE 23.288 AND 2.147 m3/s
PEAK HEIGHT IN BASIN IS .838 m, AND TIME OF PONDING IS 407.0 minutes

DETENTION BASIN
A_ 125.03 .0064.37 89.40 30 8.943 0-2514.344 .6073543423.28823.288 2.147

CIRCULAR PIPE, UNRESTRICTED, NO-OVERFLOW INLET UPGRADING
B_ 1 2.38 .0012.52 14.90 20 1.028 0-25 2.789 .544 5293 3.591 3.591 3.587
70 .50 .00 .00 .00 1295 .012 1295 .012 2 3.659 2.8 0 0 0 .000

CIRCULAR PIPE, UNRESTRICTED, NO-OVERFLOW INLET UPGRADING
C_ 1 .95 .00 5.36 6.30 15 .472 0-15 1.612 .558 2295 2.034 2.034 2.034
30 .50 .00 .00 .00 1067 .012 1067 .012 1 2.183 2.4 0 0 0 .000

CIRCULAR PIPE, UNRESTRICTED, NO-OVERFLOW INLET UPGRADING
A_ 2 .00 .00 .60 .60 0 .000 0-12 .210 .489 192 .210 7.191 7.189
60 .50 .00 .00 .00 1676 .012 2134 .012 113.863 3.9 0 0 0 .000

CIRCULAR PIPE, UNRESTRICTED, NO-OVERFLOW INLET UPGRADING
D_ 1 .28 .00 2.52 2.80 15 .140 0-15 .758 .533 974 .884 .884 .883
50 .50 .00 .00 .00 838 .012 838 .012 1 1.146 2.1 0 0 0 .000

CIRCULAR PIPE, UNRESTRICTED, NO-OVERFLOW INLET UPGRADING
A_ 3 .00 .00 1.10 1.10 0 .000 0-10 .443 .493 354 .443 8.329 8.308
80 .50 .00 .00 .00 1829 .012 2134 .012 113.863 3.9 0 0 0 .000

CIRCULAR PIPE, UNRESTRICTED, NO-OVERFLOW INLET UPGRADING
A_ 4 .00 .00 3.20 3.20 0 .000 0-10 1.290 .493 1030 1.290 9.183 9.179
130 .50 .00 .00 .00 1981 .012 2134 .012 113.863 3.9 0 0 0 .000

CIRCULAR PIPE, UNRESTRICTED, NO-OVERFLOW INLET UPGRADING
E_ 1 .74 .00 2.94 3.68 15 .367 0-15 .886 .583 1401 1.219 1.219 1.216
50 .50 .00 .00 .00 914 .012 914 .012 1 1.445 2.2 0 0 0 .000

CIRCULAR PIPE, UNRESTRICTED, NO-OVERFLOW INLET UPGRADING
A_ 5 .00 .00 1.01 1.01 0 .000 0-15 .304 .482 318 .30410.69510.693
200 .50 .00 .00 .00 1981 .012 2134 .012 113.863 3.9 0 0 0 .000

CIRCULAR PIPE, UNRESTRICTED, NO-OVERFLOW INLET UPGRADING
A_ 6 .00 .00 .70 .70 0 .000 0-15 .211 .482 220 .21110.90310.897
50 .50 .00 .00 .00 1981 .012 2134 .012 113.863 3.9 0 0 0 .000

CIRCULAR PIPE, UNRESTRICTED, NO-OVERFLOW INLET UPGRADING
F_ 1 .34 .00 .34 .69 10 .203 0-10 .139 .739 333 .342 .342 .342
110 .50 .00 .00 .00 610 .012 610 .012 1 .492 1.7 0 0 0 .000

CIRCULAR PIPE, UNRESTRICTED, NO-OVERFLOW INLET UPGRADING
F_ 2 .80 .00 .80 1.60 6 .505 0-10 .323 .739 772 .828 1.141 1.136
90 .50 .00 .00 .00 838 .012 838 .012 2 1.146 2.1 0 0 0 .000

CIRCULAR PIPE, UNRESTRICTED, NO-OVERFLOW INLET UPGRADING
F_ 3 .94 .00 .94 1.88 10 .553 0-15 .283 .734 901 .805 1.918 1.916
175 .50 .00 .00 .00 1067 .012 1067 .012 1 2.183 2.4 0 0 0 .000

CIRCULAR PIPE, UNRESTRICTED, NO-OVERFLOW INLET UPGRADING
F_ 4 .00 .00 2.75 2.75 0 .000 0-15 .828 .482 866 .828 2.685 2.677
30 .50 .00 .00 .00 1219 .012 1219 .012 1 3.114 2.7 0 0 0 .000

CIRCULAR PIPE, UNRESTRICTED, NO-OVERFLOW INLET UPGRADING
A_ 7 .00 .00 .10 .10 0 .000 0 -6 .048 .501 33 .04813.34613.336
350 .50 .00 .00 .00 2134 .012 2134 .012 113.863 3.9 0 0 0 .000

OUTFALL HYDROGRAPH (m3/s)
****
(409 VALUES AT 1.0 minute INTERVALS)

.000 .000 .002 .030 .123 .292 .522 .816 1.273 1.986
2.926 3.960 5.040 6.203 7.470 8.812 10.197 11.511 12.527 13.100
13.311 13.336 13.279 13.124 12.858 12.514 12.121 11.671 11.191 10.698
10.180 9.646 9.142 8.659 8.136 7.548 6.906 6.237 5.581 4.959

4.398	3.910	3.489	3.144	2.884	2.699	2.555	2.432	2.333	2.268
2.230	2.205	2.184	2.166	2.153	2.147	2.144	2.142	2.140	2.138
2.135	2.132	2.129	2.126	2.123	2.119	2.116	2.112	2.108	2.105
2.101	2.098	2.094	2.091	2.088	2.084	2.081	2.077	2.074	2.070
2.067	2.063	2.060	2.056	2.053	2.050	2.046	2.043	2.039	2.036
2.033	2.029	2.026	2.022	2.019	2.016	2.012	2.009	2.006	2.002
1.999	1.996	1.992	1.989	1.986	1.982	1.979	1.976	1.973	1.969
1.966	1.963	1.959	1.956	1.953	1.950	1.946	1.943	1.940	1.937
1.934	1.930	1.927	1.924	1.921	1.917	1.914	1.911	1.908	1.905
1.902	1.899	1.897	1.894	1.892	1.890	1.887	1.885	1.883	1.880
1.878	1.876	1.873	1.871	1.869	1.866	1.864	1.862	1.860	1.857
1.855	1.853	1.850	1.848	1.846	1.844	1.841	1.839	1.837	1.835
1.832	1.830	1.828	1.826	1.823	1.821	1.819	1.817	1.814	1.812
1.810	1.808	1.806	1.803	1.801	1.799	1.797	1.794	1.792	1.790
1.788	1.786	1.783	1.781	1.779	1.777	1.775	1.773	1.770	1.768
1.766	1.764	1.762	1.760	1.757	1.755	1.753	1.751	1.749	1.747
1.744	1.742	1.740	1.738	1.736	1.734	1.732	1.730	1.727	1.725
1.723	1.721	1.719	1.717	1.715	1.713	1.710	1.708	1.706	1.704
1.702	1.700	1.698	1.696	1.694	1.692	1.690	1.688	1.685	1.683
1.681	1.679	1.677	1.675	1.673	1.671	1.669	1.667	1.665	1.663
1.661	1.659	1.657	1.655	1.653	1.651	1.649	1.647	1.645	1.642
1.640	1.638	1.636	1.634	1.632	1.630	1.628	1.626	1.624	1.622
1.620	1.618	1.616	1.614	1.612	1.611	1.609	1.607	1.605	1.602
1.598	1.591	1.581	1.570	1.559	1.548	1.537	1.526	1.515	1.504
1.494	1.483	1.472	1.462	1.452	1.441	1.431	1.421	1.411	1.401
1.391	1.381	1.371	1.361	1.352	1.342	1.333	1.323	1.314	1.304
1.295	1.286	1.277	1.268	1.259	1.250	1.241	1.232	1.223	1.215
1.206	1.198	1.189	1.181	1.172	1.164	1.156	1.147	1.139	1.131
1.123	1.115	1.107	1.099	1.092	1.084	1.076	1.069	1.061	1.053
1.046	1.039	1.031	1.024	1.017	1.009	1.002	.995	.988	.981
.974	.967	.960	.953	.946	.938	.930	.921	.913	.906
.898	.890	.882	.874	.867	.859	.852	.844	.837	.830
.822	.814	.799	.761	.690	.600	.513	.436	.370	.314
.267	.227	.193	.164	.139	.118	.100	.085	.072	.062
.052	.044	.038	.032	.027	.023	.020	.017	.014	.012
.010	.009	.007	.006	.005	.005	.004	.003	.003	.002
.002	.002	.001	.001	.001	.001	.001	.001	.000	

TOTAL AREA = 130.71 ha (31.46 ha PAVED, .00 ha SUPPLEMENTARY
99.25 ha GRASSED AND .00 ha UNDRAINED)
ACCUMULATED RUNOFF = 50416 m3
INCLUDING BASEFLOW = 0 m3
& USER HYDROGRAPHS = 0 m3
VOLUME DIVERTED OUT = 0 m3
OVERFLOWS IN TRANSIT = 0 m3 (NET)
RUNOFF COEFFICIENTS = .591 (VOLUMETRIC) BASED ONLY ON RAINFALL INPUTS
.281 (PEAK/AVERAGE) AND .156 (PEAK/PEAK)
INCL. USER-PROVIDED HYDROGRAPHS, BUT NOT BASEFLOWS
NO. OF PIPES = 15
PEAK FLOWRATE = 13.336 m3/s 22.0 minutes AFTER START OF STORM
TOTAL BASEFLOW = .000 m3/s
GRASSED RUNOFF = 59.9 %

RERUN WITH NEW RAINFALL PATTERN NO. 3
****

45 MINUTE, 100 YEAR DESIGN STORM - MACLEAN
(ANTECEDENT MOISTURE CONDITION = 2.50)

CATCHMENT PARAMETERS
****

```
                                              INFILTRATION
      DEPRESSION STORAGE (mm)   SOIL TYPE     AMC        PARAMETERS
       PAVED AREA   GRASSED     1234=ABCD            FI =   47.0 mm
                                5=NEW          F0 =  162.5 mm/h
                                           FC =    9.5 mm/h
          1.0         6.0         2.50        2.50    K =    2.0 /h
                                           FID =   43.1 mm
                                     INITIAL RATE =   76.4 mm/h
```

RAINFALL PARAMETERS AND DATA
****

DURATION (minutes)	TIME INCREMENT (minutes)	NUMBER OF RAINFALL INCREMENTS	TOTAL RAINFALL (mm)
45.0	1.0	9	79.5

STANDARD AUSTRALIAN RAINFALL PATTERN FOR ZONE 1
WITH AVERAGE INTENSITY 105.96 mm/h (MULTIPLIER = 1.000)

```
  50.5   50.5   50.5   50.5   50.5  132.6  132.6  132.6  132.6  132.6
 222.2  222.2  222.2  222.2  222.2  168.8  168.8  168.8  168.8  168.8
  93.5   93.5   93.5   93.5   93.5  111.6  111.6  111.6  111.6  111.6
  75.3   75.3   75.3   75.3   75.3   62.0   62.0   62.0   62.0   62.0
  37.2   37.2   37.2   37.2   37.2
```

COMPUTATIONAL TIME STEP = 1.0 minutes

PIPE SYSTEM DETAILS
****

```
BCH RCH    AREAS (ha)    PAVED    GRASSED    C    VOL SURFACE PIT  PIPE
        PAV  SUP GRAS TOTAL TIME  Q   TIME    Q          Q     Q     Q

LEN SLOPE       ORIGINAL        DESIGNED      CAP  VEL    VOLUMES  OFLOW
        H    B    SS  NO DIA nORk NO DIA nORk PAT  Q        BYP UPW OFL  Q
```

DETENTION BASIN ROUTING

HEIGHT-STORAGE-OUTFLOW RELATIONSHIP

HEIGHT (m)	STORAGE (m3)	OUTFLOW (m3/s)
-.500	.0	.000
.000	295.0	.800
.250	1324.0	.950
.500	6799.0	1.600
.750	21445.0	1.900
1.000	46660.0	2.600
1.250	79039.0	2.800
1.300	85993.0	3.400
1.700	1442083.0	5.000
1.750	1500000.0	30.000

STARTING STORAGE IS 0. m3

VOLUMES OF INFLOW AND OUTFLOW HYDROGRAPHS ARE 44626. AND 44625. m3
AND RESPECTIVE PEAKS ARE 25.375 AND 2.365 m3/s
PEAK HEIGHT IN BASIN IS .916 m, AND TIME OF PONDING IS 476.0 minutes

```
                                        DETENTION BASIN
 A_  125.03  .0064.37 89.40 30 9.317  0-2516.059  .6284462625.37525.375 2.365

CIRCULAR PIPE,      UNRESTRICTED, NO-OVERFLOW INLET            UPGRADING
 B_  1 2.38  .0012.52 14.90 20 1.021  0-25 3.123  .568 6729 3.866 3.866 3.862
 70  .50  .00  .00  .00   1295 .012   1372 .012  3 4.269 2.9   0   0   0 .000

CIRCULAR PIPE,      UNRESTRICTED, NO-OVERFLOW INLET            UPGRADING
 C_  1  .95  .00 5.36  6.30 15  .458  0-15 1.652  .574 2876 2.076 2.076 2.068
 30  .50  .00  .00  .00   1067 .012   1067 .012  1 2.183 2.4   0   0   0 .000

CIRCULAR PIPE,      UNRESTRICTED, NO-OVERFLOW INLET            UPGRADING
 A_  2  .00  .00  .60   .60  0  .000  0-12  .210  .505  241   .210 7.259 7.257
 60  .50  .00  .00  .00   2134 .012   2134 .012  313.863 3.9   0   0   0 .000

CIRCULAR PIPE,      UNRESTRICTED, NO-OVERFLOW INLET            UPGRADING
 D_  1  .28  .00 2.52  2.80 15  .136  0-15  .777  .550 1224  .903  .903  .895
 50  .50  .00  .00  .00    838 .012    838 .012  1 1.146 2.1   0   0   0 .000
```

CIRCULAR PIPE, UNRESTRICTED, NO-OVERFLOW INLET UPGRADING
A_ 3 .00 .00 1.10 1.10 0 .000 0-10 .432 .508 444 .432 8.365 8.355
80 .50 .00 .00 .00 2134 .012 2134 .012 313.863 3.9 0 0 0 .000

CIRCULAR PIPE, UNRESTRICTED, NO-OVERFLOW INLET UPGRADING
A_ 4 .00 .00 3.20 3.20 0 .000 0-10 1.255 .508 1291 1.255 9.073 9.063
130 .50 .00 .00 .00 2134 .012 2134 .012 113.863 3.9 0 0 0 .000

CIRCULAR PIPE, UNRESTRICTED, NO-OVERFLOW INLET UPGRADING
E_ 1 .74 .00 2.94 3.68 15 .357 0-15 .908 .599 1751 1.238 1.238 1.230
50 .50 .00 .00 .00 914 .012 914 .012 1 1.445 2.2 0 0 0 .000

CIRCULAR PIPE, UNRESTRICTED, NO-OVERFLOW INLET UPGRADING
A_ 5 .00 .00 1.01 1.01 0 .000 0-15 .312 .502 403 .31210.58410.579
200 .50 .00 .00 .00 2134 .012 2134 .012 113.863 3.9 0 0 0 .000

CIRCULAR PIPE, UNRESTRICTED, NO-OVERFLOW INLET UPGRADING
A_ 6 .00 .00 .70 .70 0 .000 0-15 .216 .502 279 .21610.78610.780
50 .50 .00 .00 .00 2134 .012 2134 .012 113.863 3.9 0 0 0 .000

CIRCULAR PIPE, UNRESTRICTED, NO-OVERFLOW INLET UPGRADING
F_ 1 .34 .00 .34 .69 10 .187 0-10 .135 .747 410 .323 .323 .322
110 .50 .00 .00 .00 610 .012 610 .012 1 .492 1.7 0 0 0 .000

CIRCULAR PIPE, UNRESTRICTED, NO-OVERFLOW INLET UPGRADING
F_ 2 .80 .00 .80 1.60 6 .474 0-10 .314 .747 950 .709 1.016 1.001
90 .50 .00 .00 .00 838 .012 838 .012 2 1.146 2.1 0 0 0 .000

CIRCULAR PIPE, UNRESTRICTED, NO-OVERFLOW INLET UPGRADING
F_ 3 .94 .00 .94 1.88 10 .510 0-15 .290 .744 1112 .756 1.758 1.754
175 .50 .00 .00 .00 1067 .012 1067 .012 1 2.183 2.4 0 0 0 .000

CIRCULAR PIPE, UNRESTRICTED, NO-OVERFLOW INLET UPGRADING
F_ 4 .00 .00 2.75 2.75 0 .000 0-15 .848 .502 1096 .848 2.499 2.499
30 .50 .00 .00 .00 1219 .012 1219 .012 1 3.114 2.7 0 0 0 .000

CIRCULAR PIPE, UNRESTRICTED, NO-OVERFLOW INLET UPGRADING
A_ 7 .00 .00 .10 .10 0 .000 0 -6 .043 .511 41 .04313.06813.064
350 .50 .00 .00 .00 2134 .012 2134 .012 113.863 3.9 0 0 0 .000

OUTFALL HYDROGRAPH (m3/s)
****
(479 VALUES AT 1.0 minute INTERVALS)

.000	.000	.000	.001	.018	.064	.141	.241	.388	.599
.864	1.162	1.566	2.212	3.155	4.312	5.578	6.861	8.055	9.116
10.072	10.988	11.850	12.513	12.882	13.029	13.064	13.006	12.857	12.642
12.385	12.107	11.828	11.568	11.318	11.060	10.794	10.551	10.328	10.081
9.790	9.464	9.100	8.697	8.269	7.830	7.389	6.944	6.483	6.004
5.521	5.047	4.602	4.208	3.875	3.604	3.379	3.180	3.003	2.850
2.718	2.606	2.519	2.462	2.430	2.411	2.396	2.382	2.370	2.361
2.355	2.352	2.349	2.346	2.343	2.339	2.336	2.332	2.329	2.325
2.321	2.317	2.313	2.309	2.306	2.302	2.298	2.294	2.290	2.286
2.283	2.279	2.275	2.271	2.267	2.264	2.260	2.256	2.252	2.249
2.245	2.241	2.237	2.234	2.230	2.226	2.223	2.219	2.215	2.211
2.208	2.204	2.200	2.197	2.193	2.190	2.186	2.182	2.179	2.175
2.171	2.168	2.164	2.161	2.157	2.153	2.150	2.146	2.143	2.139
2.135	2.132	2.128	2.125	2.121	2.118	2.114	2.111	2.107	2.104
2.100	2.097	2.093	2.090	2.086	2.083	2.079	2.076	2.072	2.069
2.066	2.062	2.059	2.055	2.052	2.048	2.045	2.042	2.038	2.035
2.031	2.028	2.025	2.021	2.018	2.015	2.011	2.008	2.004	2.001
1.998	1.995	1.991	1.988	1.985	1.981	1.978	1.975	1.971	1.968
1.965	1.962	1.958	1.955	1.952	1.949	1.945	1.942	1.939	1.936
1.932	1.929	1.926	1.923	1.920	1.916	1.913	1.910	1.907	1.904
1.901	1.898	1.896	1.893	1.891	1.889	1.886	1.884	1.882	1.879
1.877	1.875	1.873	1.870	1.868	1.866	1.863	1.861	1.859	1.856
1.854	1.852	1.850	1.847	1.845	1.843	1.841	1.838	1.836	1.834
1.832	1.829	1.827	1.825	1.823	1.820	1.818	1.816	1.814	1.811
1.809	1.807	1.805	1.803	1.800	1.798	1.796	1.794	1.791	1.789
1.787	1.785	1.783	1.780	1.778	1.776	1.774	1.772	1.770	1.767
1.765	1.763	1.761	1.759	1.757	1.754	1.752	1.750	1.748	1.746

1.744	1.742	1.739	1.737	1.735	1.733	1.731	1.729	1.727	1.725
1.722	1.720	1.718	1.716	1.714	1.712	1.710	1.708	1.706	1.703
1.701	1.699	1.697	1.695	1.693	1.691	1.689	1.687	1.685	1.683
1.681	1.678	1.676	1.674	1.672	1.670	1.668	1.666	1.664	1.662
1.660	1.658	1.656	1.654	1.652	1.650	1.648	1.646	1.644	1.642
1.640	1.638	1.636	1.634	1.632	1.630	1.628	1.626	1.624	1.622
1.620	1.618	1.616	1.614	1.612	1.610	1.608	1.606	1.604	1.601
1.596	1.587	1.577	1.566	1.555	1.544	1.533	1.522	1.511	1.500
1.490	1.479	1.469	1.458	1.448	1.438	1.427	1.417	1.407	1.397
1.387	1.377	1.368	1.358	1.348	1.339	1.329	1.320	1.310	1.301
1.292	1.283	1.274	1.265	1.256	1.247	1.238	1.229	1.220	1.212
1.203	1.195	1.186	1.178	1.169	1.161	1.153	1.145	1.136	1.128
1.120	1.112	1.105	1.097	1.089	1.081	1.073	1.066	1.058	1.051
1.043	1.036	1.029	1.021	1.014	1.007	1.000	.993	.986	.979
.972	.965	.958	.950	.943	.935	.927	.919	.911	.903
.895	.887	.879	.872	.864	.857	.849	.842	.834	.827
.820	.811	.789	.738	.658	.568	.484	.411	.349	.297
.252	.214	.182	.155	.131	.112	.095	.081	.068	.058
.049	.042	.036	.030	.026	.022	.019	.016	.013	.011
.010	.008	.007	.006	.005	.004	.004	.003	.003	.002
.002	.002	.001	.001	.001	.001	.001	.001	.000	

TOTAL AREA = 130.71 ha (31.46 ha PAVED, .00 ha SUPPLEMENTARY
99.25 ha GRASSED AND .00 ha UNDRAINED)
ACCUMULATED RUNOFF = 63471 m3
INCLUDING BASEFLOW = 0 m3
& USER HYDROGRAPHS = 0 m3
VOLUME DIVERTED OUT = 0 m3
OVERFLOWS IN TRANSIT = 0 m3 (NET)
RUNOFF COEFFICIENTS = .611 (VOLUMETRIC) BASED ONLY ON RAINFALL INPUTS
.340 (PEAK/AVERAGE) AND .162 (PEAK/PEAK)
INCL. USER-PROVIDED HYDROGRAPHS, BUT NOT BASEFLOWS
NO. OF PIPES = 15
PEAK FLOWRATE = 13.064 m3/s 27.0 minutes AFTER START OF STORM
TOTAL BASEFLOW = .000 m3/s
GRASSED RUNOFF = 61.1 %

RERUN WITH NEW RAINFALL PATTERN NO. 4
****

60 MINUTE, 100 YEAR DESIGN STORM - MACLEAN
(ANTECEDENT MOISTURE CONDITION = 2.50)

CATCHMENT PARAMETERS
****

DEPRESSION STORAGE (mm) PAVED AREA	GRASSED	SOIL TYPE 1234=ABCD 5=NEW	AMC	INFILTRATION PARAMETERS
1.0	6.0	2.50	2.50	FI = 47.0 mm F0 = 162.5 mm/h FC = 9.5 mm/h K = 2.0 /h FID = 43.1 mm INITIAL RATE = 76.4 mm/h

RAINFALL PARAMETERS AND DATA
****

DURATION (minutes)	TIME INCREMENT (minutes)	NUMBER OF RAINFALL INCREMENTS	TOTAL RAINFALL (mm)
60.0	1.0	12	90.8

STANDARD AUSTRALIAN RAINFALL PATTERN FOR ZONE 1
WITH AVERAGE INTENSITY 90.77 mm/h (MULTIPLIER = 1.000)

46.8	46.8	46.8	46.8	46.8	79.5	79.5	79.5	79.5	79.5
175.4	175.4	175.4	175.4	175.4	126.4	126.4	126.4	126.4	126.4
236.4	236.4	236.4	236.4	236.4	108.9	108.9	108.9	108.9	108.9
98.0	98.0	98.0	98.0	98.0	65.4	65.4	65.4	65.4	65.4
56.6	56.6	56.6	56.6	56.6	38.1	38.1	38.1	38.1	38.1

32.7 32.7 32.7 32.7 32.7 25.1 25.1 25.1 25.1 25.1

COMPUTATIONAL TIME STEP = 1.0 minutes

PIPE SYSTEM DETAILS
****

BCH RCH AREAS (ha) PAVED GRASSED C VOL SURFACE PIT PIPE
PAV SUP GRAS TOTAL TIME Q TIME Q Q Q Q

LEN SLOPE ORIGINAL DESIGNED CAP VEL VOLUMES OFLOW
H B SS NO DIA nORk NO DIA nORk PAT Q BYP UPW OFL Q

DETENTION BASIN ROUTING

HEIGHT-STORAGE-OUTFLOW RELATIONSHIP

HEIGHT (m)	STORAGE (m3)	OUTFLOW (m3/s)
-.500	.0	.000
.000	295.0	.800
.250	1324.0	.950
.500	6799.0	1.600
.750	21445.0	1.900
1.000	46660.0	2.600
1.250	79039.0	2.800
1.300	85993.0	3.400
1.700	1442083.0	5.000
1.750	1500000.0	30.000

STARTING STORAGE IS 0. m3

VOLUMES OF INFLOW AND OUTFLOW HYDROGRAPHS ARE 51899. AND 51899. m3
AND RESPECTIVE PEAKS ARE 26.708 AND 2.529 m3/s
PEAK HEIGHT IN BASIN IS .975 m, AND TIME OF PONDING IS 527.0 minutes

DETENTION BASIN
A_ 125.03 .0064.37 89.40 30 9.556 0-2517.218 .6405189926.70826.708 2.529

CIRCULAR PIPE, UNRESTRICTED, NO-OVERFLOW INLET UPGRADING
B_ 1 2.38 .0012.52 14.90 20 1.071 0-25 3.348 .581 7862 4.251 4.251 4.241
70 .50 .00 .00 .00 1372 .012 1372 .012 4 4.269 2.9 0 0 0 .000

CIRCULAR PIPE, UNRESTRICTED, NO-OVERFLOW INLET UPGRADING
C_ 1 .95 .00 5.36 6.30 15 .471 0-15 1.790 .582 3328 2.233 2.233 2.227
30 .50 .00 .00 .00 1067 .012 1143 .012 4 2.623 2.6 0 0 0 .000

CIRCULAR PIPE, UNRESTRICTED, NO-OVERFLOW INLET UPGRADING
A_ 2 .00 .00 .60 .60 0 .000 0-12 .222 .512 279 .222 8.204 8.189
60 .50 .00 .00 .00 2134 .012 2134 .012 413.863 3.9 0 0 0 .000

CIRCULAR PIPE, UNRESTRICTED, NO-OVERFLOW INLET UPGRADING
D_ 1 .28 .00 2.52 2.80 15 .140 0-15 .843 .558 1418 .973 .973 .972
50 .50 .00 .00 .00 838 .012 838 .012 4 1.146 2.1 0 0 0 .000

CIRCULAR PIPE, UNRESTRICTED, NO-OVERFLOW INLET UPGRADING
A_ 3 .00 .00 1.10 1.10 0 .000 0-10 .413 .513 512 .413 9.281 9.278
80 .50 .00 .00 .00 2134 .012 2134 .012 413.863 3.9 0 0 0 .000

CIRCULAR PIPE, UNRESTRICTED, NO-OVERFLOW INLET UPGRADING
A_ 4 .00 .00 3.20 3.20 0 .000 0-10 1.202 .513 1490 1.20210.35110.325
130 .50 .00 .00 .00 2134 .012 2134 .012 413.863 3.9 0 0 0 .000

CIRCULAR PIPE, UNRESTRICTED, NO-OVERFLOW INLET UPGRADING
E_ 1 .74 .00 2.94 3.68 15 .367 0-15 .984 .606 2024 1.330 1.330 1.326
50 .50 .00 .00 .00 914 .012 914 .012 4 1.445 2.2 0 0 0 .000

CIRCULAR PIPE, UNRESTRICTED, NO-OVERFLOW INLET UPGRADING
A_ 5 .00 .00 1.01 1.01 0 .000 0-15 .338 .510 468 .33811.90911.901

200 .50 .00 .00 .00 2134 .012 2134 .012 413.863 3.9 0 0 0 .000

CIRCULAR PIPE, UNRESTRICTED, NO-OVERFLOW INLET UPGRADING
A_ 6 .00 .00 .70 .70 0 .000 0-15 .234 .510 324 .23412.12012.118
50 .50 .00 .00 .00 2134 .012 2134 .012 413.863 3.9 0 0 0 .000

CIRCULAR PIPE, UNRESTRICTED, NO-OVERFLOW INLET UPGRADING
F_ 1 .34 .00 .34 .69 10 .174 0-10 .130 .751 470 .303 .303 .303
110 .50 .00 .00 .00 610 .012 610 .012 1 .492 1.7 0 0 0 .000

CIRCULAR PIPE, UNRESTRICTED, NO-OVERFLOW INLET UPGRADING
F_ 2 .80 .00 .80 1.60 6 .485 0-10 .301 .751 1091 .785 1.080 1.077
90 .50 .00 .00 .00 838 .012 838 .012 2 1.146 2.1 0 0 0 .000

CIRCULAR PIPE, UNRESTRICTED, NO-OVERFLOW INLET UPGRADING
F_ 3 .94 .00 .94 1.88 10 .474 0-15 .314 .750 1279 .778 1.847 1.844
175 .50 .00 .00 .00 1067 .012 1067 .012 1 2.183 2.4 0 0 0 .000

CIRCULAR PIPE, UNRESTRICTED, NO-OVERFLOW INLET UPGRADING
F_ 4 .00 .00 2.75 2.75 0 .000 0-15 .919 .510 1273 .919 2.760 2.760
30 .50 .00 .00 .00 1219 .012 1219 .012 1 3.114 2.7 0 0 0 .000

CIRCULAR PIPE, UNRESTRICTED, NO-OVERFLOW INLET UPGRADING
A_ 7 .00 .00 .10 .10 0 .000 0 -6 .048 .515 47 .04814.72814.723
350 .50 .00 .00 .00 2134 .012 2 1829 .012 418.378 3.5 0 0 0 .000

OUTFALL HYDROGRAPH (m3/s)
****
(530 VALUES AT 1.0 minute INTERVALS)

.000	.000	.000	.001	.012	.048	.112	.200	.313	.458
.630	.818	1.018	1.255	1.570	2.008	2.616	3.379	4.188	4.931
5.583	6.185	6.830	7.650	8.729	10.006	11.339	12.592	13.619	14.299
14.630	14.723	14.701	14.606	14.435	14.225	14.009	13.740	13.373	12.917
12.385	11.791	11.183	10.640	10.197	9.835	9.515	9.199	8.864	8.487
8.062	7.603	7.143	6.721	6.369	6.090	5.855	5.635	5.420	5.214
5.015	4.819	4.619	4.401	4.159	3.901	3.654	3.438	3.263	3.122
3.008	2.906	2.812	2.734	2.679	2.643	2.618	2.596	2.577	2.561
2.548	2.536	2.525	2.515	2.507	2.501	2.497	2.493	2.490	2.486
2.483	2.479	2.475	2.471	2.467	2.463	2.459	2.454	2.450	2.446
2.442	2.438	2.434	2.430	2.426	2.422	2.418	2.414	2.410	2.406
2.402	2.398	2.394	2.390	2.386	2.382	2.378	2.374	2.370	2.366
2.362	2.358	2.354	2.350	2.346	2.343	2.339	2.335	2.331	2.327
2.323	2.319	2.315	2.312	2.308	2.304	2.300	2.296	2.292	2.289
2.285	2.281	2.277	2.273	2.270	2.266	2.262	2.258	2.255	2.251
2.247	2.243	2.240	2.236	2.232	2.228	2.225	2.221	2.217	2.214
2.210	2.206	2.203	2.199	2.195	2.192	2.188	2.184	2.181	2.177
2.173	2.170	2.166	2.163	2.159	2.155	2.152	2.148	2.145	2.141
2.138	2.134	2.130	2.127	2.123	2.120	2.116	2.113	2.109	2.106
2.102	2.099	2.095	2.092	2.088	2.085	2.081	2.078	2.074	2.071
2.067	2.064	2.061	2.057	2.054	2.050	2.047	2.044	2.040	2.037
2.033	2.030	2.027	2.023	2.020	2.016	2.013	2.010	2.006	2.003
2.000	1.996	1.993	1.990	1.986	1.983	1.980	1.977	1.973	1.970
1.967	1.963	1.960	1.957	1.954	1.950	1.947	1.944	1.941	1.937
1.934	1.931	1.928	1.925	1.921	1.918	1.915	1.912	1.909	1.905
1.902	1.900	1.897	1.895	1.892	1.890	1.888	1.885	1.883	1.881
1.878	1.876	1.874	1.872	1.869	1.867	1.865	1.862	1.860	1.858
1.855	1.853	1.851	1.849	1.846	1.844	1.842	1.840	1.837	1.835
1.833	1.831	1.828	1.826	1.824	1.822	1.819	1.817	1.815	1.813
1.810	1.808	1.806	1.804	1.802	1.799	1.797	1.795	1.793	1.791
1.788	1.786	1.784	1.782	1.780	1.777	1.775	1.773	1.771	1.769
1.766	1.764	1.762	1.760	1.758	1.756	1.754	1.751	1.749	1.747
1.745	1.743	1.741	1.738	1.736	1.734	1.732	1.730	1.728	1.726
1.724	1.721	1.719	1.717	1.715	1.713	1.711	1.709	1.707	1.705
1.703	1.700	1.698	1.696	1.694	1.692	1.690	1.688	1.686	1.684
1.682	1.680	1.678	1.676	1.674	1.671	1.669	1.667	1.665	1.663
1.661	1.659	1.657	1.655	1.653	1.651	1.649	1.647	1.645	1.643
1.641	1.639	1.637	1.635	1.633	1.631	1.629	1.627	1.625	1.623
1.621	1.619	1.617	1.615	1.613	1.611	1.609	1.607	1.605	1.603
1.599	1.593	1.583	1.572	1.561	1.550	1.539	1.528	1.517	1.507
1.496	1.485	1.475	1.464	1.454	1.443	1.433	1.423	1.413	1.403

1.393	1.383	1.373	1.364	1.354	1.344	1.335	1.325	1.316	1.306
1.297	1.288	1.279	1.270	1.261	1.252	1.243	1.234	1.225	1.217
1.208	1.199	1.191	1.182	1.174	1.166	1.157	1.149	1.141	1.133
1.125	1.117	1.109	1.101	1.093	1.086	1.078	1.070	1.063	1.055
1.048	1.040	1.033	1.025	1.018	1.011	1.004	.997	.990	.983
.976	.969	.962	.955	.947	.939	.931	.923	.915	.907
.899	.891	.884	.876	.868	.861	.853	.846	.839	.831
.824	.816	.804	.772	.708	.620	.531	.451	.383	.326
.277	.235	.200	.170	.144	.122	.104	.088	.075	.064
.054	.046	.039	.033	.028	.024	.020	.017	.015	.012
.011	.009	.008	.006	.006	.005	.004	.003	.003	.002
.002	.002	.001	.001	.001	.001	.001	.001	.001	.000

TOTAL AREA = 130.71 ha (31.46 ha PAVED, .00 ha SUPPLEMENTARY
99.25 ha GRASSED AND .00 ha UNDRAINED)
ACCUMULATED RUNOFF = 73762 m3
INCLUDING BASEFLOW = 0 m3
& USER HYDROGRAPHS = 0 m3
VOLUME DIVERTED OUT = 0 m3
OVERFLOWS IN TRANSIT = 0 m3 (NET)
RUNOFF COEFFICIENTS = .622 (VOLUMETRIC) BASED ONLY ON RAINFALL INPUTS
.447 (PEAK/AVERAGE) AND .172 (PEAK/PEAK)
INCL. USER-PROVIDED HYDROGRAPHS, BUT NOT BASEFLOWS
NO. OF PIPES = 15
PEAK FLOWRATE = 14.723 m3/s 32.0 minutes AFTER START OF STORM
TOTAL BASEFLOW = .000 m3/s
GRASSED RUNOFF = 61.7 %

RERUN WITH NEW RAINFALL PATTERN NO. 5
****

90 MINUTE, 100 YEAR DESIGN STORM - MACLEAN
(ANTECEDENT MOISTURE CONDITION = 2.50)

CATCHMENT PARAMETERS
****

DEPRESSION STORAGE (mm) PAVED AREA	GRASSED	SOIL TYPE 1234=ABCD 5=NEW	AMC	INFILTRATION PARAMETERS
				FI = 47.0 mm
				F0 = 162.5 mm/h
				FC = 9.5 mm/h
1.0	6.0	2.50	2.50	K = 2.0 /h
				FID = 43.1 mm
				INITIAL RATE = 76.4 mm/h

RAINFALL PARAMETERS AND DATA
****

DURATION (minutes)	TIME INCREMENT (minutes)	NUMBER OF RAINFALL INCREMENTS	TOTAL RAINFALL (mm)
90.0	1.0	18	105.5

STANDARD AUSTRALIAN RAINFALL PATTERN FOR ZONE 1
WITH AVERAGE INTENSITY 70.31 mm/h (MULTIPLIER = 1.000)

44.3	44.3	44.3	44.3	44.3	74.7	74.7	74.7	74.7	74.7
175.9	175.9	175.9	175.9	175.9	101.2	101.2	101.2	101.2	101.2
126.6	126.6	126.6	126.6	126.6	246.8	246.8	246.8	246.8	246.8
69.6	69.6	69.6	69.6	69.6	68.3	68.3	68.3	68.3	68.3
57.0	57.0	57.0	57.0	57.0	44.3	44.3	44.3	44.3	44.3
57.0	57.0	57.0	57.0	57.0	45.6	45.6	45.6	45.6	45.6
30.4	30.4	30.4	30.4	30.4	32.9	32.9	32.9	32.9	32.9
32.9	32.9	32.9	32.9	32.9	20.2	20.2	20.2	20.2	20.2
19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0

COMPUTATIONAL TIME STEP = 1.0 minutes

PIPE SYSTEM DETAILS
****

BCH RCH AREAS (ha) PAVED GRASSED C VOL SURFACE PIT PIPE
PAV SUP GRAS TOTAL TIME Q TIME Q Q Q Q

LEN SLOPE ORIGINAL DESIGNED CAP VEL VOLUMES OFLOW
H B SS NO DIA nORk NO DIA nORk PAT Q BYP UPW OFL Q

DETENTION BASIN ROUTING

HEIGHT-STORAGE-OUTFLOW RELATIONSHIP

HEIGHT (m)	STORAGE (m3)	OUTFLOW (m3/s)
-.500	.0	.000
.000	295.0	.800
.250	1324.0	.950
.500	6799.0	1.600
.750	21445.0	1.900
1.000	46660.0	2.600
1.250	79039.0	2.800
1.300	85993.0	3.400
1.700	1442083.0	5.000
1.750	1500000.0	30.000

STARTING STORAGE IS 0. m3

VOLUMES OF INFLOW AND OUTFLOW HYDROGRAPHS ARE 60309. AND 60309. m3
AND RESPECTIVE PEAKS ARE 25.326 AND 2.612 m3/s
PEAK HEIGHT IN BASIN IS 1.015 m, AND TIME OF PONDING IS 582.0 minutes

DETENTION BASIN
A_ 125.03 .0064.37 89.40 30 9.211 0-2516.144 .6406030925.32625.326 2.612

CIRCULAR PIPE, UNRESTRICTED, NO-OVERFLOW INLET UPGRADING
B_ 1 2.38 .0012.52 14.90 20 1.077 0-25 3.139 .581 9133 4.018 4.018 4.009
70 .50 .00 .00 .00 1372 .012 1372 .012 4 4.269 2.9 0 0 0 .000

CIRCULAR PIPE, UNRESTRICTED, NO-OVERFLOW INLET UPGRADING
C_ 1 .95 .00 5.36 6.30 15 .415 0-15 1.705 .579 3846 2.120 2.120 2.103
30 .50 .00 .00 .00 1143 .012 1143 .012 4 2.623 2.6 0 0 0 .000

CIRCULAR PIPE, UNRESTRICTED, NO-OVERFLOW INLET UPGRADING
A_ 2 .00 .00 .60 .60 0 .000 0-12 .218 .507 321 .218 7.963 7.961
60 .50 .00 .00 .00 2134 .012 2134 .012 413.863 3.9 0 0 0 .000

CIRCULAR PIPE, UNRESTRICTED, NO-OVERFLOW INLET UPGRADING
D_ 1 .28 .00 2.52 2.80 15 .123 0-15 .802 .555 1638 .925 .925 .920
50 .50 .00 .00 .00 838 .012 838 .012 4 1.146 2.1 0 0 0 .000

CIRCULAR PIPE, UNRESTRICTED, NO-OVERFLOW INLET UPGRADING
A_ 3 .00 .00 1.10 1.10 0 .000 0-10 .446 .508 589 .446 9.227 9.221
80 .50 .00 .00 .00 2134 .012 2134 .012 413.863 3.9 0 0 0 .000

CIRCULAR PIPE, UNRESTRICTED, NO-OVERFLOW INLET UPGRADING
A_ 4 .00 .00 3.20 3.20 0 .000 0-10 1.298 .508 1713 1.29810.43210.413
130 .50 .00 .00 .00 2134 .012 2134 .012 513.863 3.9 0 0 0 .000

CIRCULAR PIPE, UNRESTRICTED, NO-OVERFLOW INLET UPGRADING
E_ 1 .74 .00 2.94 3.68 15 .323 0-15 .937 .603 2341 1.261 1.261 1.252
50 .50 .00 .00 .00 914 .012 914 .012 4 1.445 2.2 0 0 0 .000

CIRCULAR PIPE, UNRESTRICTED, NO-OVERFLOW INLET UPGRADING
A_ 5 .00 .00 1.01 1.01 0 .000 0-15 .322 .506 539 .32211.96011.959
200 .50 .00 .00 .00 2134 .012 2134 .012 513.863 3.9 0 0 0 .000

CIRCULAR PIPE, UNRESTRICTED, NO-OVERFLOW INLET UPGRADING
A_ 6 .00 .00 .70 .70 0 .000 0-15 .223 .506 374 .22312.17612.158
50 .50 .00 .00 .00 2134 .012 2134 .012 513.863 3.9 0 0 0 .000

CIRCULAR PIPE, UNRESTRICTED, NO-OVERFLOW INLET UPGRADING
F_ 1 .34 .00 .34 .69 10 .179 0-10 .140 .749 545 .319 .319 .318
110 .50 .00 .00 .00 610 .012 610 .012 1 .492 1.7 0 0 0 .000

CIRCULAR PIPE, UNRESTRICTED, NO-OVERFLOW INLET UPGRADING
F_ 2 .80 .00 .80 1.60 6 .504 0-10 .324 .749 1264 .828 1.118 1.117
90 .50 .00 .00 .00 838 .012 838 .012 2 1.146 2.1 0 0 0 .000

CIRCULAR PIPE, UNRESTRICTED, NO-OVERFLOW INLET UPGRADING
F_ 3 .94 .00 .94 1.88 10 .487 0-15 .299 .748 1484 .787 1.886 1.883
175 .50 .00 .00 .00 1067 .012 1067 .012 1 2.183 2.4 0 0 0 .000

CIRCULAR PIPE, UNRESTRICTED, NO-OVERFLOW INLET UPGRADING
F_ 4 .00 .00 2.75 2.75 0 .000 0-15 .876 .506 1468 .876 2.743 2.735
30 .50 .00 .00 .00 1219 .012 1219 .012 1 3.114 2.7 0 0 0 .000

CIRCULAR PIPE, UNRESTRICTED, NO-OVERFLOW INLET UPGRADING
A_ 7 .00 .00 .10 .10 0 .000 0 -6 .052 .509 54 .05214.88514.832
350 .50 .00 .00 .00 2 1829 .012 2 2134 .012 527.727 3.9 0 0 0 .000

OUTFALL HYDROGRAPH (m3/s)
****
(585 VALUES AT 1.0 minute INTERVALS)

.000	.000	.000	.001	.010	.043	.103	.185	.291	.428
.590	.767	.955	1.183	1.488	1.908	2.487	3.212	3.953	4.577
5.066	5.483	5.896	6.347	6.853	7.402	7.934	8.477	9.208	10.243
11.455	12.653	13.710	14.468	14.816	14.832	14.692	14.492	14.215	13.839
13.411	12.952	12.404	11.767	11.111	10.460	9.810	9.221	8.765	8.434
8.175	7.944	7.723	7.514	7.313	7.107	6.889	6.667	6.463	6.314
6.230	6.190	6.160	6.114	6.035	5.931	5.816	5.695	5.571	5.454
5.346	5.243	5.146	5.066	5.011	4.974	4.945	4.917	4.878	4.817
4.733	4.638	4.538	4.435	4.331	4.232	4.135	4.041	3.953	3.880
3.819	3.764	3.706	3.629	3.519	3.383	3.243	3.122	3.024	2.944
2.876	2.816	2.765	2.728	2.705	2.688	2.674	2.660	2.648	2.638
2.630	2.623	2.616	2.610	2.605	2.602	2.601	2.599	2.596	2.592
2.589	2.584	2.580	2.576	2.572	2.568	2.563	2.559	2.555	2.551
2.546	2.542	2.538	2.534	2.529	2.525	2.521	2.517	2.513	2.508
2.504	2.500	2.496	2.492	2.488	2.483	2.479	2.475	2.471	2.467
2.463	2.459	2.455	2.451	2.446	2.442	2.438	2.434	2.430	2.426
2.422	2.418	2.414	2.410	2.406	2.402	2.398	2.394	2.390	2.386
2.382	2.378	2.374	2.370	2.366	2.362	2.358	2.355	2.351	2.347
2.343	2.339	2.335	2.331	2.327	2.323	2.319	2.316	2.312	2.308
2.304	2.300	2.296	2.293	2.289	2.285	2.281	2.277	2.274	2.270
2.266	2.262	2.258	2.255	2.251	2.247	2.243	2.240	2.236	2.232
2.229	2.225	2.221	2.217	2.214	2.210	2.206	2.203	2.199	2.195
2.192	2.188	2.184	2.181	2.177	2.174	2.170	2.166	2.163	2.159
2.156	2.152	2.148	2.145	2.141	2.138	2.134	2.131	2.127	2.124
2.120	2.116	2.113	2.109	2.106	2.102	2.099	2.095	2.092	2.088
2.085	2.081	2.078	2.075	2.071	2.068	2.064	2.061	2.057	2.054
2.051	2.047	2.044	2.040	2.037	2.034	2.030	2.027	2.023	2.020
2.017	2.013	2.010	2.007	2.003	2.000	1.997	1.993	1.990	1.987
1.983	1.980	1.977	1.973	1.970	1.967	1.964	1.960	1.957	1.954
1.951	1.947	1.944	1.941	1.938	1.934	1.931	1.928	1.925	1.922
1.918	1.915	1.912	1.909	1.906	1.903	1.900	1.897	1.895	1.892
1.890	1.888	1.886	1.883	1.881	1.879	1.876	1.874	1.872	1.869
1.867	1.865	1.862	1.860	1.858	1.856	1.853	1.851	1.849	1.847
1.844	1.842	1.840	1.837	1.835	1.833	1.831	1.828	1.826	1.824
1.822	1.819	1.817	1.815	1.813	1.811	1.808	1.806	1.804	1.802
1.799	1.797	1.795	1.793	1.791	1.788	1.786	1.784	1.782	1.780
1.777	1.775	1.773	1.771	1.769	1.767	1.764	1.762	1.760	1.758
1.756	1.754	1.751	1.749	1.747	1.745	1.743	1.741	1.739	1.736
1.734	1.732	1.730	1.728	1.726	1.724	1.722	1.719	1.717	1.715
1.713	1.711	1.709	1.707	1.705	1.703	1.701	1.698	1.696	1.694
1.692	1.690	1.688	1.686	1.684	1.682	1.680	1.678	1.676	1.674
1.672	1.669	1.667	1.665	1.663	1.661	1.659	1.657	1.655	1.653
1.651	1.649	1.647	1.645	1.643	1.641	1.639	1.637	1.635	1.633
1.631	1.629	1.627	1.625	1.623	1.621	1.619	1.617	1.615	1.613
1.611	1.609	1.607	1.605	1.603	1.599	1.593	1.584	1.573	1.562
1.551	1.540	1.529	1.518	1.507	1.496	1.486	1.475	1.465	1.454

1.444	1.434	1.424	1.413	1.403	1.393	1.384	1.374	1.364	1.354
1.345	1.335	1.326	1.316	1.307	1.298	1.288	1.279	1.270	1.261
1.252	1.243	1.235	1.226	1.217	1.208	1.200	1.191	1.183	1.175
1.166	1.158	1.150	1.142	1.133	1.125	1.117	1.109	1.102	1.094
1.086	1.078	1.071	1.063	1.055	1.048	1.041	1.033	1.026	1.019
1.011	1.004	.997	.990	.983	.976	.969	.962	.955	.948
.940	.932	.924	.916	.908	.900	.892	.884	.876	.869
.861	.854	.846	.839	.832	.824	.817	.805	.775	.713
.625	.535	.455	.386	.328	.279	.237	.201	.171	.145
.123	.105	.089	.076	.064	.055	.046	.039	.033	.028
.024	.021	.017	.015	.013	.011	.009	.008	.007	.006
.005	.004	.003	.003	.002	.002	.002	.002	.001	.001
.001	.001	.001	.001	.000					

TOTAL AREA = 130.71 ha (31.46 ha PAVED, .00 ha SUPPLEMENTARY
99.25 ha GRASSED AND .00 ha UNDRAINED)
ACCUMULATED RUNOFF = 85617 m3
INCLUDING BASEFLOW = 0 m3
& USER HYDROGRAPHS = 0 m3
VOLUME DIVERTED OUT = 0 m3
OVERFLOWS IN TRANSIT = 0 m3 (NET)
RUNOFF COEFFICIENTS = .621 (VOLUMETRIC) BASED ONLY ON RAINFALL INPUTS
.581 (PEAK/AVERAGE) AND .166 (PEAK/PEAK)
INCL. USER-PROVIDED HYDROGRAPHS, BUT NOT BASEFLOWS
NO. OF PIPES = 15
PEAK FLOWRATE = 14.832 m3/s 36.0 minutes AFTER START OF STORM
TOTAL BASEFLOW = .000 m3/s
GRASSED RUNOFF = 61.6 %

RERUN WITH NEW RAINFALL PATTERN NO. 6
****

120 MINUTE, 100 YEAR DESIGN STORM - MACLEAN
(ANTECEDENT MOISTURE CONDITION = 2.50)

CATCHMENT PARAMETERS
****

DEPRESSION STORAGE (mm) PAVED AREA	GRASSED	SOIL TYPE 1234=ABCD 5=NEW	AMC	INFILTRATION PARAMETERS
				FI = 47.0 mm
				F0 = 162.5 mm/h
				FC = 9.5 mm/h
1.0	6.0	2.50	2.50	K = 2.0 /h
				FID = 43.1 mm
				INITIAL RATE = 76.4 mm/h

RAINFALL PARAMETERS AND DATA
****

DURATION (minutes)	TIME INCREMENT (minutes)	NUMBER OF RAINFALL INCREMENTS	TOTAL RAINFALL (mm)
120.0	2.0	24	116.9

STANDARD AUSTRALIAN RAINFALL PATTERN FOR ZONE 1
WITH AVERAGE INTENSITY 58.43 mm/h (MULTIPLIER = 1.000)

33.7	33.7	53.3	72.9	72.9	46.3	46.3	57.5	68.7	68.7
127.6	127.6	100.3	72.9	72.9	234.2	234.2	200.5	166.9	166.9
74.3	74.3	60.3	46.3	46.3	47.7	47.7	54.0	60.3	60.3
60.3	60.3	47.0	33.7	33.7	33.7	33.7	40.7	47.7	47.7
33.7	33.7	25.2	16.8	16.8	16.8	16.8	25.9	35.1	35.1
16.8	16.8	17.5	18.2	18.2	18.2	18.2	18.9	19.6	19.6

COMPUTATIONAL TIME STEP = 2.0 minutes

PIPE SYSTEM DETAILS

****

BCH RCH AREAS (ha) PAVED GRASSED C VOL SURFACE PIT PIPE
PAV SUP GRAS TOTAL TIME Q TIME Q Q Q Q

LEN SLOPE ORIGINAL DESIGNED CAP VEL VOLUMES OFLOW
H B SS NO DIA nORk NO DIA nORk PAT Q BYP UPW OFL Q

DETENTION BASIN ROUTING

HEIGHT-STORAGE-OUTFLOW RELATIONSHIP

HEIGHT (m)	STORAGE (m3)	OUTFLOW (m3/s)
-.500	.0	.000
.000	295.0	.800
.250	1324.0	.950
.500	6799.0	1.600
.750	21445.0	1.900
1.000	46660.0	2.600
1.250	79039.0	2.800
1.300	85993.0	3.400
1.700	1442083.0	5.000
1.750	1500000.0	30.000

STARTING STORAGE IS 0. m3

VOLUMES OF INFLOW AND OUTFLOW HYDROGRAPHS ARE 66803. AND 66803. m3
AND RESPECTIVE PEAKS ARE 24.682 AND 2.630 m3/s
PEAK HEIGHT IN BASIN IS 1.037 m, AND TIME OF PONDING IS 630.0 minutes

DETENTION BASIN
A_ 125.03 .0064.37 89.40 30 8.577 0-2516.145 .6396680324.68224.682 2.630

CIRCULAR PIPE, UNRESTRICTED, NO-OVERFLOW INLET UPGRADING
B_ 1 2.38 .0012.52 14.90 20 .996 0-25 3.139 .58110112 4.030 4.030 4.022
70 .50 .00 .00 .00 1372 .012 1372 .012 4 4.269 2.9 0 0 0 .000

CIRCULAR PIPE, UNRESTRICTED, NO-OVERFLOW INLET UPGRADING
C_ 1 .95 .00 5.36 6.30 15 .420 0-15 1.879 .578 4259 2.294 2.294 2.292
30 .50 .00 .00 .00 1143 .012 1143 .012 6 2.623 2.6 0 0 0 .000

CIRCULAR PIPE, UNRESTRICTED, NO-OVERFLOW INLET UPGRADING
A_ 2 .00 .00 .60 .60 0 .000 0-12 .245 .507 355 .245 8.244 8.228
60 .50 .00 .00 .00 2134 .012 2134 .012 613.863 3.9 0 0 0 .000

CIRCULAR PIPE, UNRESTRICTED, NO-OVERFLOW INLET UPGRADING
D_ 1 .28 .00 2.52 2.80 15 .124 0-15 .884 .554 1813 1.007 1.007 1.005
50 .50 .00 .00 .00 838 .012 838 .012 6 1.146 2.1 0 0 0 .000

CIRCULAR PIPE, UNRESTRICTED, NO-OVERFLOW INLET UPGRADING
A_ 3 .00 .00 1.10 1.10 0 .000 0-10 .512 .507 652 .512 9.558 9.549
80 .50 .00 .00 .00 2134 .012 2134 .012 613.863 3.9 0 0 0 .000

CIRCULAR PIPE, UNRESTRICTED, NO-OVERFLOW INLET UPGRADING
A_ 4 .00 .00 3.20 3.20 0 .000 0-10 1.489 .507 1897 1.48910.68410.673
130 .50 .00 .00 .00 2134 .012 2134 .012 613.863 3.9 0 0 0 .000

CIRCULAR PIPE, UNRESTRICTED, NO-OVERFLOW INLET UPGRADING
E_ 1 .74 .00 2.94 3.68 15 .327 0-15 1.033 .603 2592 1.357 1.357 1.354
50 .50 .00 .00 .00 914 .012 914 .012 6 1.445 2.2 0 0 0 .000

CIRCULAR PIPE, UNRESTRICTED, NO-OVERFLOW INLET UPGRADING
A_ 5 .00 .00 1.01 1.01 0 .000 0-15 .354 .506 597 .35412.36512.295
200 .50 .00 .00 .00 2134 .012 2134 .012 613.863 3.9 0 0 0 .000

CIRCULAR PIPE, UNRESTRICTED, NO-OVERFLOW INLET UPGRADING
A_ 6 .00 .00 .70 .70 0 .000 0-15 .246 .506 414 .24612.54012.535
50 .50 .00 .00 .00 2134 .012 2134 .012 613.863 3.9 0 0 0 .000

CIRCULAR PIPE, UNRESTRICTED, NO-OVERFLOW INLET UPGRADING
F_ 1 .34 .00 .34 .69 10 .192 0-10 .160 .749 604 .353 .353 .334

110 .50 .00 .00 .00 610 .012 610 .012 1 .492 1.7 0 0 0 .000

CIRCULAR PIPE, UNRESTRICTED, NO-OVERFLOW INLET UPGRADING
F_ 2 .80 .00 .80 1.60 6 .495 0-10 .372 .749 1401 .777 1.102 1.091
90 .50 .00 .00 .00 838 .012 838 .012 2 1.146 2.1 0 0 0 .000

CIRCULAR PIPE, UNRESTRICTED, NO-OVERFLOW INLET UPGRADING
F_ 3 .94 .00 .94 1.88 10 .524 0-15 .330 .749 1645 .849 1.940 1.880
175 .50 .00 .00 .00 1067 .012 1067 .012 1 2.183 2.4 0 0 0 .000

CIRCULAR PIPE, UNRESTRICTED, NO-OVERFLOW INLET UPGRADING
F_ 4 .00 .00 2.75 2.75 0 .000 0-15 .965 .506 1625 .965 2.831 2.811
30 .50 .00 .00 .00 1219 .012 1219 .012 6 3.114 2.7 0 0 0 .000

CIRCULAR PIPE, UNRESTRICTED, NO-OVERFLOW INLET UPGRADING
A_ 7 .00 .00 .10 .10 0 .000 0 -6 .052 .509 59 .05215.25115.228
350 .50 .00 .00 .00 2 2134 .012 2 2134 .012 627.727 3.9 0 0 0 .000

OUTFALL HYDROGRAPH (m3/s)
****
(317 VALUES AT 2.0 minute INTERVALS)

.000	.001	.016	.082	.237	.491	.814	1.138	1.400	1.577
1.702	1.824	2.048	2.527	3.203	3.833	4.608	6.292	8.743	11.231
13.271	14.708	15.228	14.981	14.154	12.863	11.420	10.140	9.121	8.374
7.865	7.491	7.240	7.089	6.937	6.720	6.464	6.196	5.947	5.777
5.725	5.749	5.758	5.714	5.576	5.325	5.004	4.670	4.374	4.196
4.181	4.251	4.272	4.223	4.140	4.048	3.950	3.854	3.772	3.727
3.729	3.718	3.588	3.351	3.103	2.924	2.812	2.741	2.698	2.669
2.649	2.634	2.624	2.619	2.616	2.614	2.612	2.610	2.609	2.607
2.605	2.603	2.599	2.594	2.586	2.578	2.569	2.561	2.552	2.544
2.535	2.527	2.518	2.510	2.502	2.493	2.485	2.477	2.469	2.460
2.452	2.444	2.436	2.428	2.420	2.412	2.404	2.396	2.388	2.380
2.372	2.364	2.356	2.348	2.340	2.333	2.325	2.317	2.309	2.302
2.294	2.287	2.279	2.271	2.264	2.256	2.249	2.241	2.234	2.226
2.219	2.212	2.204	2.197	2.190	2.182	2.175	2.168	2.161	2.153
2.146	2.139	2.132	2.125	2.118	2.111	2.104	2.097	2.090	2.083
2.076	2.069	2.062	2.055	2.048	2.042	2.035	2.028	2.021	2.015
2.008	2.001	1.995	1.988	1.981	1.975	1.968	1.962	1.955	1.949
1.942	1.936	1.929	1.923	1.916	1.910	1.904	1.898	1.893	1.889
1.884	1.879	1.875	1.870	1.866	1.861	1.857	1.852	1.847	1.843
1.838	1.834	1.829	1.825	1.820	1.816	1.811	1.807	1.803	1.798
1.794	1.789	1.785	1.781	1.776	1.772	1.767	1.763	1.759	1.754
1.750	1.746	1.742	1.737	1.733	1.729	1.725	1.720	1.716	1.712
1.708	1.703	1.699	1.695	1.691	1.687	1.683	1.679	1.674	1.670
1.666	1.662	1.658	1.654	1.650	1.646	1.642	1.638	1.634	1.630
1.626	1.622	1.618	1.614	1.610	1.606	1.598	1.585	1.566	1.544
1.522	1.501	1.480	1.459	1.438	1.418	1.398	1.378	1.358	1.339
1.320	1.301	1.283	1.265	1.247	1.229	1.212	1.195	1.178	1.161
1.145	1.129	1.113	1.097	1.081	1.066	1.051	1.036	1.022	1.007
.993	.979	.965	.950	.935	.919	.903	.887	.872	.857
.842	.827	.799	.712	.570	.425	.308	.222	.160	.115
.083	.060	.043	.031	.022	.016	.012	.008	.006	.004
.003	.002	.002	.001	.001	.001	.000			

TOTAL AREA = 130.71 ha (31.46 ha PAVED, .00 ha SUPPLEMENTARY
99.25 ha GRASSED AND .00 ha UNDRAINED)
ACCUMULATED RUNOFF = 94829 m3
INCLUDING BASEFLOW = 0 m3
& USER HYDROGRAPHS = 0 m3
VOLUME DIVERTED OUT = 0 m3
OVERFLOWS IN TRANSIT = 0 m3 (NET)
RUNOFF COEFFICIENTS = .621 (VOLUMETRIC) BASED ONLY ON RAINFALL INPUTS
.718 (PEAK/AVERAGE) AND .179 (PEAK/PEAK)
INCL. USER-PROVIDED HYDROGRAPHS, BUT NOT BASEFLOWS
NO. OF PIPES = 15
PEAK FLOWRATE = 15.228 m3/s 46.0 minutes AFTER START OF STORM
TOTAL BASEFLOW = .000 m3/s
GRASSED RUNOFF = 61.6 %

RERUN WITH NEW RAINFALL PATTERN NO. 7
****

180 MINUTE, 100 YEAR DESIGN STORM - MACLEAN
(ANTECEDENT MOISTURE CONDITION = 2.50)

CATCHMENT PARAMETERS
****

```
                                          INFILTRATION
       DEPRESSION STORAGE (mm)   SOIL TYPE    AMC      PARAMETERS
        PAVED AREA   GRASSED    1234=ABCD           FI =   47.0 mm
                          5=NEW           F0 =  162.5 mm/h
                                          FC =    9.5 mm/h
          1.0        6.0         2.50       2.50    K =    2.0 /h
                                          FID =   43.1 mm
                                  INITIAL RATE =   76.4 mm/h
```

RAINFALL PARAMETERS AND DATA
****

DURATION (minutes)	TIME INCREMENT (minutes)	NUMBER OF RAINFALL INCREMENTS	TOTAL RAINFALL (mm)
180.0	2.0	12	134.7

STANDARD AUSTRALIAN RAINFALL PATTERN FOR ZONE 1
WITH AVERAGE INTENSITY 44.89 mm/h (MULTIPLIER = 1.000)

30.7	30.7	30.7	30.7	30.7	30.7	30.7	60.6	90.5	90.5
90.5	90.5	90.5	90.5	90.5	126.1	126.1	126.1	126.1	126.1
126.1	126.1	86.5	46.9	46.9	46.9	46.9	46.9	46.9	46.9
63.6	63.6	63.6	63.6	63.6	63.6	63.6	52.8	42.0	42.0
42.0	42.0	42.0	42.0	42.0	31.2	31.2	31.2	31.2	31.2
31.2	31.2	33.7	36.1	36.1	36.1	36.1	36.1	36.1	36.1
25.9	25.9	25.9	25.9	25.9	25.9	25.9	23.2	20.5	20.5
20.5	20.5	20.5	20.5	20.5	15.1	15.1	15.1	15.1	15.1
15.1	15.1	12.7	10.2	10.2	10.2	10.2	10.2	10.2	10.2

COMPUTATIONAL TIME STEP = 2.0 minutes

PIPE SYSTEM DETAILS
****

```
BCH RCH      AREAS (ha)     PAVED     GRASSED     C    VOL SURFACE PIT  PIPE
        PAV  SUP GRAS TOTAL TIME  Q    TIME    Q              Q     Q     Q

LEN SLOPE        ORIGINAL          DESIGNED       CAP  VEL    VOLUMES  OFLOW
        H    B    SS  NO DIA nORk NO DIA nORk PAT  Q       BYP UPW OFL  Q
```

DETENTION BASIN ROUTING

HEIGHT-STORAGE-OUTFLOW RELATIONSHIP

HEIGHT (m)	STORAGE (m3)	OUTFLOW (m3/s)
-.500	.0	.000
.000	295.0	.800
.250	1324.0	.950
.500	6799.0	1.600
.750	21445.0	1.900
1.000	46660.0	2.600
1.250	79039.0	2.800
1.300	85993.0	3.400
1.700	1442083.0	5.000
1.750	1500000.0	30.000

STARTING STORAGE IS 0. m3

VOLUMES OF INFLOW AND OUTFLOW HYDROGRAPHS ARE 77168. AND 77168. m3
AND RESPECTIVE PEAKS ARE 18.910 AND 2.652 m3/s
PEAK HEIGHT IN BASIN IS 1.065 m, AND TIME OF PONDING IS 702.0 minutes

DETENTION BASIN
A_ 125.03 .0064.37 89.40 30 7.428 0-2511.887 .6417716818.91018.910 2.652

CIRCULAR PIPE, UNRESTRICTED, NO-OVERFLOW INLET UPGRADING
B_ 1 2.38 .0012.52 14.90 20 .764 0-25 2.311 .58211685 3.015 3.015 3.012
70 .50 .00 .00 .00 1372 .012 1372 .012 4 4.269 2.9 0 0 0 .000

CIRCULAR PIPE, UNRESTRICTED, NO-OVERFLOW INLET UPGRADING
C_ 1 .95 .00 5.36 6.30 15 .325 0-15 1.310 .578 4906 1.635 1.635 1.625
30 .50 .00 .00 .00 1143 .012 1143 .012 6 2.623 2.6 0 0 0 .000

CIRCULAR PIPE, UNRESTRICTED, NO-OVERFLOW INLET UPGRADING
A_ 2 .00 .00 .60 .60 0 .000 0-12 .153 .505 408 .153 6.418 6.391
60 .50 .00 .00 .00 2134 .012 2134 .012 613.863 3.9 0 0 0 .000

CIRCULAR PIPE, UNRESTRICTED, NO-OVERFLOW INLET UPGRADING
D_ 1 .28 .00 2.52 2.80 15 .096 0-15 .617 .554 2089 .713 .713 .704
50 .50 .00 .00 .00 838 .012 838 .012 6 1.146 2.1 0 0 0 .000

CIRCULAR PIPE, UNRESTRICTED, NO-OVERFLOW INLET UPGRADING
A_ 3 .00 .00 1.10 1.10 0 .000 0-10 .283 .505 749 .283 7.359 7.323
80 .50 .00 .00 .00 2134 .012 2134 .012 613.863 3.9 0 0 0 .000

CIRCULAR PIPE, UNRESTRICTED, NO-OVERFLOW INLET UPGRADING
A_ 4 .00 .00 3.20 3.20 0 .000 0-10 .824 .505 2178 .824 8.090 8.034
130 .50 .00 .00 .00 2134 .012 2134 .012 613.863 3.9 0 0 0 .000

CIRCULAR PIPE, UNRESTRICTED, NO-OVERFLOW INLET UPGRADING
E_ 1 .74 .00 2.94 3.68 15 .253 0-15 .720 .603 2987 .973 .973 .962
50 .50 .00 .00 .00 914 .012 914 .012 6 1.445 2.2 0 0 0 .000

CIRCULAR PIPE, UNRESTRICTED, NO-OVERFLOW INLET UPGRADING
A_ 5 .00 .00 1.01 1.01 0 .000 0-15 .247 .505 687 .247 9.238 9.122
200 .50 .00 .00 .00 2134 .012 2134 .012 613.863 3.9 0 0 0 .000

CIRCULAR PIPE, UNRESTRICTED, NO-OVERFLOW INLET UPGRADING
A_ 6 .00 .00 .70 .70 0 .000 0-15 .171 .505 476 .171 9.291 9.269
50 .50 .00 .00 .00 2134 .012 2134 .012 613.863 3.9 0 0 0 .000

CIRCULAR PIPE, UNRESTRICTED, NO-OVERFLOW INLET UPGRADING
F_ 1 .34 .00 .34 .69 10 .121 0-10 .089 .749 696 .210 .210 .209
110 .50 .00 .00 .00 610 .012 610 .012 1 .492 1.7 0 0 0 .000

CIRCULAR PIPE, UNRESTRICTED, NO-OVERFLOW INLET UPGRADING
F_ 2 .80 .00 .80 1.60 6 .280 0-10 .206 .749 1614 .486 .695 .693
90 .50 .00 .00 .00 838 .012 838 .012 2 1.146 2.1 0 0 0 .000

CIRCULAR PIPE, UNRESTRICTED, NO-OVERFLOW INLET UPGRADING
F_ 3 .94 .00 .94 1.88 10 .329 0-15 .230 .749 1896 .559 1.252 1.238
175 .50 .00 .00 .00 1067 .012 1067 .012 1 2.183 2.4 0 0 0 .000

CIRCULAR PIPE, UNRESTRICTED, NO-OVERFLOW INLET UPGRADING
F_ 4 .00 .00 2.75 2.75 0 .000 0-15 .673 .505 1871 .673 1.910 1.903
30 .50 .00 .00 .00 1219 .012 1219 .012 6 3.114 2.7 0 0 0 .000

CIRCULAR PIPE, UNRESTRICTED, NO-OVERFLOW INLET UPGRADING
A_ 7 .00 .00 .10 .10 0 .000 0 -6 .026 .505 68 .02611.16511.137
350 .50 .00 .00 .00 2 2134 .012 2 2134 .012 627.727 3.9 0 0 0 .000

OUTFALL HYDROGRAPH (m3/s)
****
(353 VALUES AT 2.0 minute INTERVALS)

.000	.000	.007	.051	.149	.287	.445	.608	.779	.988
1.265	1.550	1.785	1.982	2.220	2.649	3.296	4.230	5.397	6.662
7.910	9.076	10.067	10.811	11.137	10.913	10.317	9.568	8.770	7.992
7.294	6.743	6.460	6.419	6.496	6.612	6.752	6.919	7.107	7.228

7.204	7.073	6.899	6.717	6.544	6.388	6.249	6.094	5.920	5.741
5.568	5.407	5.276	5.183	5.142	5.156	5.202	5.259	5.319	5.378
5.439	5.486	5.467	5.384	5.270	5.150	5.033	4.926	4.831	4.738
4.641	4.538	4.435	4.336	4.248	4.179	4.123	4.054	3.969	3.877
3.786	3.700	3.627	3.565	3.503	3.430	3.347	3.261	3.177	3.102
3.039	2.986	2.920	2.847	2.784	2.742	2.714	2.693	2.676	2.662
2.650	2.641	2.635	2.631	2.628	2.626	2.624	2.623	2.621	2.619
2.617	2.615	2.613	2.611	2.609	2.607	2.605	2.603	2.600	2.595
2.588	2.580	2.571	2.562	2.554	2.545	2.537	2.529	2.520	2.512
2.503	2.495	2.487	2.479	2.470	2.462	2.454	2.446	2.438	2.429
2.421	2.413	2.405	2.397	2.389	2.381	2.373	2.366	2.358	2.350
2.342	2.334	2.326	2.319	2.311	2.303	2.296	2.288	2.280	2.273
2.265	2.258	2.250	2.243	2.235	2.228	2.220	2.213	2.206	2.198
2.191	2.184	2.177	2.169	2.162	2.155	2.148	2.141	2.133	2.126
2.119	2.112	2.105	2.098	2.091	2.084	2.077	2.070	2.064	2.057
2.050	2.043	2.036	2.029	2.023	2.016	2.009	2.003	1.996	1.989
1.983	1.976	1.970	1.963	1.956	1.950	1.943	1.937	1.931	1.924
1.918	1.911	1.905	1.899	1.894	1.890	1.885	1.880	1.876	1.871
1.867	1.862	1.857	1.853	1.848	1.844	1.839	1.835	1.830	1.826
1.821	1.817	1.812	1.808	1.803	1.799	1.795	1.790	1.786	1.781
1.777	1.773	1.768	1.764	1.760	1.755	1.751	1.747	1.742	1.738
1.734	1.730	1.725	1.721	1.717	1.713	1.709	1.704	1.700	1.696
1.692	1.688	1.684	1.679	1.675	1.671	1.667	1.663	1.659	1.655
1.651	1.647	1.643	1.639	1.635	1.631	1.627	1.623	1.619	1.615
1.611	1.607	1.601	1.588	1.570	1.549	1.527	1.505	1.484	1.463
1.442	1.422	1.402	1.382	1.362	1.343	1.324	1.305	1.287	1.269
1.251	1.233	1.215	1.198	1.181	1.165	1.148	1.132	1.116	1.100
1.085	1.069	1.054	1.039	1.024	1.010	.996	.982	.968	.953
.938	.922	.906	.890	.875	.860	.845	.830	.807	.734
.601	.453	.330	.238	.171	.123	.089	.064	.046	.033
.024	.017	.012	.009	.006	.005	.003	.002	.002	.001
.001	.001	.000							

TOTAL AREA = 130.71 ha (31.46 ha PAVED, .00 ha SUPPLEMENTARY
99.25 ha GRASSED AND .00 ha UNDRAINED)
ACCUMULATED RUNOFF = 109476 m3
INCLUDING BASEFLOW = 0 m3
& USER HYDROGRAPHS = 0 m3
VOLUME DIVERTED OUT = 0 m3
OVERFLOWS IN TRANSIT = 0 m3 (NET)
RUNOFF COEFFICIENTS = .622 (VOLUMETRIC) BASED ONLY ON RAINFALL INPUTS
.683 (PEAK/AVERAGE) AND .243 (PEAK/PEAK)
INCL. USER-PROVIDED HYDROGRAPHS, BUT NOT BASEFLOWS
NO. OF PIPES = 15
PEAK FLOWRATE = 11.137 m3/s 50.0 minutes AFTER START OF STORM
TOTAL BASEFLOW = .000 m3/s
GRASSED RUNOFF = 61.6 %

PIPE DATA FROM THE LAST DESIGNED OR UPGRADED PIPE SYSTEM HAS BEEN
STORED ON FILE IOFILE7.DAT - RENAME THIS IF IT IS TO BE USED LATER

FLOWRATE DATA HAS BEEN STORED ON FILE 04122ex.int

*** THE JOB IS FINISHED *** RUNNING TIME : 0 minutes .1 seconds

Appendix C – Proposed Development with Detention Basins

```
               * * *  I L S A X  * * *

               Version V2.13 January 1993
          Produced at University of Technology, Sydney
           for IBM-PC and compatible microcomputers

* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
*                                                                             *
*  HOGUES LANE - Deveolped with Basins - Stage 1 Final                         *
*                                                                             *
*  20 MINUTE, 100 YEAR DESIGN STORM - MACLEAN                                 *
*                                                                             *
*  RUN NUMBER :  10          NO. OF RAINFALL PATTERNS IS  7                   *
*  HYDROGRAPHS ARE FORMED USING TIME-AREA METHOD APPLIED TO RAINFALLS         *
*  GRASSED AREA LOSSES ARE SUBTRACTED FROM FLOW DEPTH DISTRIBUTION            *
*  DEFAULT MODE IS UPGRADE                                                    *
*  TIME SHIFT ROUTING                                                         *
*  LIMITED OUTPUT                                                             *
*  DIAMETER AND UNIT COST SET USED IS :                                       *
*   EXACT DIAMETERS 152 TO 2134 mm, COSTS AT AUGUST 1988                      *
*  MINIMUM DIAMETER IS  375 mm                                                *
*  MANNING'S EQUATION IS USED FOR PIPES                                       *
*  OLD AND NEW DEFAULT PIPE ROUGHNESSES ARE  .012 AND  .012                   *
*                                                                             *
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *

RUN & RAINFALL FILE :    RAIN100.MAC
SYSTEM PIPE FILE :       14007.DAT
OUTPUT DATA FILE :       14007.OUT
INTERMEDIATE DATA FILE : 14007.INT


USER ...............................................   DATE ................

REFERENCE ....................................................................

..............................................................................


CATCHMENT PARAMETERS
********************
                                            INFILTRATION
     DEPRESSION STORAGE (mm)   SOIL TYPE    AMC      PARAMETERS
      PAVED AREA   GRASSED    1234=ABCD            FI =   47.0 mm
                              5=NEW           F0 =  162.5 mm/h
                                              FC =    9.5 mm/h
        1.0        6.0        2.50      2.50    K =    2.0 /h
                                              FID =   43.1 mm
                                    INITIAL RATE =   76.4 mm/h
RAINFALL PARAMETERS AND DATA
****************************

   DURATION     TIME INCREMENT     NUMBER OF      TOTAL RAINFALL
   (minutes)      (minutes)    RAINFALL INCREMENTS      (mm)

     20.0           1.0            4             53.0

STANDARD AUSTRALIAN RAINFALL PATTERN FOR ZONE  1
WITH AVERAGE INTENSITY  158.98 mm/h               ( MULTIPLIER =  1.000 )

 127.2  127.2  127.2  127.2  127.2  254.4  254.4  254.4  254.4  254.4
 190.8  190.8  190.8  190.8  190.8   63.6   63.6   63.6   63.6   63.6


COMPUTATIONAL TIME STEP =  1.0 minutes



                    PIPE SYSTEM DETAILS
                    ******************

BCH RCH     AREAS (ha)    PAVED    GRASSED    C    VOL SURFACE PIT  PIPE
       PAV  SUP GRAS TOTAL TIME  Q   TIME    Q              Q     Q     Q

LEN SLOPE       ORIGINAL        DESIGNED      CAP  VEL    VOLUMES  OFLOW
       H    B    SS  NO DIA nORk NO DIA nORk PAT  Q       BYP UPW OFL  Q
```

DETENTION BASIN ROUTING

HEIGHT-STORAGE-OUTFLOW RELATIONSHIP

HEIGHT (m)	STORAGE (m3)	OUTFLOW (m3/s)
-.500	.0	.000
.000	295.0	.800
.250	1324.0	.950
.500	6799.0	1.600
.750	21445.0	1.900
1.000	46660.0	2.600
1.250	79039.0	2.800
1.300	85993.0	3.400
1.700	1442083.0	5.000
1.750	1500000.0	30.000

STARTING STORAGE IS 0. m3

VOLUMES OF INFLOW AND OUTFLOW HYDROGRAPHS ARE 27939. AND 27939. m3
AND RESPECTIVE PEAKS ARE 19.057 AND 1.971 m3/s
PEAK HEIGHT IN BASIN IS .775 m, AND TIME OF PONDING IS 346.0 minutes

DETENTION BASIN
A_ 125.03 .0064.37 89.40 30 7.231 0-2511.826 .5902793919.05719.057 1.971

CIRCULAR PIPE, UNRESTRICTED, NO-OVERFLOW INLET UPGRADING
B_ 1 2.38 .0012.52 14.90 20 1.033 0-25 2.300 .525 4141 3.332 3.332 3.315
70 .50 .00 .00 .00 1372 .012 1372 .012 1 4.269 2.9 0 0 0 .000

CIRCULAR PIPE, UNRESTRICTED, NO-OVERFLOW INLET UPGRADING
A_ 2 .00 .00 .60 .60 0 .000 0-12 .222 .491 156 .222 5.153 5.140
60 .50 .00 .00 .00 2134 .012 2134 .012 113.863 3.9 0 0 0 .000

CIRCULAR PIPE, UNRESTRICTED, NO-OVERFLOW INLET UPGRADING
A_ 3 .00 .00 1.10 1.10 0 .000 0-10 .480 .499 291 .480 5.395 5.391
80 .50 .00 .00 .00 2134 .012 2134 .012 113.863 3.9 0 0 0 .000

CIRCULAR PIPE, UNRESTRICTED, NO-OVERFLOW INLET UPGRADING
C_ 1 2.85 .00 3.45 6.30 15 1.479 0-15 1.056 .706 2358 2.489 2.489 2.488
30 .50 .00 .00 .00 1143 .012 1143 .012 1 2.623 2.6 0 0 0 .000

CIRCULAR PIPE, UNRESTRICTED, NO-OVERFLOW INLET UPGRADING
D_ 1 1.61 .00 1.19 2.80 15 .835 0-15 .364 .768 1139 1.183 1.183 1.183
50 .50 .00 .00 .00 838 .012 914 .012 1 1.445 2.2 0 0 0 .000

CIRCULAR PIPE, UNRESTRICTED, NO-OVERFLOW INLET UPGRADING
E_ 1 2.24 .00 1.44 3.68 15 1.165 0-15 .439 .785 1531 1.584 1.584 1.583
50 .50 .00 .00 .00 991 .012 991 .012 1 1.793 2.3 0 0 0 .000

DETENTION BASIN ROUTING

HEIGHT-STORAGE-OUTFLOW RELATIONSHIP

HEIGHT (m)	STORAGE (m3)	OUTFLOW (m3/s)
.000	.0	.000
.300	1000.0	1.000
.500	1701.0	1.540
.700	2474.0	3.000
.900	3321.0	3.300
1.100	4256.0	3.500
1.300	5250.0	4.000
1.500	6400.0	10.000

STARTING STORAGE IS 0. m3

VOLUMES OF INFLOW AND OUTFLOW HYDROGRAPHS ARE 5055. AND 5054. m3
AND RESPECTIVE PEAKS ARE 5.295 AND 3.073 m3/s
PEAK HEIGHT IN BASIN IS .749 m, AND TIME OF PONDING IS 172.0 minutes

DETENTION BASIN
D_ 2 .00 .00 .10 .10 0 .000 0-10 .044 .499 26 .044 5.295 3.073

CIRCULAR PIPE, UNRESTRICTED, NO-OVERFLOW INLET UPGRADING
A_ 4 .35 .00 2.85 3.20 2 .244 0-10 1.245 .551 934 1.428 6.503 6.479
130 .50 .00 .00 .00 2134 .012 2134 .012 113.863 3.9 0 0 0 .000

CIRCULAR PIPE, UNRESTRICTED, NO-OVERFLOW INLET UPGRADING
A_ 5 .00 .00 1.01 1.01 0 .000 0-15 .309 .479 256 .309 9.362 9.342
200 .50 .00 .00 .00 2134 .012 2134 .012 113.863 3.9 0 0 0 .000

CIRCULAR PIPE, UNRESTRICTED, NO-OVERFLOW INLET UPGRADING
A_ 6 .00 .00 .70 .70 0 .000 0-15 .214 .479 178 .214 9.536 9.525
50 .50 .00 .00 .00 2134 .012 2134 .012 113.863 3.9 0 0 0 .000

CIRCULAR PIPE, UNRESTRICTED, NO-OVERFLOW INLET UPGRADING
F_ 1 .39 .00 .30 .69 10 .243 0-10 .129 .774 283 .373 .373 .372
110 .50 .00 .00 .00 610 .012 610 .012 1 .492 1.7 0 0 0 .000

CIRCULAR PIPE, UNRESTRICTED, NO-OVERFLOW INLET UPGRADING
F_ 2 .92 .00 .68 1.60 6 .623 0-10 .297 .776 658 .815 1.165 1.155
90 .50 .00 .00 .00 838 .012 914 .012 1 1.445 2.2 0 0 0 .000

CIRCULAR PIPE, UNRESTRICTED, NO-OVERFLOW INLET UPGRADING
F_ 3 1.08 .00 .80 1.88 10 .668 0-15 .245 .768 765 .901 2.055 2.052
175 .50 .00 .00 .00 1067 .012 1067 .012 1 2.183 2.4 0 0 0 .000

DETENTION BASIN ROUTING

HEIGHT-STORAGE-OUTFLOW RELATIONSHIP

HEIGHT (m)	STORAGE (m3)	OUTFLOW (m3/s)
.000	.0	.000
.100	20.0	.400
.300	62.0	.500
.500	161.0	.770
.700	290.0	1.500
.900	454.0	1.650
1.100	653.0	1.750
1.300	890.0	2.000

STARTING STORAGE IS 2. m3

VOLUMES OF INFLOW AND OUTFLOW HYDROGRAPHS ARE 1706. AND 1708. m3
AND RESPECTIVE PEAKS ARE 2.052 AND 1.596 m3/s
PEAK HEIGHT IN BASIN IS .828 m, AND TIME OF PONDING IS 38.0 minutes

DETENTION BASIN
F_ 4 .00 .00 .00 .00 0 .000 15-15 .000 .000 0 .000 2.052 1.596

CIRCULAR PIPE, UNRESTRICTED, NO-OVERFLOW INLET UPGRADING
A_ 7 .00 .00 .10 .10 0 .000 0 -6 .048 .508 27 .04811.11211.091
350 .50 .00 .00 .00 2134 .012 2134 .012 113.863 3.9 0 0 0 .000

OUTFALL HYDROGRAPH (m3/s)
****
(349 VALUES AT 1.0 minute INTERVALS)

.000	.000	.020	.032	.121	.294	.527	.824	1.255	1.894
2.734	3.678	4.652	5.688	6.700	7.635	8.472	9.222	9.881	10.409
10.767	10.988	11.091	11.019	10.768	10.391	9.849	9.279	8.796	8.435
8.085	7.687	7.277	6.824	6.238	5.668	5.143	4.642	4.197	3.824
3.541	3.356	3.239	3.158	3.092	3.036	2.985	2.930	2.874	2.819
2.767	2.718	2.671	2.627	2.585	2.545	2.507	2.471	2.437	2.405
2.374	2.345	2.318	2.292	2.268	2.244	2.222	2.201	2.181	2.162
2.144	2.127	2.111	2.096	2.082	2.069	2.056	2.044	2.032	2.021
2.011	2.001	1.991	1.982	1.973	1.965	1.957	1.949	1.942	1.935
1.928	1.922	1.915	1.909	1.903	1.898	1.892	1.887	1.882	1.877
1.873	1.868	1.864	1.859	1.855	1.851	1.847	1.843	1.839	1.836
1.832	1.829	1.825	1.822	1.819	1.815	1.812	1.809	1.806	1.803
1.800	1.797	1.794	1.792	1.789	1.786	1.783	1.781	1.778	1.775
1.773	1.770	1.768	1.765	1.763	1.760	1.758	1.755	1.753	1.751
1.748	1.746	1.744	1.741	1.739	1.737	1.734	1.732	1.730	1.728
1.725	1.723	1.721	1.719	1.717	1.714	1.712	1.710	1.708	1.706
1.703	1.701	1.699	1.697	1.695	1.693	1.691	1.688	1.686	1.684
1.682	1.680	1.678	1.676	1.674	1.671	1.669	1.667	1.665	1.663
1.661	1.659	1.657	1.655	1.653	1.651	1.649	1.647	1.645	1.643
1.641	1.639	1.637	1.635	1.633	1.631	1.629	1.627	1.625	1.623
1.621	1.619	1.617	1.615	1.613	1.611	1.609	1.607	1.605	1.602
1.599	1.592	1.582	1.571	1.560	1.549	1.538	1.527	1.516	1.505
1.495	1.484	1.474	1.463	1.453	1.443	1.432	1.422	1.412	1.402
1.392	1.382	1.372	1.363	1.353	1.343	1.334	1.324	1.315	1.306
1.296	1.287	1.278	1.269	1.260	1.251	1.242	1.233	1.225	1.216
1.207	1.199	1.190	1.182	1.173	1.165	1.157	1.148	1.140	1.132
1.124	1.116	1.108	1.100	1.093	1.085	1.077	1.070	1.062	1.054
1.047	1.039	1.032	1.025	1.017	1.010	1.003	.996	.989	.982
.975	.968	.961	.954	.947	.939	.931	.922	.914	.906
.899	.891	.883	.875	.868	.860	.853	.845	.838	.831
.823	.815	.801	.766	.699	.611	.523	.444	.378	.321
.272	.231	.197	.167	.142	.121	.102	.087	.074	.063

```
 .053   .045   .039   .033   .028   .024   .020   .017   .014   .012
 .010   .009   .008   .006   .005   .005   .004   .003   .003   .002
 .002   .002   .001   .001   .001   .001   .001   .001   .000

TOTAL AREA =           128.06 ha ( 36.86 ha PAVED,   .00 ha SUPPLEMENTARY
                      91.20 ha GRASSED AND   .00 ha UNDRAINED )
ACCUMULATED RUNOFF =    40684 m3
 INCLUDING BASEFLOW =       0 m3
 & USER HYDROGRAPHS =       0 m3
VOLUME DIVERTED OUT =       0 m3
OVERFLOWS IN TRANSIT =     0 m3 (NET)
RUNOFF COEFFICIENTS =    .599 (VOLUMETRIC) BASED ONLY ON RAINFALL INPUTS
                 .196 (PEAK/AVERAGE) AND  .123 (PEAK/PEAK)
                 INCL. USER-PROVIDED HYDROGRAPHS, BUT NOT BASEFLOWS
NO. OF PIPES =           16
PEAK FLOWRATE =        11.091 m3/s   23.0 minutes AFTER START OF STORM
TOTAL BASEFLOW =        .000 m3/s
GRASSED RUNOFF =        52.9 %


RERUN WITH NEW RAINFALL PATTERN NO.  2
**************************************

30 MINUTE, 100 YEAR DESIGN STORM - MACLEAN
(ANTECEDENT MOISTURE CONDITION = 2.50)



CATCHMENT PARAMETERS
********************
                                          INFILTRATION
      DEPRESSION STORAGE (mm)   SOIL TYPE     AMC        PARAMETERS
       PAVED AREA   GRASSED     1234=ABCD            FI =    47.0 mm
                            5=NEW              F0 =  162.5 mm/h
                                          FC =    9.5 mm/h
         1.0        6.0          2.50        2.50     K =    2.0 /h
                                          FID =   43.1 mm
                                     INITIAL RATE =   76.4 mm/h
RAINFALL PARAMETERS AND DATA
****************************

   DURATION       TIME INCREMENT       NUMBER OF       TOTAL RAINFALL
   (minutes)        (minutes)    RAINFALL INCREMENTS       (mm)

     30.0              1.0               6              65.3

STANDARD AUSTRALIAN RAINFALL PATTERN FOR ZONE  1
WITH AVERAGE INTENSITY  130.62 mm/h                  ( MULTIPLIER =  1.000 )

 125.4   125.4   125.4   125.4   125.4   188.1   188.1   188.1   188.1   188.1
 235.1   235.1   235.1   235.1   235.1    78.4    78.4    78.4    78.4    78.4
  94.0    94.0    94.0    94.0    94.0    62.7    62.7    62.7    62.7    62.7


COMPUTATIONAL TIME STEP =  1.0 minutes



                       PIPE SYSTEM DETAILS
                       *******************

BCH RCH       AREAS (ha)      PAVED    GRASSED     C    VOL SURFACE PIT  PIPE
       PAV  SUP GRAS TOTAL TIME  Q   TIME    Q              Q     Q     Q

LEN SLOPE         ORIGINAL          DESIGNED       CAP  VEL    VOLUMES  OFLOW
       H    B    SS  NO DIA nORk NO DIA nORk PAT  Q        BYP UPW OFL  Q

DETENTION BASIN ROUTING

     HEIGHT-STORAGE-OUTFLOW RELATIONSHIP
HEIGHT (m)      STORAGE (m3)     OUTFLOW (m3/s)

   -.500            .0            .000
    .000           295.0           .800
    .250          1324.0           .950
    .500          6799.0          1.600
    .750         21445.0          1.900
   1.000         46660.0          2.600
   1.250         79039.0          2.800
   1.300         85993.0          3.400
   1.700       1442083.0          5.000
   1.750       1500000.0         30.000
```

STARTING STORAGE IS 0. m3

VOLUMES OF INFLOW AND OUTFLOW HYDROGRAPHS ARE 35434. AND 35434. m3
AND RESPECTIVE PEAKS ARE 23.288 AND 2.147 m3/s
PEAK HEIGHT IN BASIN IS .838 m, AND TIME OF PONDING IS 407.0 minutes

DETENTION BASIN
A_ 125.03 .0064.37 89.40 30 8.943 0-2514.344 .6073543423.28823.288 2.147

CIRCULAR PIPE, UNRESTRICTED, NO-OVERFLOW INLET UPGRADING
B_ 1 2.38 .0012.52 14.90 20 1.028 0-25 2.789 .544 5293 3.591 3.591 3.587
70 .50 .00 .00 .00 1372 .012 1372 .012 2 4.269 2.9 0 0 0 .000

CIRCULAR PIPE, UNRESTRICTED, NO-OVERFLOW INLET UPGRADING
A_ 2 .00 .00 .60 .60 0 .000 0-12 .210 .489 192 .210 5.522 5.516
60 .50 .00 .00 .00 2134 .012 2134 .012 213.863 3.9 0 0 0 .000

CIRCULAR PIPE, UNRESTRICTED, NO-OVERFLOW INLET UPGRADING
A_ 3 .00 .00 1.10 1.10 0 .000 0-10 .443 .493 354 .443 5.637 5.630
80 .50 .00 .00 .00 2134 .012 2134 .012 213.863 3.9 0 0 0 .000

CIRCULAR PIPE, UNRESTRICTED, NO-OVERFLOW INLET UPGRADING
C_ 1 2.85 .00 3.45 6.30 15 1.423 0-15 1.038 .710 2920 2.369 2.369 2.364
30 .50 .00 .00 .00 1143 .012 1143 .012 1 2.623 2.6 0 0 0 .000

CIRCULAR PIPE, UNRESTRICTED, NO-OVERFLOW INLET UPGRADING
D_ 1 1.61 .00 1.19 2.80 15 .804 0-15 .358 .771 1410 1.130 1.130 1.126
50 .50 .00 .00 .00 914 .012 914 .012 1 1.445 2.2 0 0 0 .000

CIRCULAR PIPE, UNRESTRICTED, NO-OVERFLOW INLET UPGRADING
E_ 1 2.24 .00 1.44 3.68 15 1.121 0-15 .432 .789 1896 1.514 1.514 1.510
50 .50 .00 .00 .00 991 .012 991 .012 1 1.793 2.3 0 0 0 .000

DETENTION BASIN ROUTING

HEIGHT-STORAGE-OUTFLOW RELATIONSHIP

HEIGHT (m)	STORAGE (m3)	OUTFLOW (m3/s)
.000	.0	.000
.300	1000.0	1.000
.500	1701.0	1.540
.700	2474.0	3.000
.900	3321.0	3.300
1.100	4256.0	3.500
1.300	5250.0	4.000
1.500	6400.0	10.000

STARTING STORAGE IS 0. m3

VOLUMES OF INFLOW AND OUTFLOW HYDROGRAPHS ARE 6258. AND 6258. m3
AND RESPECTIVE PEAKS ARE 5.041 AND 3.119 m3/s
PEAK HEIGHT IN BASIN IS .780 m, AND TIME OF PONDING IS 180.0 minutes

DETENTION BASIN
D_ 2 .00 .00 .10 .10 0 .000 0-10 .040 .493 32 .040 5.041 3.119

CIRCULAR PIPE, UNRESTRICTED, NO-OVERFLOW INLET UPGRADING
A_ 4 .35 .00 2.85 3.20 2 .226 0-10 1.151 .546 1141 1.376 6.287 6.281
130 .50 .00 .00 .00 2134 .012 2134 .012 113.863 3.9 0 0 0 .000

CIRCULAR PIPE, UNRESTRICTED, NO-OVERFLOW INLET UPGRADING
A_ 5 .00 .00 1.01 1.01 0 .000 0-15 .304 .482 318 .304 9.497 9.489
200 .50 .00 .00 .00 2134 .012 2134 .012 213.863 3.9 0 0 0 .000

CIRCULAR PIPE, UNRESTRICTED, NO-OVERFLOW INLET UPGRADING
A_ 6 .00 .00 .70 .70 0 .000 0-15 .211 .482 220 .211 9.681 9.665
50 .50 .00 .00 .00 2134 .012 2134 .012 213.863 3.9 0 0 0 .000

CIRCULAR PIPE, UNRESTRICTED, NO-OVERFLOW INLET UPGRADING
F_ 1 .39 .00 .30 .69 10 .231 0-10 .120 .773 348 .351 .351 .351
110 .50 .00 .00 .00 610 .012 610 .012 1 .492 1.7 0 0 0 .000

CIRCULAR PIPE, UNRESTRICTED, NO-OVERFLOW INLET UPGRADING
F_ 2 .92 .00 .68 1.60 6 .581 0-10 .274 .776 811 .855 1.178 1.170
90 .50 .00 .00 .00 914 .012 914 .012 2 1.445 2.2 0 0 0 .000

CIRCULAR PIPE, UNRESTRICTED, NO-OVERFLOW INLET UPGRADING
F_ 3 1.08 .00 .80 1.88 10 .635 0-15 .240 .771 947 .850 1.992 1.991
175 .50 .00 .00 .00 1067 .012 1067 .012 1 2.183 2.4 0 0 0 .000

DETENTION BASIN ROUTING

HEIGHT-STORAGE-OUTFLOW RELATIONSHIP

HEIGHT (m)	STORAGE (m3)	OUTFLOW (m3/s)
.000	.0	.000
.100	20.0	.400
.300	62.0	.500
.500	161.0	.770
.700	290.0	1.500
.900	454.0	1.650
1.100	653.0	1.750
1.300	890.0	2.000

STARTING STORAGE IS 2. m3

VOLUMES OF INFLOW AND OUTFLOW HYDROGRAPHS ARE 2106. AND 2109. m3
AND RESPECTIVE PEAKS ARE 1.991 AND 1.573 m3/s
PEAK HEIGHT IN BASIN IS .797 m, AND TIME OF PONDING IS 47.0 minutes

DETENTION BASIN
F_ 4 .00 .00 .00 .00 0 .000 15-15 .000 .000 0 .000 1.991 1.573

CIRCULAR PIPE, UNRESTRICTED, NO-OVERFLOW INLET UPGRADING
A_ 7 .00 .00 .10 .10 0 .000 0 -6 .048 .501 33 .04811.22911.203
350 .50 .00 .00 .00 2134 .012 2134 .012 213.863 3.9 0 0 0 .000

OUTFALL HYDROGRAPH (m3/s)
****
(410 VALUES AT 1.0 minute INTERVALS)

.000	.000	.020	.032	.118	.289	.519	.796	1.147	1.607
2.200	2.867	3.565	4.324	5.224	6.233	7.271	8.278	9.081	9.640
10.099	10.503	10.827	11.064	11.197	11.203	11.133	10.991	10.795	10.618
10.466	10.327	10.199	10.038	9.780	9.426	8.974	8.421	7.833	7.261
6.710	6.128	5.470	4.902	4.480	4.187	3.983	3.814	3.667	3.546
3.451	3.371	3.297	3.228	3.165	3.104	3.045	2.991	2.940	2.891
2.844	2.800	2.758	2.718	2.681	2.645	2.610	2.578	2.547	2.518
2.491	2.465	2.440	2.416	2.394	2.373	2.352	2.333	2.315	2.297
2.281	2.265	2.250	2.235	2.221	2.208	2.196	2.184	2.172	2.161
2.150	2.140	2.130	2.121	2.112	2.103	2.095	2.086	2.079	2.071
2.064	2.057	2.050	2.043	2.037	2.031	2.024	2.019	2.013	2.007
2.002	1.996	1.991	1.986	1.981	1.976	1.972	1.967	1.962	1.958
1.953	1.949	1.945	1.941	1.936	1.932	1.928	1.924	1.920	1.917
1.913	1.909	1.906	1.903	1.901	1.898	1.895	1.892	1.889	1.887
1.884	1.881	1.879	1.876	1.874	1.871	1.869	1.866	1.864	1.861
1.859	1.856	1.854	1.851	1.849	1.846	1.844	1.842	1.839	1.837
1.834	1.832	1.830	1.827	1.825	1.823	1.820	1.818	1.816	1.814
1.811	1.809	1.807	1.804	1.802	1.800	1.798	1.795	1.793	1.791
1.789	1.786	1.784	1.782	1.779	1.777	1.775	1.773	1.771	1.769
1.766	1.764	1.762	1.760	1.758	1.756	1.753	1.751	1.749	1.747
1.745	1.743	1.741	1.738	1.736	1.734	1.732	1.730	1.728	1.726
1.723	1.721	1.719	1.717	1.715	1.713	1.711	1.709	1.707	1.705
1.702	1.700	1.698	1.696	1.694	1.692	1.690	1.688	1.686	1.684
1.682	1.680	1.677	1.675	1.673	1.671	1.669	1.667	1.665	1.663
1.661	1.659	1.657	1.655	1.653	1.651	1.649	1.647	1.645	1.643
1.641	1.639	1.637	1.635	1.633	1.631	1.629	1.627	1.625	1.623
1.621	1.619	1.617	1.615	1.613	1.611	1.609	1.607	1.605	1.603
1.599	1.592	1.583	1.572	1.560	1.549	1.538	1.527	1.517	1.506
1.495	1.485	1.474	1.464	1.453	1.443	1.433	1.422	1.412	1.402
1.392	1.383	1.373	1.363	1.353	1.344	1.334	1.325	1.315	1.306
1.297	1.287	1.278	1.269	1.260	1.251	1.242	1.234	1.225	1.216
1.208	1.199	1.190	1.182	1.174	1.165	1.157	1.149	1.141	1.133
1.124	1.117	1.109	1.101	1.093	1.085	1.077	1.070	1.062	1.055
1.047	1.040	1.032	1.025	1.018	1.011	1.003	.996	.989	.982
.975	.968	.961	.954	.947	.939	.931	.923	.915	.907
.899	.891	.883	.876	.868	.860	.853	.845	.838	.831
.824	.816	.802	.769	.703	.615	.526	.447	.380	.323
.274	.233	.198	.168	.143	.121	.103	.088	.074	.063
.054	.046	.039	.033	.028	.024	.020	.017	.015	.012
.011	.009	.008	.006	.005	.005	.004	.003	.003	.002
.002	.002	.001	.001	.001	.001	.001	.001	.001	.000

TOTAL AREA = 128.06 ha (36.86 ha PAVED, .00 ha SUPPLEMENTARY
91.20 ha GRASSED AND .00 ha UNDRAINED)
ACCUMULATED RUNOFF = 51350 m3
INCLUDING BASEFLOW = 0 m3
& USER HYDROGRAPHS = 0 m3

VOLUME DIVERTED OUT = 0 m3
OVERFLOWS IN TRANSIT = 0 m3 (NET)
RUNOFF COEFFICIENTS = .614 (VOLUMETRIC) BASED ONLY ON RAINFALL INPUTS
.241 (PEAK/AVERAGE) AND .134 (PEAK/PEAK)
INCL. USER-PROVIDED HYDROGRAPHS, BUT NOT BASEFLOWS
NO. OF PIPES = 16
PEAK FLOWRATE = 11.203 m3/s 26.0 minutes AFTER START OF STORM
TOTAL BASEFLOW = .000 m3/s
GRASSED RUNOFF = 53.8 %

RERUN WITH NEW RAINFALL PATTERN NO. 3
****

45 MINUTE, 100 YEAR DESIGN STORM - MACLEAN
(ANTECEDENT MOISTURE CONDITION = 2.50)

CATCHMENT PARAMETERS
****

DEPRESSION STORAGE (mm) PAVED AREA	GRASSED	SOIL TYPE 1234=ABCD 5=NEW	AMC	INFILTRATION PARAMETERS
1.0	6.0	2.50	2.50	FI = 47.0 mm F0 = 162.5 mm/h FC = 9.5 mm/h K = 2.0 /h FID = 43.1 mm INITIAL RATE = 76.4 mm/h

RAINFALL PARAMETERS AND DATA
****

DURATION (minutes)	TIME INCREMENT (minutes)	NUMBER OF RAINFALL INCREMENTS	TOTAL RAINFALL (mm)
45.0	1.0	9	79.5

STANDARD AUSTRALIAN RAINFALL PATTERN FOR ZONE 1
WITH AVERAGE INTENSITY 105.96 mm/h (MULTIPLIER = 1.000)

50.5	50.5	50.5	50.5	50.5	132.6	132.6	132.6	132.6	132.6
222.2	222.2	222.2	222.2	222.2	168.8	168.8	168.8	168.8	168.8
93.5	93.5	93.5	93.5	93.5	111.6	111.6	111.6	111.6	111.6
75.3	75.3	75.3	75.3	75.3	62.0	62.0	62.0	62.0	62.0
37.2	37.2	37.2	37.2	37.2					

COMPUTATIONAL TIME STEP = 1.0 minutes

PIPE SYSTEM DETAILS
****

BCH RCH AREAS (ha) PAVED GRASSED C VOL SURFACE PIT PIPE
PAV SUP GRAS TOTAL TIME Q TIME Q Q Q Q

LEN SLOPE ORIGINAL DESIGNED CAP VEL VOLUMES OFLOW
H B SS NO DIA nORk NO DIA nORk PAT Q BYP UPW OFL Q

DETENTION BASIN ROUTING

HEIGHT-STORAGE-OUTFLOW RELATIONSHIP

HEIGHT (m)	STORAGE (m3)	OUTFLOW (m3/s)
-.500	.0	.000
.000	295.0	.800
.250	1324.0	.950
.500	6799.0	1.600
.750	21445.0	1.900
1.000	46660.0	2.600
1.250	79039.0	2.800
1.300	85993.0	3.400
1.700	1442083.0	5.000
1.750	1500000.0	30.000

STARTING STORAGE IS 0. m3

VOLUMES OF INFLOW AND OUTFLOW HYDROGRAPHS ARE 44626. AND 44625. m3
AND RESPECTIVE PEAKS ARE 25.375 AND 2.365 m3/s
PEAK HEIGHT IN BASIN IS .916 m, AND TIME OF PONDING IS 476.0 minutes

```
                                 DETENTION BASIN
  A_  125.03  .0064.37 89.40 30 9.317  0-2516.059  .6284462625.37525.375 2.365

CIRCULAR PIPE,      UNRESTRICTED, NO-OVERFLOW INLET             UPGRADING
  B_  1 2.38  .0012.52 14.90 20 1.021  0-25 3.123  .568 6729 3.866 3.866 3.862
 70  .50  .00  .00  .00   1372 .012   1372 .012  3 4.269 2.9   0   0   0  .000

CIRCULAR PIPE,      UNRESTRICTED, NO-OVERFLOW INLET             UPGRADING
  A_  2  .00  .00  .60   .60  0  .000  0-12  .210  .505  241  .210 5.905 5.891
 60  .50  .00  .00  .00   2134 .012   2134 .012  313.863 3.9   0   0   0  .000

CIRCULAR PIPE,      UNRESTRICTED, NO-OVERFLOW INLET             UPGRADING
  A_  3  .00  .00 1.10  1.10  0  .000  0-10  .432  .508  444  .432 6.068 6.053
 80  .50  .00  .00  .00   2134 .012   2134 .012  313.863 3.9   0   0   0  .000

CIRCULAR PIPE,      UNRESTRICTED, NO-OVERFLOW INLET             UPGRADING
  C_  1 2.85  .00 3.45  6.30 15 1.382  0-15 1.064  .721 3612 2.343 2.343 2.340
 30  .50  .00  .00  .00   1143 .012   1143 .012  1 2.623 2.6   0   0   0  .000

CIRCULAR PIPE,      UNRESTRICTED, NO-OVERFLOW INLET             UPGRADING
  D_  1 1.61  .00 1.19  2.80 15  .780  0-15  .367  .781 1738 1.092 1.092 1.091
 50  .50  .00  .00  .00    914 .012    914 .012  1 1.445 2.2   0   0   0  .000

CIRCULAR PIPE,      UNRESTRICTED, NO-OVERFLOW INLET             UPGRADING
  E_  1 2.24  .00 1.44  3.68 15 1.088  0-15  .443  .798 2333 1.464 1.464 1.461
 50  .50  .00  .00  .00    991 .012    991 .012  1 1.793 2.3   0   0   0  .000

DETENTION BASIN ROUTING

     HEIGHT-STORAGE-OUTFLOW RELATIONSHIP
HEIGHT (m)     STORAGE (m3)     OUTFLOW (m3/s)

   .000           .0          .000
   .300        1000.0        1.000
   .500        1701.0        1.540
   .700        2474.0        3.000
   .900        3321.0        3.300
  1.100        4256.0        3.500
  1.300        5250.0        4.000
  1.500        6400.0       10.000


STARTING STORAGE IS     0. m3

VOLUMES OF INFLOW AND OUTFLOW HYDROGRAPHS ARE     7723. AND     7723. m3
AND RESPECTIVE PEAKS ARE     4.904 AND     3.137 m3/s
PEAK HEIGHT IN BASIN IS    .791 m, AND TIME OF PONDING IS  192.0 minutes

                                 DETENTION BASIN
  D_  2  .00  .00  .10   .10  0  .000  0-10  .039  .508   40  .039 4.904 3.137

CIRCULAR PIPE,      UNRESTRICTED, NO-OVERFLOW INLET             UPGRADING
  A_  4  .35  .00 2.85  3.20  2  .213  0-10 1.120  .559 1422 1.282 6.585 6.565
130  .50  .00  .00  .00   2134 .012   2134 .012  313.863 3.9   0   0   0  .000

CIRCULAR PIPE,      UNRESTRICTED, NO-OVERFLOW INLET             UPGRADING
  A_  5  .00  .00 1.01  1.01  0  .000  0-15  .312  .502  403  .312 9.850 9.846
200  .50  .00  .00  .00   2134 .012   2134 .012  313.863 3.9   0   0   0  .000

CIRCULAR PIPE,      UNRESTRICTED, NO-OVERFLOW INLET             UPGRADING
  A_  6  .00  .00  .70   .70  0  .000  0-15  .216  .502  279  .216 9.953 9.953
 50  .50  .00  .00  .00   2134 .012   2134 .012  313.863 3.9   0   0   0  .000

CIRCULAR PIPE,      UNRESTRICTED, NO-OVERFLOW INLET             UPGRADING
  F_  1  .39  .00  .30   .69 10  .214  0-10  .116  .781  428  .330  .330  .330
110  .50  .00  .00  .00    610 .012    610 .012  1  .492 1.7   0   0   0  .000

CIRCULAR PIPE,      UNRESTRICTED, NO-OVERFLOW INLET             UPGRADING
  F_  2  .92  .00  .68  1.60  6  .545  0-10  .267  .783  996  .721 1.037 1.028
 90  .50  .00  .00  .00    914 .012    914 .012  2 1.445 2.2   0   0   0  .000

CIRCULAR PIPE,      UNRESTRICTED, NO-OVERFLOW INLET             UPGRADING
  F_  3 1.08  .00  .80  1.88 10  .587  0-15  .246  .781 1167  .796 1.824 1.821
175  .50  .00  .00  .00   1067 .012   1067 .012  1 2.183 2.4   0   0   0  .000

DETENTION BASIN ROUTING

     HEIGHT-STORAGE-OUTFLOW RELATIONSHIP
HEIGHT (m)     STORAGE (m3)     OUTFLOW (m3/s)

   .000           .0          .000
   .100          20.0          .400
```

.300	62.0	.500
.500	161.0	.770
.700	290.0	1.500
.900	454.0	1.650
1.100	653.0	1.750
1.300	890.0	2.000

STARTING STORAGE IS 2. m3

VOLUMES OF INFLOW AND OUTFLOW HYDROGRAPHS ARE 2591. AND 2594. m3
AND RESPECTIVE PEAKS ARE 1.821 AND 1.544 m3/s
PEAK HEIGHT IN BASIN IS .759 m, AND TIME OF PONDING IS 61.0 minutes

DETENTION BASIN
F_ 4 .00 .00 .00 .00 0 .000 15-15 .000 .000 0 .000 1.821 1.544

CIRCULAR PIPE, UNRESTRICTED, NO-OVERFLOW INLET UPGRADING
A_ 7 .00 .00 .10 .10 0 .000 0 -6 .043 .511 41 .04311.24611.245
350 .50 .00 .00 .00 2134 .012 2134 .012 313.863 3.9 0 0 0 .000

OUTFALL HYDROGRAPH (m3/s)
****
(479 VALUES AT 1.0 minute INTERVALS)

.000	.000	.017	.006	.018	.063	.141	.242	.384	.597
.870	1.159	1.460	1.868	2.446	3.163	3.964	4.828	5.744	6.620
7.419	8.182	8.886	9.519	10.053	10.464	10.774	11.003	11.149	11.225
11.245	11.220	11.189	11.165	11.135	11.091	11.041	10.994	10.927	10.792
10.576	10.304	10.005	9.697	9.404	9.126	8.831	8.485	8.095	7.682
7.264	6.855	6.468	6.104	5.633	5.200	4.872	4.613	4.391	4.192
4.014	3.857	3.724	3.619	3.538	3.470	3.405	3.338	3.270	3.208
3.153	3.103	3.056	3.012	2.970	2.930	2.892	2.856	2.822	2.790
2.759	2.729	2.702	2.675	2.650	2.626	2.603	2.582	2.561	2.542
2.523	2.505	2.488	2.472	2.457	2.442	2.428	2.414	2.401	2.389
2.377	2.366	2.355	2.344	2.334	2.324	2.315	2.306	2.297	2.289
2.281	2.273	2.265	2.258	2.250	2.243	2.237	2.230	2.224	2.218
2.211	2.206	2.200	2.194	2.189	2.183	2.178	2.173	2.168	2.163
2.158	2.153	2.148	2.143	2.139	2.134	2.130	2.125	2.121	2.117
2.113	2.108	2.104	2.100	2.096	2.092	2.088	2.084	2.080	2.076
2.072	2.069	2.065	2.061	2.057	2.054	2.050	2.046	2.043	2.039
2.035	2.032	2.028	2.025	2.021	2.018	2.014	2.011	2.007	2.004
2.000	1.997	1.993	1.990	1.987	1.983	1.980	1.976	1.973	1.970
1.966	1.963	1.960	1.956	1.953	1.950	1.946	1.943	1.940	1.937
1.933	1.930	1.927	1.924	1.920	1.917	1.914	1.910	1.907	1.904
1.901	1.898	1.896	1.894	1.891	1.889	1.887	1.884	1.882	1.880
1.877	1.875	1.873	1.871	1.868	1.866	1.864	1.861	1.859	1.857
1.854	1.852	1.850	1.848	1.845	1.843	1.841	1.839	1.836	1.834
1.832	1.830	1.827	1.825	1.823	1.821	1.818	1.816	1.814	1.812
1.809	1.807	1.805	1.803	1.801	1.798	1.796	1.794	1.792	1.790
1.787	1.785	1.783	1.781	1.779	1.776	1.774	1.772	1.770	1.768
1.766	1.763	1.761	1.759	1.757	1.755	1.753	1.750	1.748	1.746
1.744	1.742	1.740	1.738	1.735	1.733	1.731	1.729	1.727	1.725
1.723	1.721	1.718	1.716	1.714	1.712	1.710	1.708	1.706	1.704
1.702	1.700	1.697	1.695	1.693	1.691	1.689	1.687	1.685	1.683
1.681	1.679	1.677	1.675	1.673	1.671	1.668	1.666	1.664	1.662
1.660	1.658	1.656	1.654	1.652	1.650	1.648	1.646	1.644	1.642
1.640	1.638	1.636	1.634	1.632	1.630	1.628	1.626	1.624	1.622
1.620	1.618	1.616	1.614	1.612	1.610	1.608	1.606	1.604	1.601
1.596	1.588	1.578	1.567	1.556	1.545	1.534	1.523	1.512	1.502
1.491	1.480	1.470	1.460	1.449	1.439	1.429	1.419	1.408	1.398
1.389	1.379	1.369	1.359	1.350	1.340	1.330	1.321	1.312	1.302
1.293	1.284	1.275	1.266	1.257	1.248	1.239	1.230	1.221	1.213
1.204	1.196	1.187	1.179	1.170	1.162	1.154	1.146	1.137	1.129
1.121	1.113	1.106	1.098	1.090	1.082	1.074	1.067	1.059	1.052
1.044	1.037	1.030	1.022	1.015	1.008	1.001	.993	.986	.979
.972	.966	.959	.951	.944	.936	.928	.920	.912	.904
.896	.888	.880	.873	.865	.857	.850	.843	.835	.828
.821	.812	.792	.746	.669	.579	.494	.420	.357	.303
.257	.219	.186	.158	.134	.114	.097	.082	.070	.059
.050	.043	.036	.031	.026	.022	.019	.016	.014	.012
.010	.008	.007	.006	.005	.004	.004	.003	.003	.002
.002	.002	.001	.001	.001	.001	.001	.001	.000	

TOTAL AREA = 128.06 ha (36.86 ha PAVED, .00 ha SUPPLEMENTARY
91.20 ha GRASSED AND .00 ha UNDRAINED)
ACCUMULATED RUNOFF = 64498 m3
INCLUDING BASEFLOW = 0 m3
& USER HYDROGRAPHS = 0 m3
VOLUME DIVERTED OUT = 0 m3
OVERFLOWS IN TRANSIT = 0 m3 (NET)

RUNOFF COEFFICIENTS = .634 (VOLUMETRIC) BASED ONLY ON RAINFALL INPUTS
.298 (PEAK/AVERAGE) AND .142 (PEAK/PEAK)
INCL. USER-PROVIDED HYDROGRAPHS, BUT NOT BASEFLOWS
NO. OF PIPES = 16
PEAK FLOWRATE = 11.245 m3/s 31.0 minutes AFTER START OF STORM
TOTAL BASEFLOW = .000 m3/s
GRASSED RUNOFF = 55.2 %

RERUN WITH NEW RAINFALL PATTERN NO. 4
****

60 MINUTE, 100 YEAR DESIGN STORM - MACLEAN
(ANTECEDENT MOISTURE CONDITION = 2.50)

CATCHMENT PARAMETERS
****

DEPRESSION STORAGE (mm) PAVED AREA	GRASSED	SOIL TYPE 1234=ABCD 5=NEW	AMC	INFILTRATION PARAMETERS
1.0	6.0	2.50	2.50	FI = 47.0 mm F0 = 162.5 mm/h FC = 9.5 mm/h K = 2.0 /h FID = 43.1 mm INITIAL RATE = 76.4 mm/h

RAINFALL PARAMETERS AND DATA
****

DURATION (minutes)	TIME INCREMENT (minutes)	NUMBER OF RAINFALL INCREMENTS	TOTAL RAINFALL (mm)
60.0	1.0	12	90.8

STANDARD AUSTRALIAN RAINFALL PATTERN FOR ZONE 1
WITH AVERAGE INTENSITY 90.77 mm/h (MULTIPLIER = 1.000)

46.8	46.8	46.8	46.8	46.8	79.5	79.5	79.5	79.5	79.5
175.4	175.4	175.4	175.4	175.4	126.4	126.4	126.4	126.4	126.4
236.4	236.4	236.4	236.4	236.4	108.9	108.9	108.9	108.9	108.9
98.0	98.0	98.0	98.0	98.0	65.4	65.4	65.4	65.4	65.4
56.6	56.6	56.6	56.6	56.6	38.1	38.1	38.1	38.1	38.1
32.7	32.7	32.7	32.7	32.7	25.1	25.1	25.1	25.1	25.1

COMPUTATIONAL TIME STEP = 1.0 minutes

PIPE SYSTEM DETAILS
****

BCH RCH AREAS (ha) PAVED GRASSED C VOL SURFACE PIT PIPE
PAV SUP GRAS TOTAL TIME Q TIME Q Q Q Q

LEN SLOPE ORIGINAL DESIGNED CAP VEL VOLUMES OFLOW
H B SS NO DIA nORk NO DIA nORk PAT Q BYP UPW OFL Q

DETENTION BASIN ROUTING

HEIGHT-STORAGE-OUTFLOW RELATIONSHIP

HEIGHT (m)	STORAGE (m3)	OUTFLOW (m3/s)
-.500	.0	.000
.000	295.0	.800
.250	1324.0	.950
.500	6799.0	1.600
.750	21445.0	1.900
1.000	46660.0	2.600
1.250	79039.0	2.800
1.300	85993.0	3.400
1.700	1442083.0	5.000
1.750	1500000.0	30.000

STARTING STORAGE IS 0. m3

VOLUMES OF INFLOW AND OUTFLOW HYDROGRAPHS ARE 51899. AND 51899. m3
AND RESPECTIVE PEAKS ARE 26.708 AND 2.529 m3/s
PEAK HEIGHT IN BASIN IS .975 m, AND TIME OF PONDING IS 527.0 minutes

DETENTION BASIN
A_ 125.03 .0064.37 89.40 30 9.556 0-2517.218 .6405189926.70826.708 2.529

CIRCULAR PIPE, UNRESTRICTED, NO-OVERFLOW INLET UPGRADING
B_ 1 2.38 .0012.52 14.90 20 1.071 0-25 3.348 .581 7862 4.251 4.251 4.241
70 .50 .00 .00 .00 1372 .012 1372 .012 4 4.269 2.9 0 0 0 .000

CIRCULAR PIPE, UNRESTRICTED, NO-OVERFLOW INLET UPGRADING
A_ 2 .00 .00 .60 .60 0 .000 0-12 .222 .512 279 .222 6.282 6.280
60 .50 .00 .00 .00 2134 .012 2134 .012 413.863 3.9 0 0 0 .000

CIRCULAR PIPE, UNRESTRICTED, NO-OVERFLOW INLET UPGRADING
A_ 3 .00 .00 1.10 1.10 0 .000 0-10 .413 .513 512 .413 6.455 6.453
80 .50 .00 .00 .00 2134 .012 2134 .012 413.863 3.9 0 0 0 .000

CIRCULAR PIPE, UNRESTRICTED, NO-OVERFLOW INLET UPGRADING
C_ 1 2.85 .00 3.45 6.30 15 1.420 0-15 1.153 .727 4156 2.500 2.500 2.498
30 .50 .00 .00 .00 1143 .012 1143 .012 4 2.623 2.6 0 0 0 .000

CIRCULAR PIPE, UNRESTRICTED, NO-OVERFLOW INLET UPGRADING
D_ 1 1.61 .00 1.19 2.80 15 .802 0-15 .398 .785 1996 1.168 1.168 1.165
50 .50 .00 .00 .00 914 .012 914 .012 1 1.445 2.2 0 0 0 .000

CIRCULAR PIPE, UNRESTRICTED, NO-OVERFLOW INLET UPGRADING
E_ 1 2.24 .00 1.44 3.68 15 1.118 0-15 .480 .802 2680 1.560 1.560 1.554
50 .50 .00 .00 .00 991 .012 991 .012 1 1.793 2.3 0 0 0 .000

DETENTION BASIN ROUTING

HEIGHT-STORAGE-OUTFLOW RELATIONSHIP

HEIGHT (m)	STORAGE (m3)	OUTFLOW (m3/s)
.000	.0	.000
.300	1000.0	1.000
.500	1701.0	1.540
.700	2474.0	3.000
.900	3321.0	3.300
1.100	4256.0	3.500
1.300	5250.0	4.000
1.500	6400.0	10.000

STARTING STORAGE IS 0. m3

VOLUMES OF INFLOW AND OUTFLOW HYDROGRAPHS ARE 8879. AND 8878. m3
AND RESPECTIVE PEAKS ARE 5.245 AND 3.280 m3/s
PEAK HEIGHT IN BASIN IS .887 m, AND TIME OF PONDING IS 202.0 minutes

DETENTION BASIN
D_ 2 .00 .00 .10 .10 0 .000 0-10 .038 .513 47 .038 5.245 3.280

CIRCULAR PIPE, UNRESTRICTED, NO-OVERFLOW INLET UPGRADING
A_ 4 .35 .00 2.85 3.20 2 .227 0-10 1.072 .564 1639 1.299 7.236 7.230
130 .50 .00 .00 .00 2134 .012 2134 .012 413.863 3.9 0 0 0 .000

CIRCULAR PIPE, UNRESTRICTED, NO-OVERFLOW INLET UPGRADING
A_ 5 .00 .00 1.01 1.01 0 .000 0-15 .338 .510 468 .33810.64310.639
200 .50 .00 .00 .00 2134 .012 2134 .012 413.863 3.9 0 0 0 .000

CIRCULAR PIPE, UNRESTRICTED, NO-OVERFLOW INLET UPGRADING
A_ 6 .00 .00 .70 .70 0 .000 0-15 .234 .510 324 .23410.85710.856
50 .50 .00 .00 .00 2134 .012 2134 .012 413.863 3.9 0 0 0 .000

CIRCULAR PIPE, UNRESTRICTED, NO-OVERFLOW INLET UPGRADING
F_ 1 .39 .00 .30 .69 10 .198 0-10 .111 .784 491 .310 .310 .309
110 .50 .00 .00 .00 610 .012 610 .012 1 .492 1.7 0 0 0 .000

CIRCULAR PIPE, UNRESTRICTED, NO-OVERFLOW INLET UPGRADING
F_ 2 .92 .00 .68 1.60 6 .557 0-10 .255 .787 1142 .813 1.113 1.111
90 .50 .00 .00 .00 914 .012 914 .012 2 1.445 2.2 0 0 0 .000

CIRCULAR PIPE, UNRESTRICTED, NO-OVERFLOW INLET UPGRADING
F_ 3 1.08 .00 .80 1.88 10 .545 0-15 .267 .785 1340 .800 1.906 1.903
175 .50 .00 .00 .00 1067 .012 1067 .012 1 2.183 2.4 0 0 0 .000

DETENTION BASIN ROUTING

HEIGHT-STORAGE-OUTFLOW RELATIONSHIP

HEIGHT (m)	STORAGE (m3)	OUTFLOW (m3/s)
.000	.0	.000
.100	20.0	.400

.300	62.0	.500
.500	161.0	.770
.700	290.0	1.500
.900	454.0	1.650
1.100	653.0	1.750
1.300	890.0	2.000

STARTING STORAGE IS 2. m3

VOLUMES OF INFLOW AND OUTFLOW HYDROGRAPHS ARE 2974. AND 2977. m3
AND RESPECTIVE PEAKS ARE 1.903 AND 1.581 m3/s
PEAK HEIGHT IN BASIN IS .809 m, AND TIME OF PONDING IS 76.0 minutes

DETENTION BASIN
F_ 4 .00 .00 .00 .00 0 .000 15-15 .000 .000 0 .000 1.903 1.581

CIRCULAR PIPE, UNRESTRICTED, NO-OVERFLOW INLET UPGRADING
A_ 7 .00 .00 .10 .10 0 .000 0 -6 .048 .515 47 .04812.45312.449
350 .50 .00 .00 .00 2134 .012 2134 .012 413.863 3.9 0 0 0 .000

OUTFALL HYDROGRAPH (m3/s)
****
(530 VALUES AT 1.0 minute INTERVALS)

.000	.000	.017	.006	.016	.057	.127	.219	.335	.487
.669	.868	1.081	1.326	1.603	1.930	2.332	2.822	3.359	3.885
4.391	4.929	5.500	6.147	6.939	7.828	8.751	9.721	10.586	11.242
11.721	12.071	12.290	12.411	12.449	12.434	12.393	12.329	12.253	12.157
11.992	11.786	11.558	11.317	11.074	10.839	10.612	10.394	10.171	9.910
9.602	9.264	8.918	8.580	8.237	7.895	7.572	7.269	6.982	6.707
6.447	6.172	5.871	5.586	5.315	5.072	4.864	4.680	4.511	4.354
4.209	4.071	3.940	3.825	3.734	3.662	3.599	3.533	3.466	3.402
3.341	3.284	3.229	3.178	3.132	3.090	3.051	3.015	2.981	2.949
2.918	2.889	2.861	2.835	2.810	2.785	2.763	2.741	2.720	2.700
2.681	2.663	2.646	2.630	2.614	2.599	2.585	2.571	2.558	2.545
2.533	2.521	2.510	2.499	2.489	2.479	2.469	2.460	2.451	2.442
2.434	2.426	2.418	2.410	2.403	2.396	2.389	2.382	2.375	2.369
2.362	2.356	2.350	2.344	2.339	2.333	2.327	2.322	2.317	2.311
2.306	2.301	2.296	2.291	2.286	2.282	2.277	2.272	2.268	2.263
2.259	2.254	2.250	2.246	2.241	2.237	2.233	2.229	2.224	2.220
2.216	2.212	2.208	2.204	2.200	2.196	2.192	2.188	2.184	2.181
2.177	2.173	2.169	2.165	2.162	2.158	2.154	2.150	2.147	2.143
2.139	2.136	2.132	2.128	2.125	2.121	2.117	2.114	2.110	2.107
2.103	2.100	2.096	2.092	2.089	2.085	2.082	2.078	2.075	2.071
2.068	2.064	2.061	2.057	2.054	2.050	2.047	2.043	2.040	2.037
2.033	2.030	2.026	2.023	2.020	2.016	2.013	2.010	2.006	2.003
2.000	1.996	1.993	1.990	1.986	1.983	1.980	1.976	1.973	1.970
1.967	1.963	1.960	1.957	1.953	1.950	1.947	1.944	1.940	1.937
1.934	1.931	1.928	1.924	1.921	1.918	1.915	1.912	1.908	1.905
1.902	1.899	1.897	1.895	1.892	1.890	1.888	1.885	1.883	1.881
1.878	1.876	1.874	1.871	1.869	1.867	1.865	1.862	1.860	1.858
1.855	1.853	1.851	1.849	1.846	1.844	1.842	1.839	1.837	1.835
1.833	1.830	1.828	1.826	1.824	1.821	1.819	1.817	1.815	1.813
1.810	1.808	1.806	1.804	1.801	1.799	1.797	1.795	1.793	1.790
1.788	1.786	1.784	1.782	1.779	1.777	1.775	1.773	1.771	1.769
1.766	1.764	1.762	1.760	1.758	1.756	1.753	1.751	1.749	1.747
1.745	1.743	1.740	1.738	1.736	1.734	1.732	1.730	1.728	1.726
1.723	1.721	1.719	1.717	1.715	1.713	1.711	1.709	1.707	1.705
1.702	1.700	1.698	1.696	1.694	1.692	1.690	1.688	1.686	1.684
1.682	1.680	1.677	1.675	1.673	1.671	1.669	1.667	1.665	1.663
1.661	1.659	1.657	1.655	1.653	1.651	1.649	1.647	1.645	1.643
1.641	1.639	1.637	1.635	1.633	1.631	1.629	1.627	1.625	1.623
1.621	1.619	1.617	1.615	1.613	1.611	1.609	1.607	1.605	1.603
1.599	1.592	1.582	1.572	1.560	1.549	1.538	1.527	1.517	1.506
1.495	1.485	1.474	1.464	1.453	1.443	1.433	1.422	1.412	1.402
1.392	1.382	1.373	1.363	1.353	1.344	1.334	1.325	1.315	1.306
1.297	1.287	1.278	1.269	1.260	1.251	1.242	1.234	1.225	1.216
1.207	1.199	1.190	1.182	1.174	1.165	1.157	1.149	1.141	1.132
1.124	1.116	1.109	1.101	1.093	1.085	1.077	1.070	1.062	1.055
1.047	1.040	1.032	1.025	1.018	1.011	1.003	.996	.989	.982
.975	.968	.961	.954	.947	.939	.931	.923	.915	.907
.899	.891	.883	.876	.868	.860	.853	.845	.838	.831
.824	.816	.803	.770	.703	.614	.525	.446	.379	.322
.274	.232	.197	.168	.143	.121	.103	.087	.074	.063
.054	.046	.039	.033	.028	.024	.020	.017	.015	.012
.010	.009	.008	.006	.005	.005	.004	.003	.003	.002
.002	.002	.001	.001	.001	.001	.001	.001	.001	.000

TOTAL AREA = 128.06 ha (36.86 ha PAVED, .00 ha SUPPLEMENTARY

91.20 ha GRASSED AND .00 ha UNDRAINED)
ACCUMULATED RUNOFF = 74882 m3
INCLUDING BASEFLOW = 0 m3
& USER HYDROGRAPHS = 0 m3
VOLUME DIVERTED OUT = 0 m3
OVERFLOWS IN TRANSIT = 0 m3 (NET)
RUNOFF COEFFICIENTS = .644 (VOLUMETRIC) BASED ONLY ON RAINFALL INPUTS
.386 (PEAK/AVERAGE) AND .148 (PEAK/PEAK)
INCL. USER-PROVIDED HYDROGRAPHS, BUT NOT BASEFLOWS
NO. OF PIPES = 16
PEAK FLOWRATE = 12.449 m3/s 35.0 minutes AFTER START OF STORM
TOTAL BASEFLOW = .000 m3/s
GRASSED RUNOFF = 55.8 %

RERUN WITH NEW RAINFALL PATTERN NO. 5
****

90 MINUTE, 100 YEAR DESIGN STORM - MACLEAN
(ANTECEDENT MOISTURE CONDITION = 2.50)

CATCHMENT PARAMETERS
****

```
                                    INFILTRATION
     DEPRESSION STORAGE (mm)   SOIL TYPE    AMC      PARAMETERS
      PAVED AREA   GRASSED    1234=ABCD          FI =   47.0 mm
                          5=NEW            F0 =  162.5 mm/h
                                        FC =    9.5 mm/h
        1.0        6.0        2.50      2.50    K =    2.0 /h
                                        FID =   43.1 mm
                                 INITIAL RATE =   76.4 mm/h
```

RAINFALL PARAMETERS AND DATA
****

DURATION (minutes)	TIME INCREMENT (minutes)	NUMBER OF RAINFALL INCREMENTS	TOTAL RAINFALL (mm)
90.0	1.0	18	105.5

STANDARD AUSTRALIAN RAINFALL PATTERN FOR ZONE 1
WITH AVERAGE INTENSITY 70.31 mm/h (MULTIPLIER = 1.000)

44.3	44.3	44.3	44.3	44.3	74.7	74.7	74.7	74.7	74.7
175.9	175.9	175.9	175.9	175.9	101.2	101.2	101.2	101.2	101.2
126.6	126.6	126.6	126.6	126.6	246.8	246.8	246.8	246.8	246.8
69.6	69.6	69.6	69.6	69.6	68.3	68.3	68.3	68.3	68.3
57.0	57.0	57.0	57.0	57.0	44.3	44.3	44.3	44.3	44.3
57.0	57.0	57.0	57.0	57.0	45.6	45.6	45.6	45.6	45.6
30.4	30.4	30.4	30.4	30.4	32.9	32.9	32.9	32.9	32.9
32.9	32.9	32.9	32.9	32.9	20.2	20.2	20.2	20.2	20.2
19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0

COMPUTATIONAL TIME STEP = 1.0 minutes

PIPE SYSTEM DETAILS
****

BCH RCH AREAS (ha) PAVED GRASSED C VOL SURFACE PIT PIPE
PAV SUP GRAS TOTAL TIME Q TIME Q Q Q Q

LEN SLOPE ORIGINAL DESIGNED CAP VEL VOLUMES OFLOW
H B SS NO DIA nORk NO DIA nORk PAT Q BYP UPW OFL Q

DETENTION BASIN ROUTING

HEIGHT-STORAGE-OUTFLOW RELATIONSHIP

HEIGHT (m)	STORAGE (m3)	OUTFLOW (m3/s)
-.500	.0	.000
.000	295.0	.800
.250	1324.0	.950
.500	6799.0	1.600
.750	21445.0	1.900
1.000	46660.0	2.600
1.250	79039.0	2.800
1.300	85993.0	3.400
1.700	1442083.0	5.000

1.750 1500000.0 30.000

STARTING STORAGE IS 0. m3

VOLUMES OF INFLOW AND OUTFLOW HYDROGRAPHS ARE 60309. AND 60309. m3
AND RESPECTIVE PEAKS ARE 25.326 AND 2.612 m3/s
PEAK HEIGHT IN BASIN IS 1.015 m, AND TIME OF PONDING IS 582.0 minutes

DETENTION BASIN
A_ 125.03 .0064.37 89.40 30 9.211 0-2516.144 .6406030925.32625.326 2.612

CIRCULAR PIPE, UNRESTRICTED, NO-OVERFLOW INLET UPGRADING
B_ 1 2.38 .0012.52 14.90 20 1.077 0-25 3.139 .581 9133 4.018 4.018 4.009
70 .50 .00 .00 .00 1372 .012 1372 .012 4 4.269 2.9 0 0 0 .000

CIRCULAR PIPE, UNRESTRICTED, NO-OVERFLOW INLET UPGRADING
A_ 2 .00 .00 .60 .60 0 .000 0-12 .218 .507 321 .218 6.059 6.056
60 .50 .00 .00 .00 2134 .012 2134 .012 413.863 3.9 0 0 0 .000

CIRCULAR PIPE, UNRESTRICTED, NO-OVERFLOW INLET UPGRADING
A_ 3 .00 .00 1.10 1.10 0 .000 0-10 .446 .508 589 .446 6.301 6.298
80 .50 .00 .00 .00 2134 .012 2134 .012 413.863 3.9 0 0 0 .000

CIRCULAR PIPE, UNRESTRICTED, NO-OVERFLOW INLET UPGRADING
C_ 1 2.85 .00 3.45 6.30 15 1.253 0-15 1.098 .725 4820 2.351 2.351 2.335
30 .50 .00 .00 .00 1143 .012 1143 .012 4 2.623 2.6 0 0 0 .000

CIRCULAR PIPE, UNRESTRICTED, NO-OVERFLOW INLET UPGRADING
D_ 1 1.61 .00 1.19 2.80 15 .707 0-15 .379 .785 2317 1.086 1.086 1.078
50 .50 .00 .00 .00 914 .012 914 .012 1 1.445 2.2 0 0 0 .000

CIRCULAR PIPE, UNRESTRICTED, NO-OVERFLOW INLET UPGRADING
E_ 1 2.24 .00 1.44 3.68 15 .986 0-15 .457 .802 3111 1.443 1.443 1.432
50 .50 .00 .00 .00 991 .012 991 .012 1 1.793 2.3 0 0 0 .000

DETENTION BASIN ROUTING

HEIGHT-STORAGE-OUTFLOW RELATIONSHIP

HEIGHT (m)	STORAGE (m3)	OUTFLOW (m3/s)
.000	.0	.000
.300	1000.0	1.000
.500	1701.0	1.540
.700	2474.0	3.000
.900	3321.0	3.300
1.100	4256.0	3.500
1.300	5250.0	4.000
1.500	6400.0	10.000

STARTING STORAGE IS 0. m3

VOLUMES OF INFLOW AND OUTFLOW HYDROGRAPHS ARE 10302. AND 10301. m3
AND RESPECTIVE PEAKS ARE 4.878 AND 3.254 m3/s
PEAK HEIGHT IN BASIN IS .869 m, AND TIME OF PONDING IS 222.0 minutes

DETENTION BASIN
D_ 2 .00 .00 .10 .10 0 .000 0-10 .041 .508 54 .041 4.878 3.254

CIRCULAR PIPE, UNRESTRICTED, NO-OVERFLOW INLET UPGRADING
A_ 4 .35 .00 2.85 3.20 2 .237 0-10 1.158 .560 1889 1.394 7.372 7.366
130 .50 .00 .00 .00 2134 .012 2134 .012 513.863 3.9 0 0 0 .000

CIRCULAR PIPE, UNRESTRICTED, NO-OVERFLOW INLET UPGRADING
A_ 5 .00 .00 1.01 1.01 0 .000 0-15 .322 .506 539 .32210.75110.742
200 .50 .00 .00 .00 2134 .012 2134 .012 513.863 3.9 0 0 0 .000

CIRCULAR PIPE, UNRESTRICTED, NO-OVERFLOW INLET UPGRADING
A_ 6 .00 .00 .70 .70 0 .000 0-15 .223 .506 374 .22310.95210.949
50 .50 .00 .00 .00 2134 .012 2134 .012 513.863 3.9 0 0 0 .000

CIRCULAR PIPE, UNRESTRICTED, NO-OVERFLOW INLET UPGRADING
F_ 1 .39 .00 .30 .69 10 .204 0-10 .120 .783 570 .324 .324 .324
110 .50 .00 .00 .00 610 .012 610 .012 1 .492 1.7 0 0 0 .000

CIRCULAR PIPE, UNRESTRICTED, NO-OVERFLOW INLET UPGRADING
F_ 2 .92 .00 .68 1.60 6 .579 0-10 .276 .785 1325 .855 1.150 1.148
90 .50 .00 .00 .00 914 .012 914 .012 2 1.445 2.2 0 0 0 .000

CIRCULAR PIPE, UNRESTRICTED, NO-OVERFLOW INLET UPGRADING
F_ 3 1.08 .00 .80 1.88 10 .561 0-15 .254 .785 1556 .815 1.944 1.941

175 .50 .00 .00 .00 1067 .012 1067 .012 1 2.183 2.4 0 0 0 .000

DETENTION BASIN ROUTING

HEIGHT-STORAGE-OUTFLOW RELATIONSHIP

HEIGHT (m)	STORAGE (m3)	OUTFLOW (m3/s)
.000	.0	.000
.100	20.0	.400
.300	62.0	.500
.500	161.0	.770
.700	290.0	1.500
.900	454.0	1.650
1.100	653.0	1.750
1.300	890.0	2.000

STARTING STORAGE IS 2. m3

VOLUMES OF INFLOW AND OUTFLOW HYDROGRAPHS ARE 3451. AND 3453. m3
AND RESPECTIVE PEAKS ARE 1.941 AND 1.568 m3/s
PEAK HEIGHT IN BASIN IS .791 m, AND TIME OF PONDING IS 105.0 minutes

DETENTION BASIN
F_ 4 .00 .00 .00 .00 0 .000 15-15 .000 .000 0 .000 1.941 1.568

CIRCULAR PIPE, UNRESTRICTED, NO-OVERFLOW INLET UPGRADING
A_ 7 .00 .00 .10 .10 0 .000 0 -6 .052 .509 54 .05212.53312.529
350 .50 .00 .00 .00 2134 .012 2134 .012 513.863 3.9 0 0 0 .000

OUTFALL HYDROGRAPH (m3/s)
****
(585 VALUES AT 1.0 minute INTERVALS)

.000	.000	.017	.005	.014	.050	.115	.200	.309	.452
.623	.809	1.010	1.256	1.533	1.852	2.237	2.702	3.196	3.650
4.060	4.465	4.887	5.319	5.760	6.199	6.602	6.994	7.509	8.291
9.255	10.259	11.219	11.947	12.349	12.490	12.526	12.529	12.489	12.389
12.245	12.059	11.728	11.339	11.018	10.769	10.562	10.387	10.243	10.090
9.907	9.703	9.495	9.284	9.043	8.722	8.357	7.997	7.670	7.414
7.239	7.118	7.018	6.913	6.789	6.653	6.514	6.376	6.244	6.124
6.016	5.923	5.807	5.716	5.663	5.629	5.601	5.573	5.532	5.466
5.377	5.279	5.177	5.075	4.977	4.884	4.796	4.710	4.631	4.566
4.513	4.465	4.417	4.350	4.251	4.127	4.000	3.884	3.776	3.674
3.578	3.490	3.411	3.347	3.297	3.254	3.215	3.177	3.140	3.104
3.070	3.037	3.006	2.977	2.951	2.928	2.908	2.888	2.868	2.849
2.830	2.812	2.794	2.778	2.762	2.746	2.732	2.718	2.704	2.691
2.679	2.667	2.655	2.644	2.633	2.623	2.613	2.604	2.594	2.585
2.577	2.568	2.560	2.552	2.545	2.537	2.530	2.523	2.516	2.509
2.503	2.496	2.490	2.484	2.478	2.472	2.466	2.460	2.455	2.449
2.444	2.439	2.433	2.428	2.423	2.418	2.413	2.408	2.403	2.399
2.394	2.389	2.385	2.380	2.376	2.371	2.367	2.362	2.358	2.354
2.349	2.345	2.341	2.336	2.332	2.328	2.324	2.320	2.316	2.312
2.308	2.304	2.299	2.295	2.291	2.287	2.284	2.280	2.276	2.272
2.268	2.264	2.260	2.256	2.252	2.249	2.245	2.241	2.237	2.233
2.230	2.226	2.222	2.218	2.214	2.211	2.207	2.203	2.200	2.196
2.192	2.189	2.185	2.181	2.177	2.173	2.170	2.166	2.163	2.159
2.155	2.152	2.148	2.145	2.141	2.138	2.134	2.130	2.127	2.123
2.120	2.116	2.113	2.109	2.106	2.102	2.099	2.095	2.092	2.088
2.085	2.081	2.078	2.074	2.071	2.068	2.064	2.061	2.057	2.054
2.050	2.047	2.044	2.040	2.037	2.033	2.030	2.027	2.023	2.020
2.016	2.013	2.010	2.006	2.003	2.000	1.996	1.993	1.990	1.986
1.983	1.980	1.977	1.973	1.970	1.967	1.963	1.960	1.957	1.954
1.950	1.947	1.944	1.941	1.937	1.934	1.931	1.928	1.925	1.921
1.918	1.915	1.912	1.909	1.905	1.902	1.900	1.897	1.895	1.892
1.890	1.888	1.885	1.883	1.881	1.878	1.876	1.874	1.872	1.869
1.867	1.865	1.862	1.860	1.858	1.856	1.853	1.851	1.849	1.846
1.844	1.842	1.840	1.837	1.835	1.833	1.831	1.828	1.826	1.824
1.822	1.819	1.817	1.815	1.813	1.810	1.808	1.806	1.804	1.802
1.799	1.797	1.795	1.793	1.791	1.788	1.786	1.784	1.782	1.780
1.777	1.775	1.773	1.771	1.769	1.767	1.764	1.762	1.760	1.758
1.756	1.754	1.751	1.749	1.747	1.745	1.743	1.741	1.739	1.736
1.734	1.732	1.730	1.728	1.726	1.724	1.721	1.719	1.717	1.715
1.713	1.711	1.709	1.707	1.705	1.703	1.700	1.698	1.696	1.694
1.692	1.690	1.688	1.686	1.684	1.682	1.680	1.678	1.676	1.674
1.671	1.669	1.667	1.665	1.663	1.661	1.659	1.657	1.655	1.653
1.651	1.649	1.647	1.645	1.643	1.641	1.639	1.637	1.635	1.633
1.631	1.629	1.627	1.625	1.623	1.621	1.619	1.617	1.615	1.613
1.611	1.609	1.607	1.605	1.603	1.599	1.593	1.583	1.572	1.561
1.550	1.539	1.528	1.517	1.507	1.496	1.485	1.475	1.464	1.454
1.444	1.433	1.423	1.413	1.403	1.393	1.383	1.373	1.364	1.354

1.344	1.335	1.325	1.316	1.307	1.297	1.288	1.279	1.270	1.261
1.252	1.243	1.234	1.225	1.217	1.208	1.200	1.191	1.183	1.174
1.166	1.158	1.149	1.141	1.133	1.125	1.117	1.109	1.101	1.093
1.086	1.078	1.070	1.063	1.055	1.048	1.040	1.033	1.026	1.018
1.011	1.004	.997	.990	.983	.976	.969	.962	.955	.947
.939	.931	.923	.915	.907	.899	.892	.884	.876	.868
.861	.853	.846	.839	.831	.824	.817	.805	.774	.709
.621	.531	.451	.383	.326	.277	.235	.200	.170	.144
.122	.104	.088	.075	.064	.054	.046	.039	.033	.028
.024	.020	.017	.015	.012	.011	.009	.008	.007	.006
.005	.004	.003	.003	.002	.002	.002	.001	.001	.001
.001	.001	.001	.001	.000					

TOTAL AREA = 128.06 ha (36.86 ha PAVED, .00 ha SUPPLEMENTARY
91.20 ha GRASSED AND .00 ha UNDRAINED)
ACCUMULATED RUNOFF = 86960 m3
INCLUDING BASEFLOW = 0 m3
& USER HYDROGRAPHS = 0 m3
VOLUME DIVERTED OUT = 0 m3
OVERFLOWS IN TRANSIT = 0 m3 (NET)
RUNOFF COEFFICIENTS = .644 (VOLUMETRIC) BASED ONLY ON RAINFALL INPUTS
.501 (PEAK/AVERAGE) AND .143 (PEAK/PEAK)
INCL. USER-PROVIDED HYDROGRAPHS, BUT NOT BASEFLOWS
NO. OF PIPES = 16
PEAK FLOWRATE = 12.529 m3/s 38.0 minutes AFTER START OF STORM
TOTAL BASEFLOW = .000 m3/s
GRASSED RUNOFF = 55.7 %

RERUN WITH NEW RAINFALL PATTERN NO. 6
****

120 MINUTE, 100 YEAR DESIGN STORM - MACLEAN
(ANTECEDENT MOISTURE CONDITION = 2.50)

CATCHMENT PARAMETERS
****

INFILTRATION
DEPRESSION STORAGE (mm) SOIL TYPE AMC PARAMETERS
PAVED AREA GRASSED 1234=ABCD FI = 47.0 mm
5=NEW F0 = 162.5 mm/h
FC = 9.5 mm/h
1.0 6.0 2.50 2.50 K = 2.0 /h
FID = 43.1 mm
INITIAL RATE = 76.4 mm/h

RAINFALL PARAMETERS AND DATA
****

DURATION (minutes)	TIME INCREMENT (minutes)	NUMBER OF RAINFALL INCREMENTS	TOTAL RAINFALL (mm)
120.0	2.0	24	116.9

STANDARD AUSTRALIAN RAINFALL PATTERN FOR ZONE 1
WITH AVERAGE INTENSITY 58.43 mm/h (MULTIPLIER = 1.000)

33.7	33.7	53.3	72.9	72.9	46.3	46.3	57.5	68.7	68.7
127.6	127.6	100.3	72.9	72.9	234.2	234.2	200.5	166.9	166.9
74.3	74.3	60.3	46.3	46.3	47.7	47.7	54.0	60.3	60.3
60.3	60.3	47.0	33.7	33.7	33.7	33.7	40.7	47.7	47.7
33.7	33.7	25.2	16.8	16.8	16.8	16.8	25.9	35.1	35.1
16.8	16.8	17.5	18.2	18.2	18.2	18.2	18.9	19.6	19.6

COMPUTATIONAL TIME STEP = 2.0 minutes

PIPE SYSTEM DETAILS
****

BCH RCH AREAS (ha) PAVED GRASSED C VOL SURFACE PIT PIPE
PAV SUP GRAS TOTAL TIME Q TIME Q Q Q Q

LEN SLOPE ORIGINAL DESIGNED CAP VEL VOLUMES OFLOW
H B SS NO DIA nORk NO DIA nORk PAT Q BYP UPW OFL Q

DETENTION BASIN ROUTING

HEIGHT-STORAGE-OUTFLOW RELATIONSHIP

HEIGHT (m) STORAGE (m3) OUTFLOW (m3/s)

HEIGHT (m)	STORAGE (m3)	OUTFLOW (m3/s)
-.500	.0	.000
.000	295.0	.800
.250	1324.0	.950
.500	6799.0	1.600
.750	21445.0	1.900
1.000	46660.0	2.600
1.250	79039.0	2.800
1.300	85993.0	3.400
1.700	1442083.0	5.000
1.750	1500000.0	30.000

STARTING STORAGE IS 0. m3

VOLUMES OF INFLOW AND OUTFLOW HYDROGRAPHS ARE 66803. AND 66803. m3
AND RESPECTIVE PEAKS ARE 24.682 AND 2.630 m3/s
PEAK HEIGHT IN BASIN IS 1.037 m, AND TIME OF PONDING IS 630.0 minutes

DETENTION BASIN
A_ 125.03 .0064.37 89.40 30 8.577 0-2516.145 .6396680324.68224.682 2.630

CIRCULAR PIPE, UNRESTRICTED, NO-OVERFLOW INLET UPGRADING
B_ 1 2.38 .0012.52 14.90 20 .996 0-25 3.139 .58110112 4.030 4.030 4.022
70 .50 .00 .00 .00 1372 .012 1372 .012 4 4.269 2.9 0 0 0 .000

CIRCULAR PIPE, UNRESTRICTED, NO-OVERFLOW INLET UPGRADING
A_ 2 .00 .00 .60 .60 0 .000 0-12 .245 .507 355 .245 6.059 6.055
60 .50 .00 .00 .00 2134 .012 2134 .012 413.863 3.9 0 0 0 .000

CIRCULAR PIPE, UNRESTRICTED, NO-OVERFLOW INLET UPGRADING
A_ 3 .00 .00 1.10 1.10 0 .000 0-10 .512 .507 652 .512 6.267 6.266
80 .50 .00 .00 .00 2134 .012 2134 .012 413.863 3.9 0 0 0 .000

CIRCULAR PIPE, UNRESTRICTED, NO-OVERFLOW INLET UPGRADING
C_ 1 2.85 .00 3.45 6.30 15 1.266 0-15 1.210 .725 5341 2.464 2.464 2.463
30 .50 .00 .00 .00 1143 .012 1143 .012 4 2.623 2.6 0 0 0 .000

CIRCULAR PIPE, UNRESTRICTED, NO-OVERFLOW INLET UPGRADING
D_ 1 1.61 .00 1.19 2.80 15 .715 0-15 .417 .785 2568 1.126 1.126 1.125
50 .50 .00 .00 .00 914 .012 914 .012 1 1.445 2.2 0 0 0 .000

CIRCULAR PIPE, UNRESTRICTED, NO-OVERFLOW INLET UPGRADING
E_ 1 2.24 .00 1.44 3.68 15 .997 0-15 .503 .802 3449 1.493 1.493 1.490
50 .50 .00 .00 .00 991 .012 991 .012 1 1.793 2.3 0 0 0 .000

DETENTION BASIN ROUTING

HEIGHT-STORAGE-OUTFLOW RELATIONSHIP

HEIGHT (m)	STORAGE (m3)	OUTFLOW (m3/s)
.000	.0	.000
.300	1000.0	1.000
.500	1701.0	1.540
.700	2474.0	3.000
.900	3321.0	3.300
1.100	4256.0	3.500
1.300	5250.0	4.000
1.500	6400.0	10.000

STARTING STORAGE IS 0. m3

VOLUMES OF INFLOW AND OUTFLOW HYDROGRAPHS ARE 11418. AND 11417. m3
AND RESPECTIVE PEAKS ARE 5.106 AND 3.260 m3/s
PEAK HEIGHT IN BASIN IS .873 m, AND TIME OF PONDING IS 250.0 minutes

DETENTION BASIN
D_ 2 .00 .00 .10 .10 0 .000 0-10 .047 .507 59 .047 5.106 3.260

CIRCULAR PIPE, UNRESTRICTED, NO-OVERFLOW INLET UPGRADING
A_ 4 .35 .00 2.85 3.20 2 .225 0-10 1.328 .560 2093 1.488 7.462 7.392
130 .50 .00 .00 .00 2134 .012 2134 .012 613.863 3.9 0 0 0 .000

CIRCULAR PIPE, UNRESTRICTED, NO-OVERFLOW INLET UPGRADING
A_ 5 .00 .00 1.01 1.01 0 .000 0-15 .354 .506 597 .35410.78310.737
200 .50 .00 .00 .00 2134 .012 2134 .012 613.863 3.9 0 0 0 .000

CIRCULAR PIPE, UNRESTRICTED, NO-OVERFLOW INLET UPGRADING
A_ 6 .00 .00 .70 .70 0 .000 0-15 .246 .506 414 .24610.98210.969
50 .50 .00 .00 .00 2134 .012 2134 .012 613.863 3.9 0 0 0 .000

CIRCULAR PIPE, UNRESTRICTED, NO-OVERFLOW INLET UPGRADING
F_ 1 .39 .00 .30 .69 10 .219 0-10 .138 .783 632 .357 .357 .338
110 .50 .00 .00 .00 610 .012 610 .012 1 .492 1.7 0 0 0 .000

CIRCULAR PIPE, UNRESTRICTED, NO-OVERFLOW INLET UPGRADING
F_ 2 .92 .00 .68 1.60 6 .570 0-10 .316 .786 1469 .809 1.110 1.104
90 .50 .00 .00 .00 914 .012 914 .012 2 1.445 2.2 0 0 0 .000

CIRCULAR PIPE, UNRESTRICTED, NO-OVERFLOW INLET UPGRADING
F_ 3 1.08 .00 .80 1.88 10 .602 0-15 .280 .785 1725 .879 1.983 1.929
175 .50 .00 .00 .00 1067 .012 1067 .012 1 2.183 2.4 0 0 0 .000

DETENTION BASIN ROUTING

HEIGHT-STORAGE-OUTFLOW RELATIONSHIP

HEIGHT (m)	STORAGE (m3)	OUTFLOW (m3/s)
.000	.0	.000
.100	20.0	.400
.300	62.0	.500
.500	161.0	.770
.700	290.0	1.500
.900	454.0	1.650
1.100	653.0	1.750
1.300	890.0	2.000

WARNING - TIME STEP 120. seconds IS MORE THAN TWICE THE MINIMUM RATIO OF
STORAGE DIFFERENCE vs OUTFLOW DIFFERENCE IN THE HEIGHT-STORAGE-OUTFLOW TABLE
- 50. seconds.
THIS MAY CAUSE INSTABILITIES IN BASIN CALCULATIONS.
YOU NEED TO CHECK RESULTS, AND POSSIBLY USE A SHORTER TIME STEP,
OR TO MODIFY THE TABLE.

STARTING STORAGE IS 2. m3

VOLUMES OF INFLOW AND OUTFLOW HYDROGRAPHS ARE 3825. AND 3829. m3
AND RESPECTIVE PEAKS ARE 1.929 AND 1.585 m3/s
PEAK HEIGHT IN BASIN IS .814 m, AND TIME OF PONDING IS 138.0 minutes

DETENTION BASIN
F_ 4 .00 .00 .00 .00 0 .000 15-15 .000 .000 0 .000 1.929 1.585

CIRCULAR PIPE, UNRESTRICTED, NO-OVERFLOW INLET UPGRADING
A_ 7 .00 .00 .10 .10 0 .000 0 -6 .052 .509 59 .05212.57612.527
350 .50 .00 .00 .00 2134 .012 2134 .012 613.863 3.9 0 0 0 .000

OUTFALL HYDROGRAPH (m3/s)
****
(317 VALUES AT 2.0 minute INTERVALS)

.000	.024	.018	.091	.254	.519	.855	1.200	1.495	1.715
1.888	2.066	2.310	2.675	3.151	3.644	4.265	5.357	6.909	8.681
10.404	11.764	12.434	12.527	12.334	11.979	11.443	10.850	10.393	10.024
9.629	9.163	8.632	8.142	7.736	7.388	7.085	6.817	6.583	6.406
6.305	6.262	6.220	6.138	5.983	5.749	5.484	5.233	5.028	4.901
4.867	4.876	4.842	4.745	4.613	4.474	4.348	4.255	4.197	4.162
4.139	4.095	3.975	3.785	3.584	3.417	3.285	3.184	3.106	3.043
2.986	2.934	2.890	2.855	2.825	2.800	2.777	2.756	2.738	2.721
2.706	2.693	2.679	2.665	2.649	2.634	2.619	2.605	2.591	2.578
2.566	2.554	2.542	2.531	2.521	2.510	2.500	2.490	2.480	2.471
2.461	2.452	2.443	2.434	2.425	2.417	2.408	2.400	2.391	2.383
2.375	2.366	2.358	2.350	2.342	2.334	2.326	2.318	2.310	2.303
2.295	2.287	2.279	2.272	2.264	2.257	2.249	2.241	2.234	2.226
2.219	2.211	2.204	2.197	2.190	2.182	2.175	2.168	2.161	2.153
2.146	2.139	2.132	2.125	2.118	2.111	2.104	2.097	2.090	2.083
2.076	2.069	2.062	2.055	2.048	2.042	2.035	2.028	2.021	2.015
2.008	2.001	1.995	1.988	1.981	1.975	1.968	1.962	1.955	1.949
1.942	1.936	1.929	1.923	1.916	1.910	1.904	1.898	1.893	1.889
1.884	1.879	1.875	1.870	1.866	1.861	1.856	1.852	1.847	1.843
1.838	1.834	1.829	1.825	1.820	1.816	1.811	1.807	1.803	1.798
1.794	1.789	1.785	1.780	1.776	1.772	1.767	1.763	1.759	1.754
1.750	1.746	1.742	1.737	1.733	1.729	1.725	1.720	1.716	1.712
1.708	1.703	1.699	1.695	1.691	1.687	1.683	1.678	1.674	1.670
1.666	1.662	1.658	1.654	1.650	1.646	1.642	1.638	1.634	1.630
1.626	1.622	1.618	1.614	1.610	1.605	1.598	1.585	1.565	1.544
1.522	1.500	1.479	1.458	1.438	1.417	1.397	1.378	1.358	1.339
1.320	1.301	1.283	1.265	1.247	1.229	1.212	1.195	1.178	1.161
1.145	1.128	1.112	1.097	1.081	1.066	1.051	1.036	1.021	1.007
.993	.979	.965	.950	.935	.919	.903	.887	.872	.857

```
 .842   .827   .796   .708   .568   .424   .308   .222   .160   .115
 .083   .060   .043   .031   .022   .016   .012   .008   .006   .004
 .003   .002   .002   .001   .001   .001   .000

TOTAL AREA =          128.06 ha ( 36.86 ha PAVED,   .00 ha SUPPLEMENTARY
                       91.20 ha GRASSED AND   .00 ha UNDRAINED )
ACCUMULATED RUNOFF =    96330 m3
 INCLUDING BASEFLOW =       0 m3
 & USER HYDROGRAPHS =       0 m3
VOLUME DIVERTED OUT =       0 m3
OVERFLOWS IN TRANSIT =      0 m3 (NET)
RUNOFF COEFFICIENTS =    .644 (VOLUMETRIC) BASED ONLY ON RAINFALL INPUTS
                  .603 (PEAK/AVERAGE) AND  .150 (PEAK/PEAK)
                  INCL. USER-PROVIDED HYDROGRAPHS, BUT NOT BASEFLOWS
NO. OF PIPES =          16
PEAK FLOWRATE =       12.527 m3/s   48.0 minutes AFTER START OF STORM
TOTAL BASEFLOW =        .000 m3/s
GRASSED RUNOFF =        55.7 %


RERUN WITH NEW RAINFALL PATTERN NO.  7
*************************************

180 MINUTE, 100 YEAR DESIGN STORM - MACLEAN
(ANTECEDENT MOISTURE CONDITION = 2.50)



CATCHMENT PARAMETERS
********************
                                          INFILTRATION
      DEPRESSION STORAGE (mm)   SOIL TYPE     AMC       PARAMETERS
       PAVED AREA   GRASSED     1234=ABCD            FI =   47.0 mm
                               5=NEW            F0 =  162.5 mm/h
                                          FC =    9.5 mm/h
         1.0        6.0        2.50       2.50    K =    2.0 /h
                                          FID =   43.1 mm
                                   INITIAL RATE =   76.4 mm/h
RAINFALL PARAMETERS AND DATA
****************************

   DURATION      TIME INCREMENT      NUMBER OF      TOTAL RAINFALL
   (minutes)       (minutes)    RAINFALL INCREMENTS      (mm)

    180.0            2.0            12            134.7

STANDARD AUSTRALIAN RAINFALL PATTERN FOR ZONE  1
WITH AVERAGE INTENSITY   44.89 mm/h                ( MULTIPLIER =  1.000 )

  30.7   30.7   30.7   30.7   30.7   30.7   30.7   60.6   90.5   90.5
  90.5   90.5   90.5   90.5   90.5  126.1  126.1  126.1  126.1  126.1
 126.1  126.1   86.5   46.9   46.9   46.9   46.9   46.9   46.9   46.9
  63.6   63.6   63.6   63.6   63.6   63.6   63.6   52.8   42.0   42.0
  42.0   42.0   42.0   42.0   42.0   31.2   31.2   31.2   31.2   31.2
  31.2   31.2   33.7   36.1   36.1   36.1   36.1   36.1   36.1   36.1
  25.9   25.9   25.9   25.9   25.9   25.9   25.9   23.2   20.5   20.5
  20.5   20.5   20.5   20.5   20.5   15.1   15.1   15.1   15.1   15.1
  15.1   15.1   12.7   10.2   10.2   10.2   10.2   10.2   10.2   10.2


COMPUTATIONAL TIME STEP =  2.0 minutes



                  PIPE SYSTEM DETAILS
                  *******************

BCH RCH      AREAS (ha)     PAVED    GRASSED    C    VOL SURFACE PIT  PIPE
      PAV  SUP GRAS TOTAL TIME  Q   TIME    Q              Q     Q     Q

LEN SLOPE        ORIGINAL         DESIGNED      CAP  VEL    VOLUMES  OFLOW
      H    B    SS  NO DIA nORk NO DIA nORk PAT  Q       BYP UPW OFL  Q

DETENTION BASIN ROUTING

    HEIGHT-STORAGE-OUTFLOW RELATIONSHIP
HEIGHT (m)     STORAGE (m3)    OUTFLOW (m3/s)

  -.500          .0          .000
   .000        295.0          .800
   .250       1324.0          .950
   .500       6799.0         1.600
```

```
   .750       21445.0        1.900
  1.000       46660.0        2.600
  1.250       79039.0        2.800
  1.300       85993.0        3.400
  1.700     1442083.0        5.000
  1.750     1500000.0       30.000
```

STARTING STORAGE IS 0. m3

VOLUMES OF INFLOW AND OUTFLOW HYDROGRAPHS ARE 77168. AND 77168. m3
AND RESPECTIVE PEAKS ARE 18.910 AND 2.652 m3/s
PEAK HEIGHT IN BASIN IS 1.065 m, AND TIME OF PONDING IS 702.0 minutes

```
                                        DETENTION BASIN
 A_  125.03  .0064.37 89.40 30 7.428  0-2511.887  .6417716818.91018.910 2.652

CIRCULAR PIPE,       UNRESTRICTED, NO-OVERFLOW INLET              UPGRADING
 B_  1 2.38  .0012.52 14.90 20  .764  0-25 2.311  .58211685 3.015 3.015 3.012
 70  .50  .00  .00  .00   1372 .012   1372 .012  4 4.269 2.9   0   0   0  .000

CIRCULAR PIPE,       UNRESTRICTED, NO-OVERFLOW INLET              UPGRADING
 A_  2  .00  .00  .60   .60  0  .000  0-12  .153  .505  408  .153 4.919 4.913
 60  .50  .00  .00  .00   2134 .012   2134 .012  413.863 3.9   0   0   0  .000

CIRCULAR PIPE,       UNRESTRICTED, NO-OVERFLOW INLET              UPGRADING
 A_  3  .00  .00 1.10  1.10  0  .000  0-10  .283  .505  749  .283 5.088 5.088
 80  .50  .00  .00  .00   2134 .012   2134 .012  413.863 3.9   0   0   0  .000

CIRCULAR PIPE,       UNRESTRICTED, NO-OVERFLOW INLET              UPGRADING
 C_  1 2.85  .00 3.45  6.30 15  .979  0-15  .844  .726 6157 1.823 1.823 1.814
 30  .50  .00  .00  .00   1143 .012   1143 .012  4 2.623 2.6   0   0   0  .000

CIRCULAR PIPE,       UNRESTRICTED, NO-OVERFLOW INLET              UPGRADING
 D_  1 1.61  .00 1.19  2.80 15  .553  0-15  .291  .785 2962  .844  .844  .836
 50  .50  .00  .00  .00    914 .012    914 .012  1 1.445 2.2   0   0   0  .000

CIRCULAR PIPE,       UNRESTRICTED, NO-OVERFLOW INLET              UPGRADING
 E_  1 2.24  .00 1.44  3.68 15  .771  0-15  .351  .802 3977 1.122 1.122 1.113
 50  .50  .00  .00  .00    991 .012    991 .012  1 1.793 2.3   0   0   0  .000
```

DETENTION BASIN ROUTING

```
     HEIGHT-STORAGE-OUTFLOW RELATIONSHIP
HEIGHT (m)    STORAGE (m3)    OUTFLOW (m3/s)

   .000           .0           .000
   .300       1000.0          1.000
   .500       1701.0          1.540
   .700       2474.0          3.000
   .900       3321.0          3.300
  1.100       4256.0          3.500
  1.300       5250.0          4.000
  1.500       6400.0         10.000
```

STARTING STORAGE IS 0. m3

VOLUMES OF INFLOW AND OUTFLOW HYDROGRAPHS ARE 13164. AND 13163. m3
AND RESPECTIVE PEAKS ARE 3.789 AND 2.873 m3/s
PEAK HEIGHT IN BASIN IS .683 m, AND TIME OF PONDING IS 298.0 minutes

```
                                        DETENTION BASIN
 D_  2  .00  .00  .10   .10  0  .000  0-10  .026  .505   68  .026 3.789 2.873

CIRCULAR PIPE,       UNRESTRICTED, NO-OVERFLOW INLET              UPGRADING
 A_  4  .35  .00 2.85  3.20  2  .121  0-10  .735  .558 2404  .856 5.768 5.725
130  .50  .00  .00  .00   2134 .012   2134 .012  613.863 3.9   0   0   0  .000

CIRCULAR PIPE,       UNRESTRICTED, NO-OVERFLOW INLET              UPGRADING
 A_  5  .00  .00 1.01  1.01  0  .000  0-15  .247  .505  687  .247 8.700 8.687
200  .50  .00  .00  .00   2134 .012   2134 .012  613.863 3.9   0   0   0  .000

CIRCULAR PIPE,       UNRESTRICTED, NO-OVERFLOW INLET              UPGRADING
 A_  6  .00  .00  .70   .70  0  .000  0-15  .171  .505  476  .171 8.821 8.816
 50  .50  .00  .00  .00   2134 .012   2134 .012  613.863 3.9   0   0   0  .000

CIRCULAR PIPE,       UNRESTRICTED, NO-OVERFLOW INLET              UPGRADING
 F_  1  .39  .00  .30   .69 10  .138  0-10  .076  .783  728  .214  .214  .213
110  .50  .00  .00  .00    610 .012    610 .012  1  .492 1.7   0   0   0  .000

CIRCULAR PIPE,       UNRESTRICTED, NO-OVERFLOW INLET              UPGRADING
```

F_ 2 .92 .00 .68 1.60 6 .322 0-10 .175 .785 1693 .497 .711 .709
90 .50 .00 .00 .00 914 .012 914 .012 2 1.445 2.2 0 0 0 .000

CIRCULAR PIPE, UNRESTRICTED, NO-OVERFLOW INLET UPGRADING
F_ 3 1.08 .00 .80 1.88 10 .379 0-15 .195 .785 1989 .574 1.283 1.271
175 .50 .00 .00 .00 1067 .012 1067 .012 1 2.183 2.4 0 0 0 .000

DETENTION BASIN ROUTING

HEIGHT-STORAGE-OUTFLOW RELATIONSHIP

HEIGHT (m)	STORAGE (m3)	OUTFLOW (m3/s)
.000	.0	.000
.100	20.0	.400
.300	62.0	.500
.500	161.0	.770
.700	290.0	1.500
.900	454.0	1.650
1.100	653.0	1.750
1.300	890.0	2.000

WARNING - TIME STEP 120. seconds IS MORE THAN TWICE THE MINIMUM RATIO OF
STORAGE DIFFERENCE vs OUTFLOW DIFFERENCE IN THE HEIGHT-STORAGE-OUTFLOW TABLE
- 50. seconds.
THIS MAY CAUSE INSTABILITIES IN BASIN CALCULATIONS.
YOU NEED TO CHECK RESULTS, AND POSSIBLY USE A SHORTER TIME STEP,
OR TO MODIFY THE TABLE.

STARTING STORAGE IS 2. m3

VOLUMES OF INFLOW AND OUTFLOW HYDROGRAPHS ARE 4409. AND 4413. m3
AND RESPECTIVE PEAKS ARE 1.271 AND 1.220 m3/s
PEAK HEIGHT IN BASIN IS .623 m, AND TIME OF PONDING IS 198.0 minutes

DETENTION BASIN
F_ 4 .00 .00 .00 .00 0 .000 15-15 .000 .000 0 .000 1.271 1.220

CIRCULAR PIPE, UNRESTRICTED, NO-OVERFLOW INLET UPGRADING
A_ 7 .00 .00 .10 .10 0 .000 0 -6 .026 .505 68 .026 9.979 9.975
350 .50 .00 .00 .00 2134 .012 2134 .012 613.863 3.9 0 0 0 .000

OUTFALL HYDROGRAPH (m3/s)
****
(353 VALUES AT 2.0 minute INTERVALS)

.000	.024	.011	.061	.164	.307	.474	.653	.845	1.085
1.392	1.707	1.959	2.161	2.411	2.775	3.283	3.962	4.775	5.654
6.564	7.489	8.394	9.204	9.762	9.975	9.893	9.605	9.184	8.721
8.270	7.837	7.480	7.219	7.039	6.928	6.886	6.914	7.000	7.089
7.123	7.097	7.028	6.931	6.820	6.705	6.586	6.453	6.309	6.159
5.996	5.819	5.691	5.613	5.564	5.540	5.531	5.531	5.536	5.546
5.561	5.572	5.551	5.494	5.419	5.338	5.257	5.185	5.119	5.047
4.958	4.855	4.749	4.648	4.559	4.488	4.428	4.359	4.276	4.186
4.098	4.015	3.945	3.885	3.824	3.752	3.670	3.586	3.505	3.432
3.372	3.316	3.247	3.164	3.086	3.024	2.975	2.935	2.899	2.866
2.834	2.805	2.780	2.760	2.743	2.728	2.714	2.702	2.691	2.681
2.672	2.664	2.657	2.650	2.643	2.637	2.632	2.627	2.621	2.614
2.604	2.594	2.584	2.574	2.564	2.554	2.545	2.535	2.526	2.517
2.508	2.499	2.490	2.482	2.473	2.464	2.456	2.447	2.439	2.431
2.423	2.414	2.406	2.398	2.390	2.382	2.374	2.366	2.358	2.350
2.342	2.334	2.326	2.318	2.311	2.303	2.295	2.288	2.280	2.273
2.265	2.257	2.250	2.242	2.235	2.228	2.220	2.213	2.205	2.198
2.191	2.183	2.176	2.169	2.162	2.155	2.147	2.140	2.133	2.126
2.119	2.112	2.105	2.098	2.091	2.084	2.077	2.070	2.063	2.056
2.050	2.043	2.036	2.029	2.022	2.016	2.009	2.002	1.996	1.989
1.982	1.976	1.969	1.963	1.956	1.950	1.943	1.937	1.930	1.924
1.917	1.911	1.905	1.899	1.894	1.889	1.885	1.880	1.876	1.871
1.866	1.862	1.857	1.853	1.848	1.844	1.839	1.835	1.830	1.826
1.821	1.817	1.812	1.808	1.803	1.799	1.794	1.790	1.786	1.781
1.777	1.772	1.768	1.764	1.759	1.755	1.751	1.747	1.742	1.738
1.734	1.729	1.725	1.721	1.717	1.713	1.708	1.704	1.700	1.696
1.692	1.687	1.683	1.679	1.675	1.671	1.667	1.663	1.659	1.655
1.651	1.646	1.642	1.638	1.634	1.630	1.626	1.622	1.618	1.614
1.610	1.606	1.600	1.587	1.569	1.547	1.526	1.504	1.483	1.462
1.441	1.421	1.401	1.381	1.361	1.342	1.323	1.304	1.286	1.268
1.250	1.232	1.215	1.198	1.181	1.164	1.147	1.131	1.115	1.099
1.084	1.069	1.053	1.038	1.024	1.009	.995	.981	.967	.952
.937	.921	.905	.890	.874	.859	.844	.830	.802	.726
.593	.448	.326	.235	.169	.122	.088	.063	.046	.033
.024	.017	.012	.009	.006	.005	.003	.002	.002	.001

```
 .001   .001   .000

TOTAL AREA =          128.06 ha ( 36.86 ha PAVED,   .00 ha SUPPLEMENTARY
                       91.20 ha GRASSED AND   .00 ha UNDRAINED )
ACCUMULATED RUNOFF =   111220 m3
 INCLUDING BASEFLOW =      0 m3
 & USER HYDROGRAPHS =      0 m3
VOLUME DIVERTED OUT =      0 m3
OVERFLOWS IN TRANSIT =     0 m3 (NET)
RUNOFF COEFFICIENTS =    .645 (VOLUMETRIC) BASED ONLY ON RAINFALL INPUTS
                  .625 (PEAK/AVERAGE) AND  .222 (PEAK/PEAK)
                  INCL. USER-PROVIDED HYDROGRAPHS, BUT NOT BASEFLOWS
NO. OF PIPES =          16
PEAK FLOWRATE =        9.975 m3/s   52.0 minutes AFTER START OF STORM
TOTAL BASEFLOW =        .000 m3/s
GRASSED RUNOFF =        55.7 %

PIPE DATA FROM THE LAST DESIGNED OR UPGRADED PIPE SYSTEM HAS BEEN
STORED ON FILE  IOFILE7.DAT  -  RENAME THIS IF IT IS TO BE USED LATER

FLOWRATE DATA HAS BEEN STORED ON FILE  14007.INT


***  THE JOB IS FINISHED  ***        RUNNING TIME :    0 minutes 11.3 seconds
```

Appendix D – Ilsax Data Files

Rainfall File

```
3 2 7
20 MINUTE, 100 YEAR DESIGN STORM - MACLEAN
10 3 -1 0 0.012 0 375 0.012
1 06 2.5 2.5 1 0 0
1
5 20 5 1 1.0
1 100 158.98
0
30 MINUTE, 100 YEAR DESIGN STORM - MACLEAN
-1 0 2.5
1
5 30 5 1 1.0
1 100 130.62
0
45 MINUTE, 100 YEAR DESIGN STORM - MACLEAN
-1 0 2.5
1
5 45 5 1 1.0
1 100 105.96
0
60 MINUTE, 100 YEAR DESIGN STORM - MACLEAN
-1 0 2.5
1
5 60 5 1 1.0
1 100  90.77
0
90 MINUTE, 100 YEAR DESIGN STORM - MACLEAN
-1 0 2.5
1
5 90 5 1 1.0
1 100 70.31
0
120 MINUTE, 100 YEAR DESIGN STORM - MACLEAN
```

-1 0 2.5
1
5 120 5 2 1.0
1 100 58.43
0
180 MINUTE, 100 YEAR DESIGN STORM - MACLEAN
-1 0 2.5
1
5 180 5 2 1.0
1 100 44.89
0

Existing Situation

```
HOGUES LANE

A    1    -1   -1
 10   0    70.0   0.500     0.   0
9
-0.5  0  0
0.2  2291   .8
.4  3867  .95
.6  6708  1.6
.8  11430  1.9
1  18785  2.6
1.2 29486  2.8
1.4  43754  3.4
1.7  29300 10.0
0
89.4000   28.   30.0    0.   72.   25.0   0.0

B    1    -1   -1
 0   0    70.0   0.500     0.   0
014.9000   16.   20.0    0.   84.   25.0   0.0

ADD B TO A

C    1    -1   -1
 0   0    30.0   0.500     0.   0
  6.3000   15.   15.0    0.   85.   15.0   0.0

ADD C TO A

A    2    -1   -1
 0   0    60.0   0.500     0.   0
  0.6000    0.    6.0    0.  100.   12.0   0.0

D    1    -1   -1
 0   0    50.0   0.500     0.   0
  2.8000   10.   15.0    0.   90.   15.0   0.0

ADD D TO A

A    3    -1   -1
 0   0    80.0   0.500     0.   0
  1.1000    0.    6.0    0.  100.   10.0   0.0

A    4    -1   -1
 0   0   130.0   0.500     0.   0
  3.2000    0.    6.0    0.  100.   10.0   0.0

E    1    -1   -1
 0   0    50.0   0.500     0.   0
  3.6800   20.   15.0    0.   80.   15.0   0.0

ADD E TO A

A    5    -1   -1
 0   0   200.0   0.500     0.   0
  1.0100    0.    6.0    0.  100.   15.0   0.0

A    6    -1   -1
 0   0    50.0   0.500     0.   0
  0.7000    0.    6.0    0.  100.   15.0   0.0

F    1    -1   -1
 0   0   110.0   0.500     0.   0
  0.6900   50.   10.0    0.   50.   10.0   0.0

F    2    -1   -1
 0   0    90.0   0.500     0.   0
  1.6000   50.    6.0    0.   50.   10.0   0.0
```

```
F   3   -1  -1
 0  0  175.0  0.500    0.  0
  1.8800  50.  10.0   0.  50.  15.0  0.0

F   4   -1  -1
 0  0   30.0  0.500    0.  0
  2.7500  0.  10.0   0.  100.  15.0  0.0

ADD F TO A

A   7   -1  -1
 0  0  350.0  0.500    0.  0
  0.1000  0.   6.0   0.  100.   6.0  0.0

END
```

Proposed Development – No Basins

```
HOGUES LANE - Developed with NO Basins

A   1   -1  -1
 10  0   70.0  0.500    0.  0
10
-0.5  0  0
0.0  295  .8
.25  1324  .95
.50  6799  1.6
.75  21445  1.9
1  46660  2.6
1.25 79039  2.8
1.3  85993  3.4
1.7  1442083 5.0
1.75 1500000 30.0
0
89.4000  28.  30.0   0.  72.  25.0  0.0

B   1   -1  -1
 0  0   70.0  0.500    0.  0
014.9000  16.  20.0   0.  84.  25.0  0.0

ADD B TO A

C   1   -1  -1
 0  0   30.0  0.500    0.  0
  6.3000  45.25  15.0   0.  54.75  15.0  0.0

ADD C TO A

A   2   -1  -1
 0  0   60.0  0.500    0.  0
  0.6000  0.   6.0   0.  100.  12.0  0.0

D   1   -1  -1
 0  0   50.0  0.500    0.  0
  2.8000  57.5  15.0   0.  42.5  15.0  0.0

ADD D TO A

A   3   -1  -1
 0  0   80.0  0.500    0.  0
  1.1000  0.   6.0   0.  100.  10.0  0.0

A   4   -1  -1
 0  0  130.0  0.500    0.  0
  3.2000  0.   6.0   0.  100.  10.0  0.0

E   1   -1  -1
 0  0   50.0  0.500    0.  0
  3.6800  61.  15.0   0.  39.  15.0  0.0

ADD E TO A
```

```
A    5    -1   -1
 0   0   200.0   0.500     0.   0
  1.0100    0.    6.0    0.  100.   15.0   0.0

A    6    -1   -1
 0   0    50.0   0.500     0.   0
  0.7000    0.    6.0    0.  100.   15.0   0.0

F    1    -1   -1
 0   0   110.0   0.500     0.   0
  0.6900   57.5   10.0    0.   42.5   10.0   0.0

F    2    -1   -1
 0   0    90.0   0.500     0.   0
  1.6000   57.5    6.0    0.   42.5   10.0   0.0

F    3    -1   -1
 0   0   175.0   0.500     0.   0
  1.8800   57.5   10.0    0.   42.5   15.0   0.0

F    4    -1   -1
 0   0    30.0   0.500     0.   0
  2.7500   57.5   10.0    0.   42.5   15.0   0.0

ADD F TO A

A    7    -1   -1
 0   0   350.0   0.500     0.   0
  0.1000    0.    6.0    0.  100.    6.0   0.0

END
```

Proposed Development – Detention Basins

```
HOGUES LANE - Deveolped with Basins - Stage 1 Final
  A   1  1  0  1    .00
  4  1
 10  0   70.0   .500   .012  1  2134.   .000   .000      .000   .000 1.000    .0
  0    0
 10
      -.500        .000      .00000
       .000     295.000      .80000
       .250    1324.000      .95000
       .500    6799.000     1.60000
       .750   21445.000     1.90000
      1.000   46660.000     2.60000
      1.250   79039.000     2.80000
      1.300   85993.000     3.40000
      1.700 1442083.000     5.00000
      1.750 1500000.000    30.00000
       .000
 89.4000   .0000   28.00   .0000     .00  30.000      .0    .000
   .0000   72.00 25.0000      .0    .000     .00    2.50
  B   1  1  0  1    .00
  4  1
  0  0   70.0   .500   .012  1  1372.   .000   .000      .000   .000 1.000    .0
  0    0
 14.9000   .0000   16.00   .0000     .00  20.000      .0    .000
   .0000   84.00 25.0000      .0    .000     .00    2.50
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  4  1
  0  0   60.0   .500   .012  1  2134.   .000   .000      .000   .000 1.000    .0
  0    0
   .6000   .0000     .00   .0000     .00    .000      .0    .000
   .0000  100.00 12.0000      .0    .000     .00    2.50
  A   3  1  0  1    .00
  4  1
  0  0   80.0   .500   .012  1  2134.   .000   .000      .000   .000 1.000    .0
  0    0
```

```
 1.1000   .0000    .00   .0000    .00    .000     .0   .000
  .0000  100.00 10.0000     .0    .000     .00    2.50
 C   1  1  0  1    .00
 1  1
 0  0   30.0   .500   .012  1  1143.   .000   .000     .000   .000 1.000    .0
 0    0
 6.3000   .0000   45.25   .0000     .00  15.000     .0    .000
  .0000   54.75 15.0000     .0    .000     .00    2.50
 D   1  1  0  1    .00
 1  1
 0  0   50.0   .500   .012  1   838.   .000   .000     .000   .000 1.000    .0
 0    0
 2.8000   .0000   57.50   .0000     .00  15.000     .0    .000
  .0000   42.50 15.0000     .0    .000     .00    2.50
ADD   C TO   D
 E   1  1  0  1    .00
 1  1
 0  0   50.0   .500   .012  1   991.   .000   .000     .000   .000 1.000    .0
 0    0
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  .0000   39.00 15.0000     .0    .000     .00    2.50
ADD   E TO   D
 D   2  1  0  1    .00
 1  1
10  0   20.0   .500   .012  1   991.   .000   .000     .000   .000 1.000    .0
 0    0
 8
      .000        .000      .00000
      .300    1000.000     1.00000
      .500    1701.000     1.54000
      .700    2474.000     3.00000
      .900    3321.000     3.30000
     1.100    4256.000     3.50000
     1.300    5250.000     4.00000
     1.500    6400.000    10.00000
      .000
  .1000   .0000    .00   .0000    .00    .000     .0    .000
  .0000  100.00 10.0000     .0    .000     .00    2.50
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 0    0
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  .0000  89.20  10.0000     .0    .000     .00    2.50
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 0    0
 1.0100   .0000    .00   .0000    .00    .000     .0    .000
  .0000  100.00 15.0000     .0    .000     .00    2.50
 A   6  1  0  1    .00
 6  1
 0  0   50.0   .500   .012  1  2134.   .000   .000     .000   .000 1.000    .0
 0    0
  .7000   .0000    .00   .0000    .00    .000     .0    .000
  .0000  100.00 15.0000     .0    .000     .00    2.50
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  .0000   43.00 10.0000     .0    .000     .00    2.50
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 2  1
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 0    0
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  .0000   42.50 10.0000     .0    .000     .00    2.50
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```

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  .0000   42.50 15.0000     .0    .000     .00    2.50
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 1  1
10  0   30.0   .500   .012  1  1067.   .000   .000      .000   .000 1.000    .0
 0    0
 8
      .000        .000      .00000
      .100      20.000      .40000
      .300      62.000      .50000
      .500     161.000      .77000
      .700     290.000     1.50000
      .900     454.000     1.65000
     1.100     653.000     1.75000
     1.300     890.000     2.00000
     1.700
  .0000   .0000    2.75   .0000   10.00    .000      .0    .000
  .0000     .00   .0000      .0    .000   15.00     .00
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 6  1
 0  0  350.0   .500   .012  1  2134.   .000   .000      .000   .000 1.000    .0
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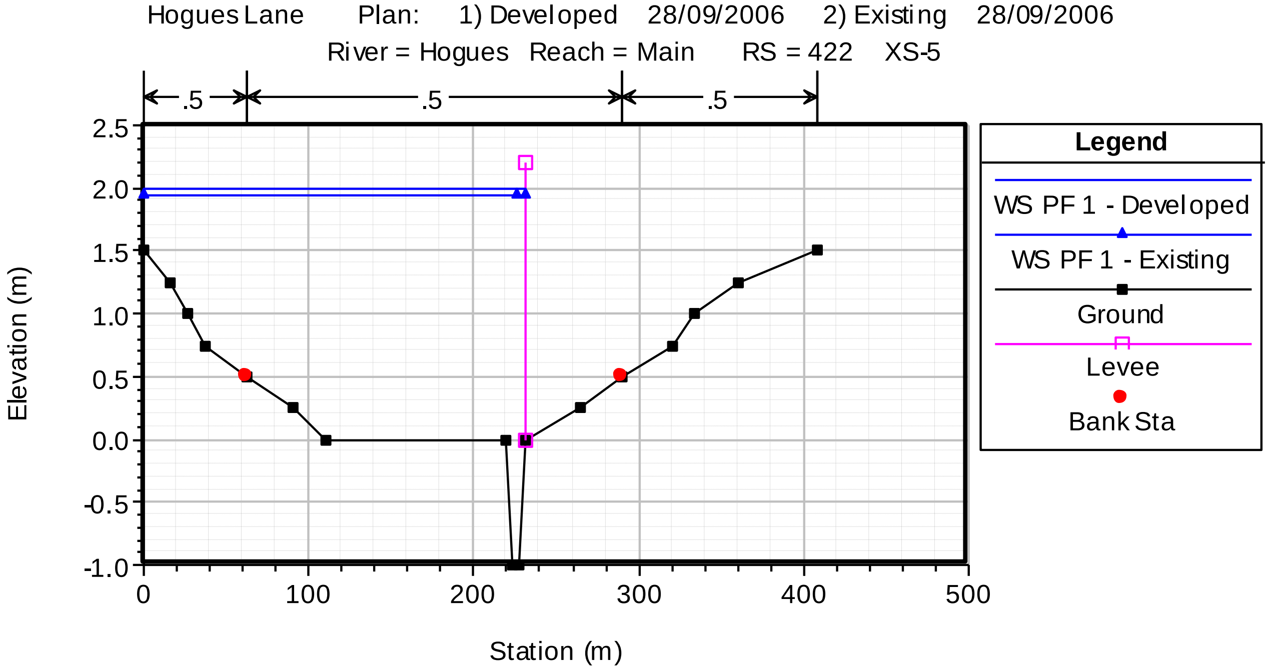
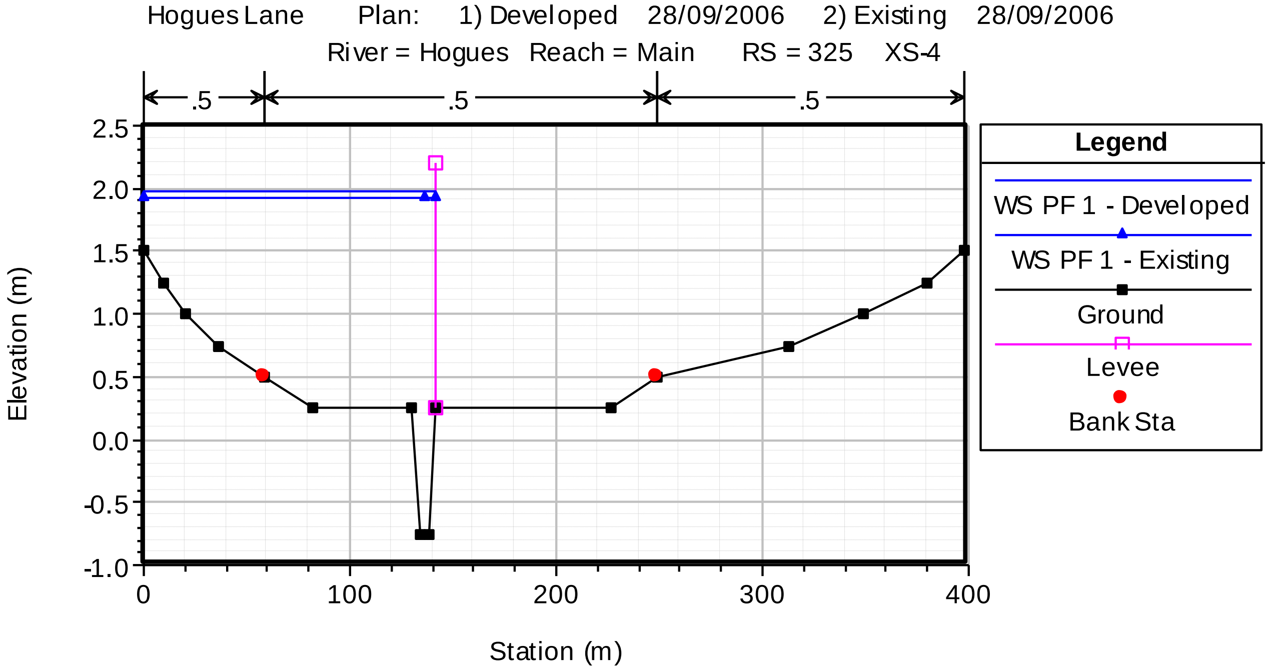
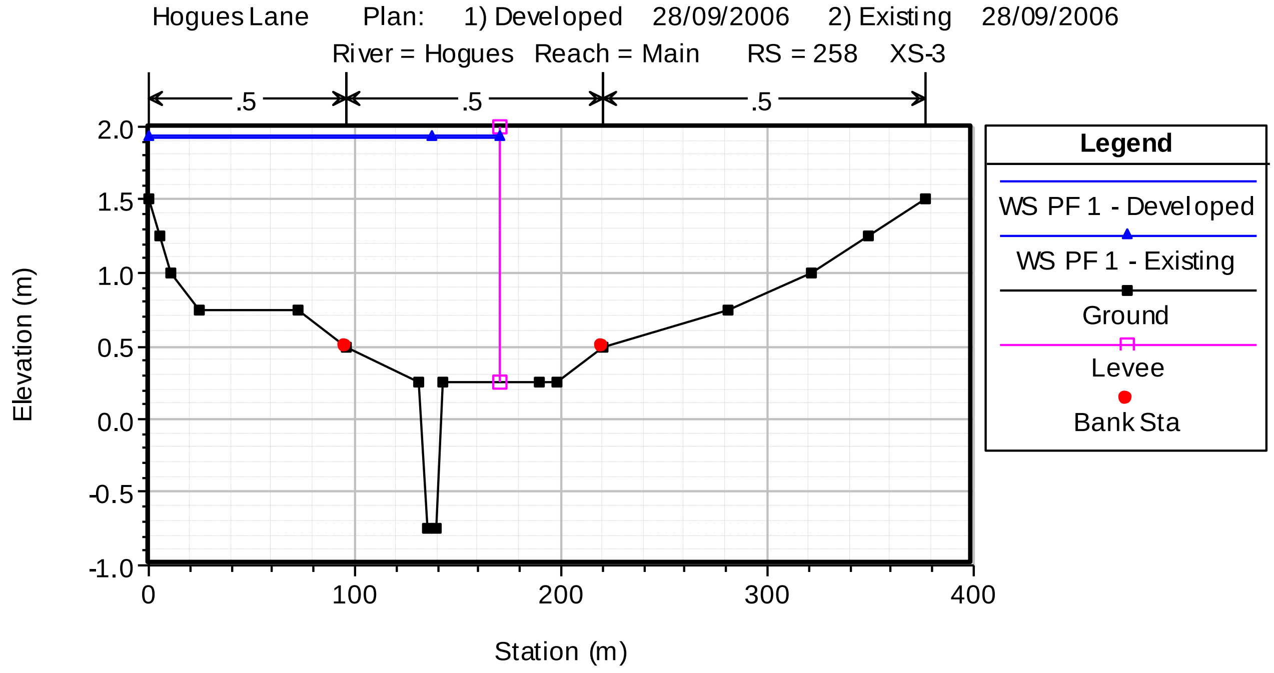
Appendix E – HEC RAS Cross Sections

Refer to Drawing 14007-14 for cross section locations






Hogues Lane Plan: 1) Developed 28/09/2006 2) Existing 28/09/2006
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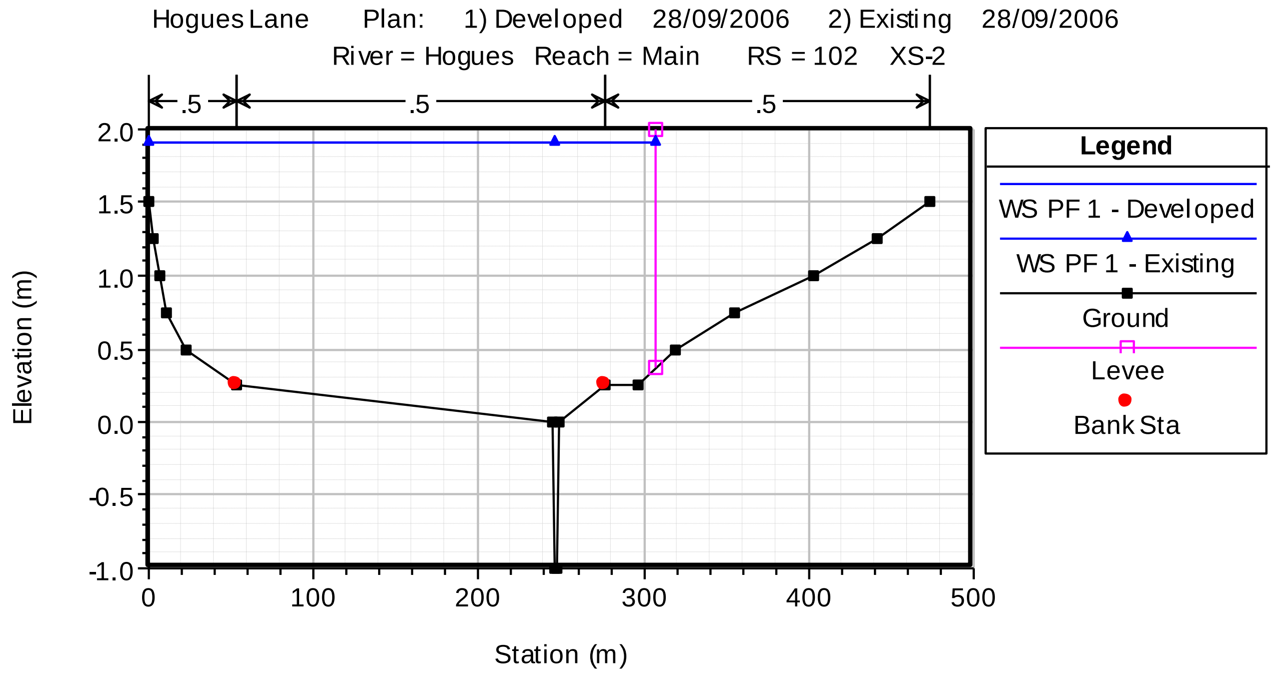
.5
.5
.5
Elevation (m)
Station (m)
Legend
WS PF 1 - Developed
WS PF 1 - Existing
Ground
Levee
Bank Sta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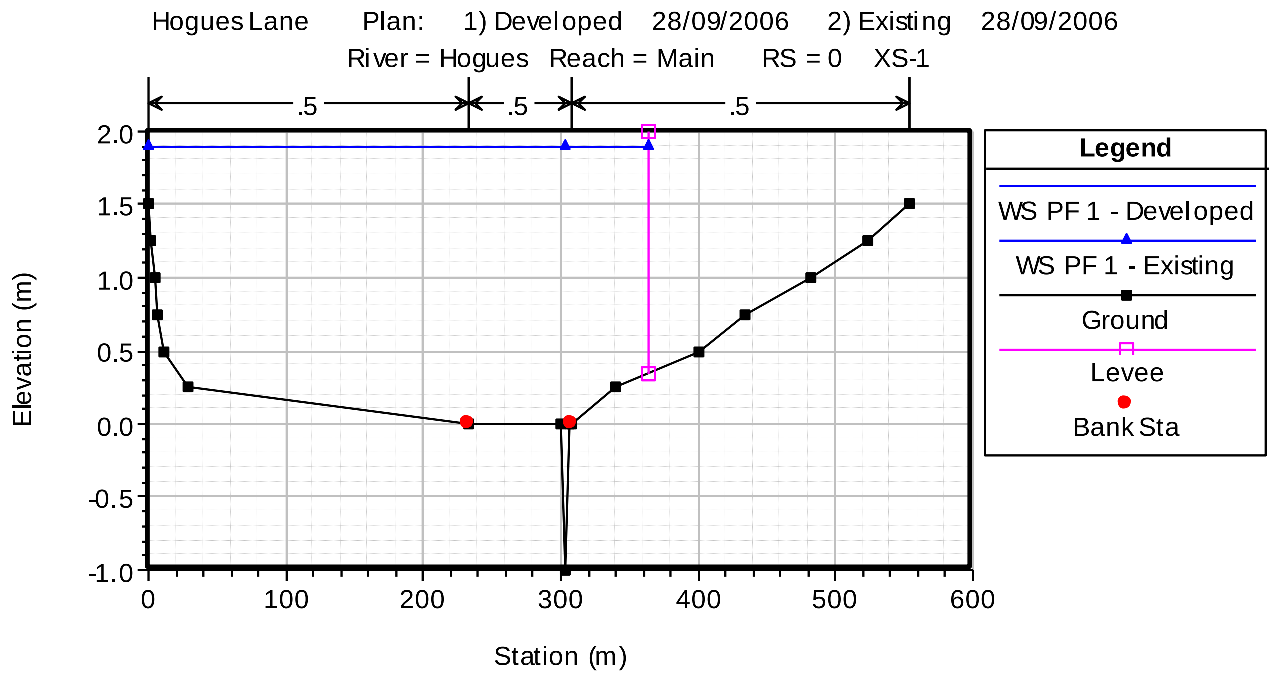
Elevation (m)
Station (m)
Legend
WS PF 1 - Developed
WS PF 1 - Existing
Ground
Levee
Bank Sta



Hogues Lane Plan: 1) Developed 28/09/2006 2) Existing 28/09/2006
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.5
.5
.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
Elevation (m)
0
100
200
300
400
500
600
Station (m)
Legend
WS PF 1 - Developed
WS PF 1 - Existing
Ground
Levee
Bank Sta

Appendix F – HEC RAS Additional Modelling

Refer to Section 5.2 for discussion of the results presented here. Refer to Drawing 14007-14 for cross section locations

Table 1 - HEC-RAS OUTPUT

Water Level in Clarence River (RL m AHD)	Headloss across Culverts in Essex Drain at River Street (m)	Water Level upstream of Culverts in Essex Drain at River Street (RL m AHD)	Starting Water Level at XS-1 CH 0.0 (downstream extent of development) (RL m AHD)	Existing Development Level D/S of Wherrit Park (RL m AHD)	Proposed Development Level D/S of Wherrit Park (RL m AHD)	Difference in flood level height at XS-5 CH 422 (near Wherrit Park) (m)	Difference "on the ground" on southern side near Wherrit Park (m)
0.39 *(Note 2)*	1.5 *(Note 4)*	1.90	2.00	2.03	2.05	0.02	3

Notes:
1. MLWS in Clarence River RL -0.18 m AHD
2. MHWS in Clarence River 0.39 m AHD
3. Assumes that culverts are freely discharging approximately 6 m³/s into Clarence River (based on calculations with CULVERT software)
4. Assumes that culverts are freely discharging approximately 13.5 m³/s into Clarence River (based on calculations with CULVERT software)

HEC-RAS River: Hogues Reach: Main Profile: PF 1											
River Sta	Plan	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
		(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
0	Existing	15.5	0	2	0.13	2	0.000039	0.02	887.69	554	0
0	Developed	15.5	-1	2	0.11	2	0.000057	0.02	678.97	364	0.01
102	Existing	15.5	0	2.01		2.01	0.000061	0.02	726.89	474	0.01
102	Developed	15.5	-1	2.01	0.17	2.01	0.000061	0.02	729.91	474	0.01
258	Existing	15.5	0.25	2.02		2.02	0.000154	0.04	504.05	377	0.01
258	Developed	15.5	-0.75	2.02	0.11	2.02	0.000148	0.03	512.35	377	0.01
325	Existing	12.5	0.25	2.03		2.03	0.000072	0.02	568.92	398	0.01
325	Developed	12.5	-0.75	2.04	0.02	2.04	0.000437	0.06	219.98	142	0.01
422	Existing	8.5	0	2.03		2.03	0.000025	0.02	609.17	396	0
422	Developed	8.5	-1	2.05	-0.38	2.05	0.000049	0.02	403.09	220	0

Table 2 - HEC-RAS OUTPUT

Water Level in Clarence River (RL m AHD)	Headloss across Culverts in Essex Drain at River Street (m)	Water Level upstream of Culverts in Essex Drain at River Street (RL m AHD)	Starting Water Level at XS-1 CH 0.0 (downstream extent of development) (RL m AHD)	Existing Development Level D/S of Wherrit Park (RL m AHD)	Proposed Development Level D/S of Wherrit Park (RL m AHD)	Difference in flood level height at XS-5 CH 422 (near Wherrit Park) (m)	Difference "on the ground" on southern side near Wherrit Park (m)
Scenario 1 – 50% discharge to River from Essex Drain and to rural land eastwards							
-0.18 *(Note 1)*	0.7 *(Note 3)*	0.52	0.82 *(normal depth)*	1.34	1.54	0.20	4

Notes:

1. MLWS in Clarence River RL -0.18 m AHD
2. MHWS in Clarence River 0.39 m AHD
3. Assumes that culverts are freely discharging approximately 6 m³/s into Clarence River (based on calculations with CULVERT software)
4. Assumes that culverts are freely discharging approximately 13.5 m³/s into Clarence River (based on calculations with CULVERT software)

HEC-RAS River: Hogues Reach: Main Profile: PF 1											
River Sta	Plan	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
		(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
0	Existing	15.5	0	0.82	0.13	0.82	0.001492	0.07	269.59	441.81	0.02
0	Developed	15.5	-1	0.82	0.11	0.82	0.001492	0.07	251.81	357.86	0.02
102	Existing	15.5	0	0.97		0.97	0.001402	0.07	257.15	390.79	0.02
102	Developed	15.5	-1	0.97	0.17	0.97	0.001437	0.07	236.53	300.54	0.02
258	Existing	15.5	0.25	1.24		1.24	0.002143	0.09	213.38	342.12	0.03
258	Developed	15.5	-0.75	1.32	0.11	1.32	0.003982	0.13	134.02	166.42	0.04
325	Existing	12.5	0.25	1.31		1.31	0.0006	0.05	285.77	376.72	0.02
325	Developed	12.5	-0.75	1.49	0.02	1.49	0.001678	0.1	143.23	141.79	0.03
422	Existing	8.5	0	1.34		1.34	0.000145	0.03	337.89	363.16	0.01
422	Developed	8.5	-1	1.54	-0.38	1.54	0.000139	0.03	290.35	220	0.01

Appendix G – Development Impervious Area Calculations

NORMAL DENSITY RESIDENTIAL AREAS

	AREA	IMPERVIOUS FRACTION	PERVIOUS FRACTION	IMPERVIOUS AREA	PERVIOUS AREA
D1	28212	0.57528	0.42471	16229.98	11982.01
D1 - LOTS	22681	0.58875	0.41124	13353.5	9327.49
D1 - ROAD	5531	0.52006	0.47993	2876.484	2654.51
E1	36839	0.61443	0.38556	22635.17	14203.82
E1 - LOTS	19003	0.58875	0.41124	11188.07	7814.928
E1 - ROAD	8876	0.52006	0.47993	4616.104	4259.895
OTHER (PETROL ST)	8960	0.76238	0.23761	6831	2129
F1	6898	0.5728	0.4271	3951.455	2946.544
F1 - LOTS	5300	0.58875	0.41124	3120.390	2179.609
F1 - ROAD	1598	0.52006	0.47993	831.0652	766.9347
F2	15611	0.57323	0.42676	8948.845	6662.154
F2 - LOTS	12085.21	0.58875	0.41124	7115.202	4970.0075
F2 - ROAD	3525.79	0.52006	0.47993	1833.642	1692.147
F3	18848	0.58072	0.41927	10945.56	7902.434
F3 - LOTS	16646	0.58875	0.41124	9800.380	6845.619
F3 - ROAD	2202	0.52006	0.47993	1145.184	1056.815
F4	27589	0.56996	0.43003	15724.85	11864.14
F4 - LOTS	20044	0.58875	0.41124	11800.96	8243.036
F4 - ROAD	7545	0.52006	0.47993	3923.896	3621.103
A5	32107	0.10577	0.89422	3396.13	28710.86
A5 - LOTS	3863	0.58875	0.41124	2274.352	1588.647
A5 - ROAD	2157	0.52006	0.47993	1121.78	1035.217
OTHER (GRASSED)	26087	0	1	0	26087

Appendix H – Flood Safe Plan

K6. MACLEAN SECTOR RESPONSE

This annex provides further detail of the planned response strategies within Maclean Sector.

Maclean Sector See Map Attached			
Sector Description	This sector covers the towns of Maclean, and Taloumbi, it also includes the villages of Chatsworth, Harwood, Ilarwill, South Arm, Ashby, Shark Creek and extensive rural areas.		
Hazard	Clarence River Riverine Flooding		
Flood Affect Classification	Maclean: Rising Road access and between 2.5 and 2.7m becomes a High Flood island (with Levee: overtopping height at low points 3.3-3.4m) Chatsworth, Harwood and Warregah Islands: Low Flood islands		
At risk properties	372 residential 102 commercial	**Total number of properties**	2267 (2006 Census)
Population	5774 (2006 Census)		
Sector Control	The Maclean Unit Controller will control evacuations in this sector. The SES will conduct evacuations in this sector with assistance from NSW Police, Fire and Rescue NSW, and NSWRFS.		
Key Warning Gauge Name: Maclean (204410)	Minor: 1.60m	Moderate: 2.20m	Major: 2.50m *100 YR ARI is 3.71m*
General Strategy	Evacuation of at risk population. • Self-evacuation to friends/family outside of the impact area. • Establishment of an Assembly Area at the Maclean Showground, where evacuees are able to gather while flood situation is monitored.		
Key Risks / Consequences	• Potential loss of life from rapid and potentially high velocity flooding inundation. • Overtopping and/or failure of Maclean Levee resulting in inundation behind the levees. • Potential loss of life from rapid and potentially high velocity inundation in levee overtopping/failure scenario. • Potential isolation of thousands of people estimated to be for a number of days.		
Information and Warnings	• Flood Watches • Flood Bulletins • Evacuation Warning • Evacuation Order • Sequenced door knocking of evacuation sectors • Media announcements • Emergency Alert SEWS (SMS, Landlines)		

<table>
<tr><td>Property Protection</td><td>Specific property protection measures:
Monitoring rising flood waters.
Relocation of livestock.
Relocation of farm machinery and valuable goods
Control of surface water through sandbagging measures.
Assist in the lifting of furniture to residents in need.
Monitoring integrity of dwellings surrounded by flood waters.
Monitoring integrity of existing levee system.
Control of surface water inside levee.</td></tr>
<tr><td></td><td>Protection of essential infrastructure:
No identified essential infrastructure requiring protection
Sewer system in urban areas of sector in Maclean, Townsend, Ilarwill, rural areas of sector are on septic tank. Evacuations may be required in rural areas for sanitary reasons if septic systems overflow.
Clarence Valley Council Water and Sewerage Flood Plan addresses procedures for sewerage system.</td></tr>
<tr><td>Evacuation/Isolation Triggers</td><td>The key evacuation triggers based on Bureau of Meteorology flood height predictions at the Maclean Gauge (204410):
Prediction to reach and/or exceed 1.5m
Advise schools of possible Lawrence Ferry closure affecting students returning home.
Prediction of between 2.5m to 2.7m (Isolation)
Targeted evacuation Warning/Order for residents in Harwood. The town of Maclean becomes progressively isolated by flood waters. The village of Harwood is totally flooded, most houses in this area are raised preventing over floor flooding.
Prediction to reach and/or exceed 3.0m
Evacuation Warning issued for Maclean residents living behind the levee system to prepare to relocate outside of the impact area.
Extensive flooding of Chatsworth, Harwood and Warregah Islands. Evacuations of low-lying houses may be necessary.
Prediction to reach 3.3m
At 3.3m the <u>levee design height</u> is thought to be exceeded and it likely that the low points in the levee will begin to be overtopped.

Based on monitoring and assessment of levee condition, consideration of targeted Evacuation Order of :

Argyle Street, (13 houses 1 business)
Bakers Lane, (4 houses)
Bank Lane, (1 house 1 business)
Basin Street, (1 business)</td></tr>
</table>

	Cameron Street, (6 houses) Centenary Drive, (15 businesses) Central Avenue, (14 houses) Church Street, (3 houses 1 business) Clyde Street, (9 houses, 2 businesses) Diamond Street, (17 houses)** Dunoon Crescent, (18 houses) Dwartes Lane, (1 house) Emerald Street, (8 houses)** Houghs Lane, (10 houses) Howard Street, (12 houses) Iona Close, (9 houses) John Street, (5 houses) Jubilee Street, (10 houses) McLachlan Street, (84 houses, 3 businesses) McNaughton Place, (2 houses, 4 businesses) Morven Street, (17 houses) Rannoch Ave, (13 houses, 1 business) River Street, (70 houses) River Street, Shops, (66 businesses) Rush Lane, (8 houses) Sapphire Close, (17 houses)** Stanley Street, (1 house, 5 businesses) Taloumbi Street, (12 houses) Union Street, (8 houses, 2 businesses) and other low lying areas. 5. ** Isolation only not flooded over-floor. **6. Prediction to exceed 3.3m** Evacuation Order issued for all impacted residences mentioned above to commence evacuation.
Sequencing of evacuation	• Evacuation of vulnerable facilities such as (Eg: Aged care facilities, schools, child care facilities) will require a higher priority. • Outside of the identified sequenced evacuation areas, a number of residences and properties may need to be evacuated during periods of significant flooding. In most floods, the evacuation tasks will only involve a small number of people. These properties would be dealt with on a case by case situation in conjunction with the Family and Community Services.
Evacuation Routes	**Option 1:** River Street to Cameron Street. **Option** 2: McLachlan Street, Short Street, River Street, then Cameron Street.

	Option 3: McLachlan Street, Union Street, Woodford Street, Church Street, River Street, then Cameron Street See attached map.
Evacuation Route Closures	Road closures affecting the evacuation: • The closure of local roads will be dependent on local rainfall conditions. • Known streets affected once overtopping has commenced are shown in the "EVACUATION TRIGGER SECTION" of annexure. • Pacific Highway closes (2.1m Maclean gauge) at the "Cloverleaf" (Southern approach to Harwood Bridge 5km north of Maclean). • Pacific Highway closed at Ferry Park, Maclean (2.5m Maclean gauge) Other known road closures: • Pacific Highway Closes (5.4m Prince Street gauge) at Alipou Creek, Alternate route high level bypass Centenary Drive.
Method of Evacuation	• Primarily self-evacuation by private transport before road closures. • At risk residents will be door knocked by SES, RFS and other emergency personnel and advised on the evacuation details. • Public transport will be available to transport the public without private transport to the Evacuation Centre/Assembly Area at the Maclean Showground. • Car parking capability on the Maclean Hill is unlimited for population at-risk. • Other outlying areas such as Chatsworth, Harwood, Goodwood, and Warregah islands may require evacuating on a case by case basis and can be transported by boat to the Evacuation Centre at the Maclean Show Ground.
Evacuation Centre/Assembly Point	• Maclean Showground buildings, Cameron Street, Maclean
Large scale evacuations	In the event that large scale evacuations are required residents will be transported to where an evacuation centre will be established. The following stages will occur; • **Stage 1:** Evacuation of the elderly, sick and frail as well as families with young children. This evacuation would be by private vehicles or school buses if possible. If roads are inundated flood boats and helicopters will be utilised.

	• **Stage 2:** Evacuation of all people not required for emergency Operations • **Stage 3:** Evacuation of emergency personnel by flood boat.
Rescue	The Maclean SES Unit will undertake all Flood Rescue Operations as per the Flood Rescue Operations Policy.
Resupply	• Resupply will be provided by the SES through the 132500 call out system. • The Maclean Base Hospital, Spar Supermarket, Local Bakery and Fruit & Vegetable Store will be resupplied if required. This will ensure residents are continually provided with essential food items.
Aircraft Management	Helicopter Landing Zones • Maclean Showground (S29°27' 51.6", E153°11'59.9") • Maclean Lookout (S29°27'32.3", E153°12'92.9") • Gulmarrad Public School oval for larger helicopters (S 29° 29'39.5", E153°14'0.08")
Other	Special considerations relating to the evacuation: • Closure of Schools - coordinated through the Department of Education and Training, District Office, Grafton. • Closure of Licensed Premises. All hotels and licensed clubs will be closed if affected. • Security. Police patrols to be established to maintain law and order after evacuation has occurred. • The SES will use flood boats and helicopters to monitor safety of individuals. Maclean has one peak season with potential population increase of more than 10%: • Highland Gathering – Easter long weekend These arrangements will stay in place until the ALL CLEAR is provided by the SES to residents to return to their premises.

MAP 7 - MACLEAN SECTOR

ANNEXURE D

Acid Sulfate Management Plan by Australian Soil & Concrete Testing Pty Ltd

Acid Sulfate Soil Management Plan

For

Proposed Residential Subdivision
Application No. SUB2006/0055
Stage 1, Hogues Lane
Maclean, NSW

Prepared for: **de Groot & Benson Pty. Ltd.**

Prepared by: **Australian Soil and Concrete Testing P/L**
7/17 Southern Cross Drive, Ballina, NSW, 2478

A.B.N. **49 050 539 930**

Email: asct@bigpond.com

Reference: **1159 - 001**

Date: **2nd December, 2007**

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1. Introduction

The Acid Sulfate Soil Management Plan (ASSMP) has been prepared for the excavation activities involved in the construction of a proposed residential development located at Hogues Lane, Maclean, NSW.

Australian Soil and Concrete Testing Pty. Ltd. (ASCT) have been engaged by de Groot & Benson Pty. Ltd. to carry out an Acid Sulfate Soil Assessment and prepare a Management Plan to be submitted to Clarence Valley Council as part of the Development Application process.

The ASS assessment and management plan have been conducted and developed in accordance with the NSW Acid Sulfate Soils Management Advisory Committee (ASSMAC) – Acid Sulfate Soil Management Guidelines, 1998.

2. Background

2.1 General

Acid Sulfate Soil (ASS) typically occurs in low-lying coastal areas. Developments involving excavation or lowering of the water table may result in the oxidation of sulfur (predominately in the form of pyrite) contained within these soils and the subsequent generation of acid discharge from the soil. The resultant discharge may find its way into the groundwater or stormwater and eventually into natural aquatic environments. The acidic run-off may lower the pH of the receiving water system, increase the concentration of metals and reduce the natural buffering capacity of the receiving waters.

There are two basic types of ASS. Actual Acid Sulfate Soils (AASS) are soils where the pyrites have been oxidised and sulfuric acid is present. Potential Acid Sulfate Soils (PASS) have not been oxidised and sulfuric acid has not yet been generated.

PASS in anaerobic conditions such as below the water table do not present an environmental hazard. However, if conditions change from anaerobic to aerobic, the pyrite in PASS will oxidise to form sulfuric acid. Oxidation can occur by either lowering the water table or removing the soil from below the water table, such as excavation.

2.2 Previous Investigation

de Groot & Benson have already undertaken some ASS investigation work on the subject site and this information is detailed in their report (ref: 04122). In summary, this previous work involved the collection of eight samples from four borehole locations in the vicinity of the proposed detention basin and diversion channel. Samples were taken from two depths at each borehole location, including a topsoil sample (0.0 – 0.3 m) and a deeper sample (0.7 – 0.8 m). The samples were analysed using the POCAS test method and the results showed the site contained ASS to varying degrees with the topsoil samples having the greatest acid generating potential.

2.3 Current Investigation

The scope of work for the current Acid Sulfate Soil Assessment included:

- Drilling of ten boreholes across the entire proposed stage 1 site.
- Obtaining soil samples from the boreholes at 0.5 m intervals.
- Analysis of all samples for field pH (pH_f) and field peroxide pH (pH_{fox}) to provide initial indication of PASS/AASS.
- POCAS laboratory analysis of ten samples to determine Total Actual Acidity (TAA) and % Oxidisable Sulfur.
- Summary of ASS Assessment results with calculated liming rates.
- Development of an ASSMP

2.4 ASS Management Principles and Guidelines

The following management principles are in accordance with the ASSMAC Management Guidelines (1998) and are the fundamental strategies that underpin the ASSMP.

2.3.1 Avoidance

This is the soundest strategy and the proposed works should always attempt to modify work practices in order to avoid unnecessarily exposing of disturbing ASS. The proposed works should also where possible avoid activities that result in the fluctuation of the groundwater, in particular the lowering of groundwater.

2.3.2 Minimisation

Appropriate handling techniques and treatment of excavated soil are to be used to minimise and or prevent the disturbance of ASS. Furthermore, earthworks activities should be managed to minimise or mitigate the potential of ASS to impact on the surrounding environment.

2.3.3 Neutralisation

Sufficient neutralising agent should be incorporated into excavated soils in order to neutralise acid that is generated over time due to the gradual oxidation of ASS. Neutralising agent should also be applied to acidified water run-off and any remaining water 'in-situ' (within the pore spaces of the material being excavated) that has become acidified.

The management and remediation of the excavated soil for the proposed works will be achieved using a combination of the management strategies outlined above. The client shall also exercise proper diligence in monitoring the excavation of material.

3. Proposed Development

The proposed stage 1 development of the site covers a total area of approximately four hectares. The works will involve the development of 22 residential lots and the construction of a diversion channel, detention basin and approximately 415 lineal m of paved roads. The proposed development is displayed in figure 1.

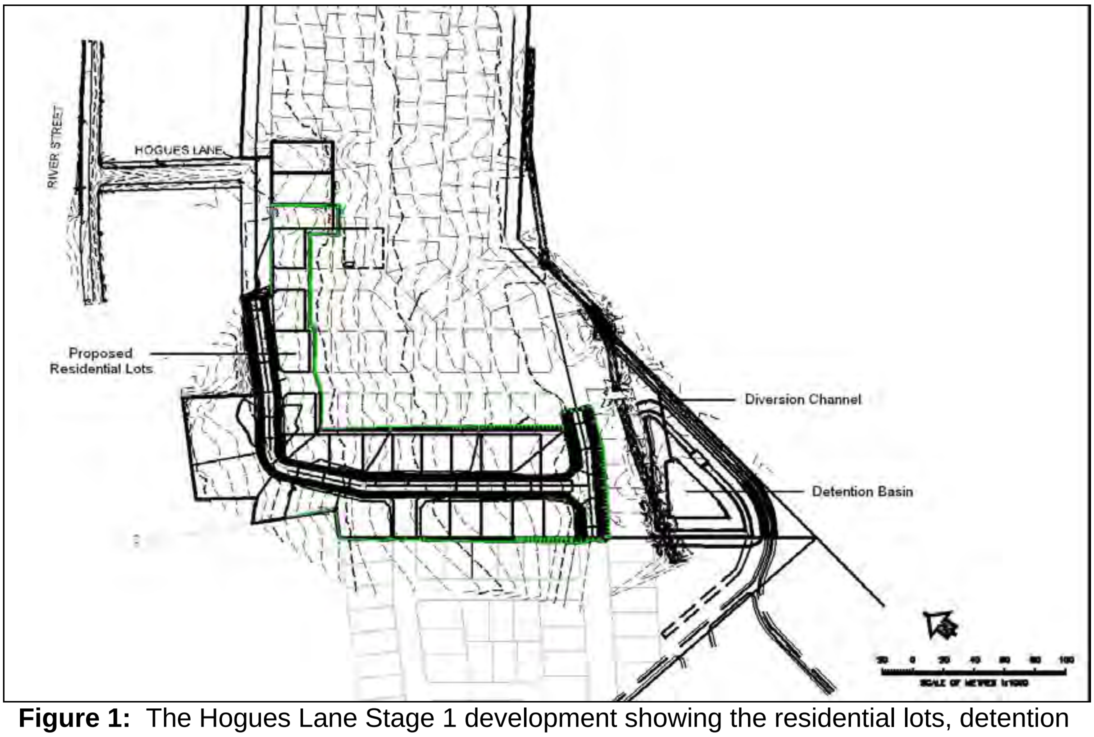

Figure 1: The Hogues Lane Stage 1 development showing the residential lots, detention basin and diversion channel.

3.1 Proposed Earthworks

A summary of the projected earthworks volumes are displayed in table 1. The earthworks proposed for the site are listed below:

- The entire site will be stripped of topsoil up to a depth of 0.3 m.
- The residential lots will be filled to depths ranging from 0.2 – 1.0 m, with an average fill depth of approximately 0.5 m.
- The detention basin and the diversion channel will also need to be excavated to depths of approximately 0.8 m and 1.5 m respectively.
- It is projected that a total of approximately 10 000 m^3 of fill will be required for the residential lots, with approximately 2250 m^3 of neutralised site won fill to come from the detention basin.

Table 1: Summary of projected earthworks volumes.

	Approximate Area (m^2)	**Approximate Depth (m)**	**Projected Volume (m^3)**
Excavations			
Topsoil (entire site)	20 000	0.3	6000
Detention basin	4 500	0.5*	2250
Diversion channel	1 200	1.2*	1440
Fill			
Total Fill (A)	20 000	0.5	10 000
Site Won Fill (B)	4 500	0.5	2250
	Total Imported Fill (A – B)		7750

* Depth of excavations have been calculated after the topsoil has been stripped.

4. Site Characteristics

4.1 Site Description

The site is located on the rural/urban fringe of the Maclean town-ship and has good access via Hogues Lane. The site is bordered by established residential areas to the north-west and open low-lying grazing country in all other directions. The proposed residential area and the majority of the site is cleared and well grassed. The site slopes gradually and uniformly at approximately 2 % south-east. The proposed detention basin area is located in the southern corner of the site and contains a variety of scattered wetland vegetation such as tall reeds, casuarina and melaleuca trees. There is also an existing drainage channel that runs approximately south to north on the eastern side of the site and it bisects the proposed residential area and the proposed detention basin area. The drainage channel is approximately 3.0 m across and 0.3 – 0.7 m in depth. The banks of the drainage channel are generally well vegetated with tall grass/reeds, shrubs and small to medium sized trees. The site has poor drainage due to its low elevation, gentle slope and impermeable clay soil type. However, the drainage is worst in the south-eastern half of the site (the lowest area) and the majority of the ground surface in this region was wet at the time of the investigation. Finally, the site had no visible signs of erosion or settlement at the time of the investigation.

4.2 Soils and Subsurface Conditions

The soil of the site is mainly comprised of approximately 0.3 m of moderately reactive silty clay topsoil overlying moderate to highly reactive silty clays and clays. The site is identified as having class 2 acid sulfate soil according to the Clarence Valley Council's acid sulfate soils planning map (see figure 2). However a small portion of the western corner of the site resides in class 3 ASS. Areas defined as class 2 soil are those that require development consent for any one of the following:

- Works below the ground surface.
- Works by which the water table is likely to be lowered.

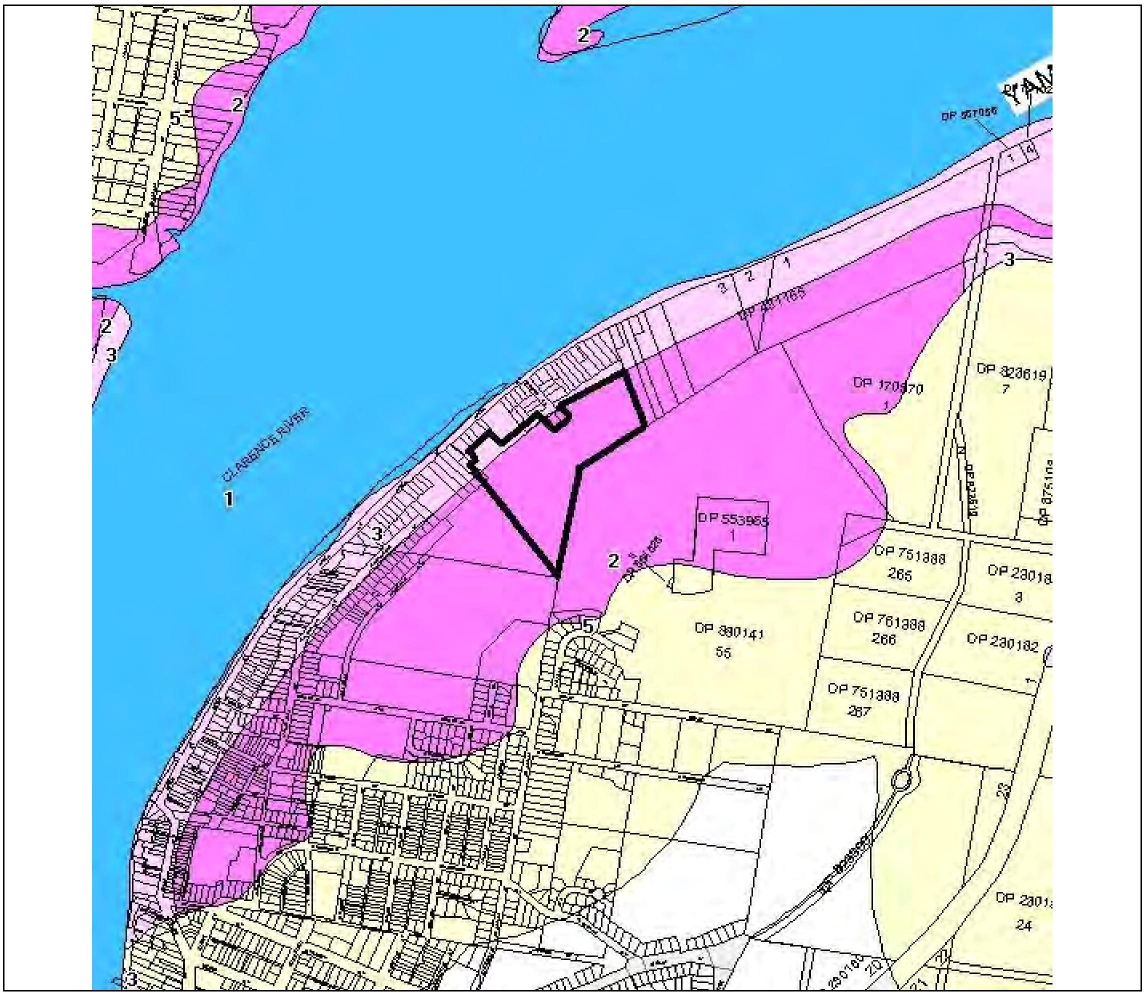

Figure 2: Acid sulfate soils planning map showing the Hogues Lane site outlined in bold. The site predominately resides in class 2 ASS with the western corner being class 3 (sourced: http://mapping.clarence.nsw.gov.au/Exponare/cvc_mapping.aspx on 29/11/07).

Groundwater was also encountered at variable depths during drilling at the site. The depth to groundwater ranged from 1.5 m below the ground surface on the western side of the site (borehole 2) to 0.5 m below the ground surface on the eastern side of the site (boreholes 6 & 10), with a general trend of the groundwater becoming more shallow from west to east. Table 2 presents a summary of the subsurface conditions and the complete engineering logs have been included in appendix A.

Table 2: Summary of subsurface conditions.

Borehole	Area	Topsoil (m)	Silty Clays & Clays (m)	Depth to Groundwater (m)
1	Residential Lots	0.25	0.25 - 1.60	-
2	"	"	"	1.4
3	"	"	"	1.3
4	"	"	"	1.2
5	Detention Basin	0.30	0.30 - 2.10	0.8
6	"	"	"	0.5
7	"	"	"	0.7
8	"	"	"	0.7
9	Diversion Channel	"	0.30 - 2.50	0.7
10	"	"	"	0.5

5. Acid Sulfate Soil Assessment

The broad aim of the ASS assessment was to determine the presence and severity of AASS and PASS on the site and subsequently determine their neutralisation requirements.

5.1 Soil Sampling

Soil Sampling was conducted in accordance with the ASSMAC guidelines (1998) and included:

- The drilling of ten boreholes on 14th November, 2007. The number of boreholes was determined using table 4.1 of the ASSMAC guidelines (*i.e*. 3 – 4 ha).
- The borehole locations were spread across the area of the site to be excavated and are displayed in figure 3.
- Sampling was undertaken by staff of this Laboratory (ASCT), namely by Ben Hart (BAppSc). ASCT is a NATA Accredited Laboratory.
- Soil samples were collected from the topsoil (0.0 – 0.3 m) and then at every 0.5 m depth interval at each borehole location. Boreholes were drilled to at least 1 m below the maximum excavation depth (*i.e.* residential lots to 1.5 m, detention basin to 2.0 m and the diversion channel to 2.5 m) using a truck mounted drilling rig. Therefore, a total of 47 samples were collected from the site.
- The sampling augers were washed with clean water between each sample location.
- Samples were placed in zip lock plastic bags and transferred immediately to an esky with ice for storage. Samples were stored on ice overnight before being field (pH_f) and field peroxide (pH_{fox}) tested in accordance with ASSMAC test method codes 21Af and 21Bf respectively. Furthermore, pH_{fox} testing was carried out using 30 % hydrogen peroxide adjusted to pH 5.5.
- Subsequently, ten samples were selected to be tested for the Peroxide Oxidation Combined Acidity and Sulfate (POCAS) testing and liming requirements. These samples were transferred under ASCT's chain of custody conditions to the Environmental Analysis Laboratory (EAL), Lismore for analysis.

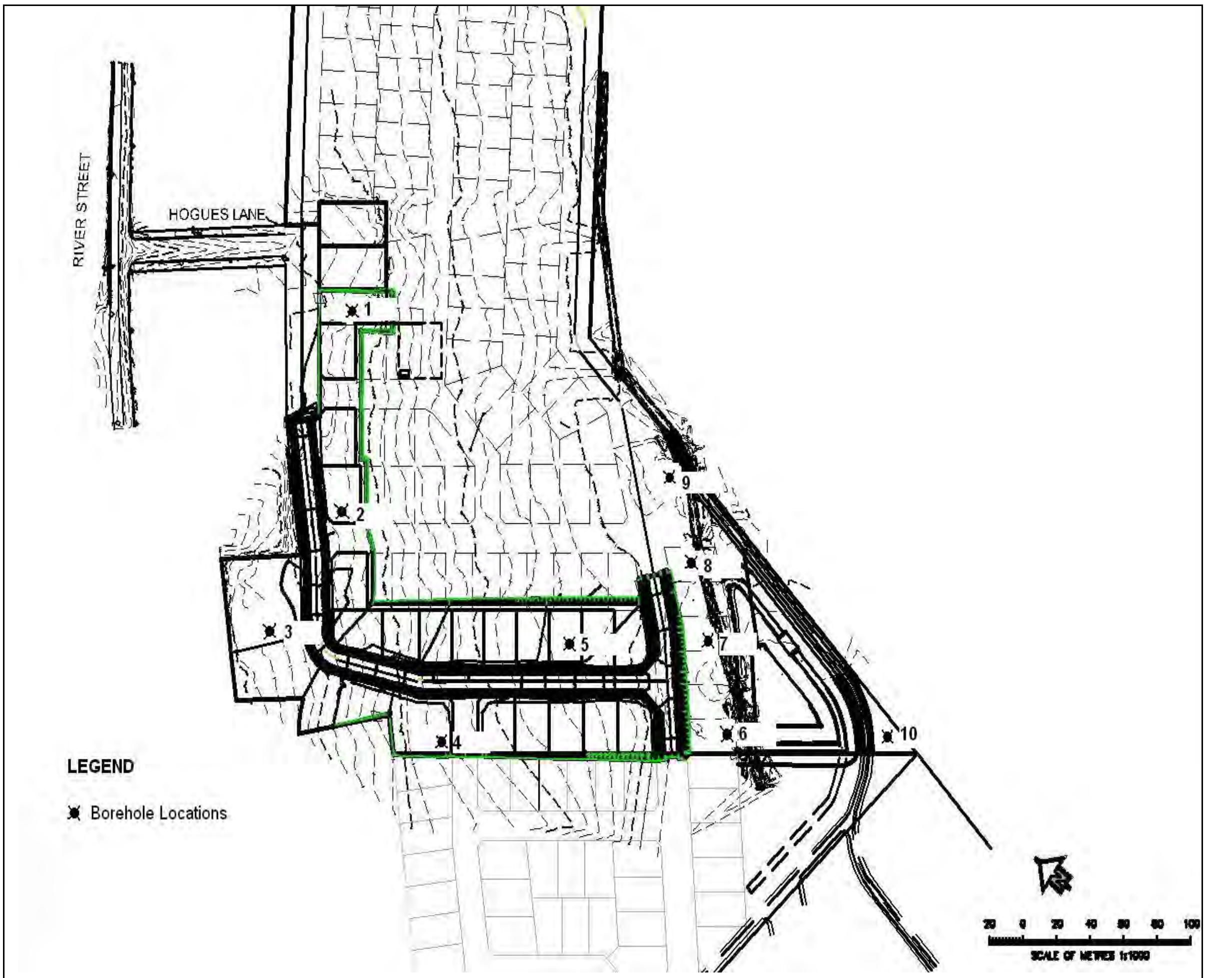

Figure 3: Site plan showing the borehole sampling locations.

6. Results

6.1 Field Testing

A summary of the field testing results are displayed in table 3. The results indicate that the site contains a considerable amount of PASS, with its presence most noticeable in the topsoil (all boreholes) and then throughout the entire soil profile towards the east of the site (boreholes 5 – 10). The results also indicate there is an isolated presence of AASS in the top 0.5 m of the soil profile in the vicinity of borehole 7.

Table 3: Summary of the field testing results.

Sample Source	Sample Depth (m)	pH_f	pH_{fox}	pH_f - pH_{fox}	Indication*
BH1	Topsoil	6.81	5.33	**1.48**	Possible PASS
"	0.5	5.69	4.76	0.93	PASS Unlikely
"	1.0	5.61	4.66	0.95	PASS Unlikely
"	1.5	6.46	4.95	**1.51**	PASS very likely
BH2	Topsoil	6.08	4.01	**2.07**	Possible PASS
"	0.5	6.46	5.29	**1.17**	Possible PASS
"	1.0	6.22	4.75	**1.47**	Possible PASS
"	1.5	6.86	6.02	0.84	PASS Unlikely
BH3	Topsoil	6.12	4.52	**1.60**	PASS very likely
"	0.5	5.18	4.57	0.61	PASS Unlikely
"	1.0	5.07	4.34	0.73	PASS Unlikely
"	1.5	5.21	**3.95**	**1.26**	Possible PASS
BH4	Topsoil	5.48	4.57	0.91	PASS Unlikely
"	0.5	5.17	4.25	0.92	PASS Unlikely
"	1.0	5.12	4.52	0.60	PASS Unlikely
"	1.5	6.60	5.31	**1.29**	Possible PASS
BH5	Topsoil	4.53	**3.04**	**1.49**	Possible PASS
"	0.5	5.27	**3.69**	**1.58**	PASS very likely
"	1.0	4.97	**3.70**	**1.27**	Possible PASS
"	1.5	5.89	5.08	0.81	PASS Unlikely
BH6	Topsoil	4.26	**3.03**	**1.23**	Possible PASS
"	0.5	4.52	**3.30**	**1.22**	Possible PASS
"	1.0	4.58	**2.96**	**1.62**	PASS very likely
"	1.5	5.40	**3.15**	**2.25**	PASS very likely
"	2.0	5.79	**2.50**	**3.29**	PASS very likely
BH7	Topsoil	**4.00**	**2.93**	**1.07**	ASS Present & PASS very likely
"	0.5	**3.96**	**2.45**	**1.51**	ASS Present & PASS very likely
"	1.0	4.11	**2.36**	**1.75**	PASS very likely
"	1.5	5.58	**2.55**	**3.03**	PASS very likely
"	2.0	5.77	**2.95**	**2.81**	PASS very likely
BH8	Topsoil	4.62	**2.64**	**1.98**	PASS very likely
"	0.5	4.50	**3.44**	**1.06**	Possible PASS
"	1.0	4.28	**2.83**	**1.45**	PASS very likely
"	1.5	5.52	**2.50**	**3.02**	PASS very likely
"	2.0	5.83	**2.42**	**3.41**	PASS very likely
"	2.5	5.99	**2.17**	**3.82**	PASS very likely
BH9	Topsoil	4.44	**2.96**	**1.48**	PASS very likely
"	0.5	4.23	**3.27**	0.96	Possible PASS
"	1.0	4.84	**3.67**	**1.17**	Possible PASS
"	1.5	5.95	**3.86**	**2.09**	PASS very likely
"	2.0	6.41	**2.11**	**4.30**	PASS very likely
"	2.5	6.52	**2.22**	**4.30**	PASS very likely
BH10	Topsoil	4.21	**3.02**	**1.19**	Possible PASS
"	0.5	4.47	**3.21**	**1.26**	Possible PASS
"	1.0	4.52	**3.01**	**1.51**	PASS very likely
"	1.5	5.09	**3.26**	**1.83**	PASS very likely
"	2.0	5.53	**2.70**	**2.83**	PASS very likely

* Indications are based on the ASSMAC guidelines and are determined as follows:

- PASS unlikely if, $pH_f - pH_{fox} < 1.0$
- Possible PASS if, $5 < pH_{fox} > 3$, or $pH_f - pH_{fox} > 1.0$
- PASS very likely if, $pH_{fox} < 3.0$, or $pH_f - pH_{fox} > 1.5$
- ASS present if, $pH_f < 4.0$

6.2 Laboratory Testing

A summary of the laboratory results are displayed in table 4 and the complete results have been included in Appendix B. The laboratory testing provides more reliable results than the field testing and the ASS classifications of the laboratory samples are based on the following:

- Non-Potential Acid Sulfate Soils (Non PASS/ASS) – POCAS testing indicates these soils have a Total Potential Acidity (TPA) below the ASSMAC action criteria and are not considered to present and environmental hazard.
- Potential Acid Sulfate Soils (PASS) – POCAS testing indicates these soils have S_{pos} (peroxide oxidisable sulfur) values above the ASSMAC action criteria, they may generate sulfuric acid and may present an environmental hazard. Management of these soils will be required.
- Actual Acid Sulfate Soils (AASS) – POCAS testing indicates that these soils are actual acid sulfate when total actual acidity (TAA) is pH_{KCl} < 4.0. These soils may leach acid and will require management.

Table 4: Summary of laboratory test results

Borehole	Depth (m)	Area	% S Oxidisable (S_{pos})	TAA (pH_{KCl})	Action Criteria* (S_{pos})	Acid Sulfate Potential
1	1.5	Residential Lots	0.00	4.72	≥ 0.03	NON PASS
2	0.5	"	0.00	5.19	"	NON PASS
3	Topsoil	"	0.01	4.96	"	NON PASS
5	0.5	"	**0.03**	4.30	"	**PASS**
6	Topsoil	Detention Basin	**0.20**	4.29	"	**PASS**
6	1.0	"	**0.07**	4.50	"	**PASS**
7	2.0	"	**0.83**	4.53	"	**PASS**
9	1.5	Diversion Channel	**0.04**	5.59	"	**PASS**
9	2.5	"	**1.42**	4.24	"	**PASS**
10	0.5	"	**0.11**	5.30	"	**PASS**

* Action criteria taken from the ASSMAC guidelines and is based on more than1000 tonnes of fine textured soil to be disturbed.

Laboratory analysis showed that a number of the samples have S_{pos} values above the ASSMAC action criteria. Based on the laboratory testing the site can be classified as having Potential Acid Sulfate Soils. PASS occur from borehole 5 and all locations that were sampled to the east of this point. Furthermore, PASS are present throughout the entire depth of the soil profile. The laboratory testing indicates that there are no AASS at the site.

The laboratory analysis has also determined a liming application rate (with a safety factor of 1.5) based on the results of testing. The recommended liming rates are displayed in table 5 and are highly variable with a range of 0 – 74 kg $CaCo_3$ (lime)/m^3. However, the entire site has been represented in the results with the highest lime requirements being for soils that will not need to be excavated. For example, the borehole 7 result of 41 kg lime/m^3 and the borehole 9 result of 74 kg lime/m^3 are below the maximum depths of excavation. Although these soils will not be excavated it does show that extreme care should be taken not to excavate beyond the proposed depths.

Table 5: Summary of liming rates.

Borehole	Depth (m)	Bulk Density (t/m^3)	Lime (kg/t)	Lime (kg/m^3)
1	1.5	1.4	1	1.4
2	0.5	"	1	1.4
3	Topsoil	"	1	1.4
5	0.5	1.10	5	5.5
6	Topsoil	0.90	21	18.9
6	1.0	1.00	3	3
7	2.0	0.90	46	41*
9	1.5	1.30	0	0
9	2.5	1.10	67	73.7*
10	0.5	1.20	13	15.6

* Soils are below the maximum depth of excavation.
Highlight – The highest requirements of the soils to be excavated, therefore these values will be adopted as the liming rates (*e.g.* 18.9 kg lime/m^3 for topsoil and 15.6 kg lime/m^3 for underlying soils).

7. ASS Summary

The field testing indicates the site contains PASS and the laboratory testing shows that the soil contains oxidisable sulfur levels above the ASSMAC action criteria. Therefore, the soil analyses together with the general site information have enabled the following conclusions to be made:

- The soils on the site can be classified Potential Acid Sulfate Soils (PASS).
- PASS was found to exist eastwards from borehole 5 at all depths throughout the soil profile.
- Excavated PASS will require a lime application of approximately 19 kg/m^3 for topsoil and 16 kg/m^3 for underlying soils in order to neutralise the soil.
- The laboratory testing suggests that Actual Acid Sulfate Soils (ASS) do not exist at the site.

The presence of PASS indicates these are soils are likely to generate sulfuric acid if they are allowed to oxidise during excavation. Subsequently, this may present an environmental hazard and the appropriate management of these soils will be required.

8. Management Plan

Based on the findings of the Acid Sulfate Soil Assessment the following Acid Sulfate Soil Management Plan shall be adopted during the construction activities on the site.

8.1 Training and Supervision

All staff involved in the excavation, storage, handling and transport of earthworks materials shall undertake a training session/s (toolbox meeting/s) to ensure they are aware of their responsibilities and the requirements that relate to the management of ASS. Training sessions will be undertaken prior to the commencement of earthworks and the minutes of session/s shall be recorded and kept on file.

8.2 ASS Treatment Controls

The following controls shall apply to the treatment of ASS:

- Treatment of acidic soil and/or water should be carried out in accordance with Section 7 of the ASSMAC Management Guidelines 1998.
- In order to control the neutralising rate of ASS the client will need to accurately monitor the excavation quantities and apply the neutralising agent at the calculated rate.
- Agricultural lime may be used to neutralise soils, however hydrated lime shall be used to neutralise acidic water. Acidified soil or water shall be neutralised so that the pH is brought within the pH range of **6.5 – 8.5**.

8.3 ASS and Water Treatment

<u>8.3.1 Topsoil (0.0 – 0.3 m)</u>

Excavated topsoil shall be stockpiled and neutralised using agricultural lime at a dose rate equivalent to 19 kg/m^3. The liming rate is the maximum rate calculated for topsoils by the laboratory analysis and therefore should be sufficient to neutralise the worst case PASS.

<u>8.3.2 Subsoil (below 0.3 m)</u>

Subsoil refers to those soils underlying the topsoil. Excavated subsoil shall also be stockpiled and neutralised using agricultural lime at a dose rate equivalent to 16 kg/m^3. The liming rate is the maximum rate calculated for subsoil that is to be excavated and therefore should be sufficient to neutralise the worst case PASS.

The calculated liming rates are based on the actual bulk density of the soil samples taken from the site and include a safety factor of 1.5. The soil stockpiles should be thoroughly mixed as the lime is added and monitoring of the pH should be carried out to confirm the effectiveness of the treatment. Additional lime may need to be added if acceptable results are not achieved within the allowable timeframe.

<u>8.3.3 Acidic Waters</u>

Water that is tested as low pH (< 6.5) will require treatment. Hydrated lime ($Ca(OH)_2$) will need to be mixed into a slurry and incorporated into the water to be treated. The slurry can be produced by mixing hydrated lime with water at a concentration of 2g/L and can be applied by pouring or spraying the slurry across the surface of the water to be treated. The slurry will be highly caustic (pH 12) and should be applied in small increments to avoid overdosing the treatment waters. The pH of the water should be checked and further application of slurry should be carried out if necessary. The water shall be monitored until the pH has stabilised and the water is acceptable for discharge (**pH of 6.5 – 8.5, EC < 80 mS**).

8.4 Lime Application Method

All excavated PASS shall be spread loosely in layers (maximum 0.3 m depth) in the designated lime treatment/storage area and each layer is to be limed at the calculated rate. The lime must be mixed thoroughly before subsequent layers can be added to the treatment/storage area. Soils will require drying and must be worked several times to ensure thorough mixing. It will be necessary for the mixing and stockpiling process to be carried out with some form of mechanical equipment capable of mixing the projected soil quantities, such as an excavator or backhoe.

8.5 ASS Storage

A guard layer of neutralising agent should be spread onto the soil surface of the treatment/storage area prior to the placement of excavated AS soils. This will reduce risk by neutralising acidic leachate generated in the treatment pile and not neutralised during the treatment process. To further reduce risk, a layer of compacted non-ASS clayey material (minimum 0.3 m thick) may be placed on the surface of the treatment pad and below the guard layer to restrict infiltration from the material being tested. Stockpiles should also have perimeter bunds that are constructed of material other than other AS soil and that has an appropriately low permeability to avoid leakage (*i.e*. should be constructed of clayey material). Stockpiles will require a perimeter drain that terminates at a central sump inside the bund wall so run-off can be collected and treated if necessary. Furthermore, surface liming of earth bunds and perimeter drains can assist with neutralising any acidic run-off. A cross section of the stockpile design has been included in Appendix D.

8.6 Testing

A summary of the testing requirements is displayed in table 6 below.

8.6.1 Soils

Excavated soils will require a minimum field test frequency of one pH_{fox} test per 500 m^3. Therefore, approximately 20 field pH_{fox} tests will need to be performed on treated soils, provided there is no need for retesting. Excavated soils will also require one laboratory test (TPA – Total Potential Acidity) per 2500 m^3 in order to confirm neutralisation. Therefore, approximately 4 laboratory test will be required. The treatment of soils will be deemed successful when they have a pH_{fox} within the range 6.5 – 8.5 and when the TPA component of the POCAS test method is above pH 6.5.

Each soil test shall be a composite sample (comprised of sub-samples) in order to provide a result that is representative of the whole sample.

Where soils fail testing, the soils shall be re-limed, remixed and retested.

8.6.2 Water

A water monitoring programme will be necessary and shall include sampling from two permanent locations, including the existing open drain downstream of the proposed works and from within the proposed detention basin. Further sampling shall also be conducted from any stockpile run-off collection points. The water shall be tested for pH and Electrical Conductivity, with the following performance criteria:

- **pH 6.5 – 8.5,** in accordance with the ASSMAC guidelines.
- **EC < 80 mS**

The permanent sampling points shall be tested on a weekly basis and other locations such as stockpile run-off collection points shall be tested before intended discharge. The client shall **not** discharge water from such locations until it is confirmed that the collected water has met the performance criteria.

If allowable thresholds are exceeded the client shall treat non-conforming waters with hydrated lime as outlined in section 8.3.3 (treatment of acidic water) in order to raise the pH and flocculate/precipitate dissolved solids.

Table 6: Summary of testing requirements.

	Test Required	Test Frequency	Performance Criteria	To Be Sampled By	To Be Tested By
Soils	pH_{fox}	1 per 500m^3	$8.5 < pH_{fox} > 6.5$	ASCT	ASCT
	TPA	1 per 2500m^3	TPA > 6.5	ASCT	EAL[1]
Water (permanent sample points)	pH	Weekly	8.5 < pH > 6.5	ASCT	ASCT
	EC	Weekly	EC < 80 mS	ASCT	ASCT
Water (stockpile sample points)	pH	Before Discharge	8.5 < pH > 6.5	ASCT	ASCT
	EC	Before Discharge	EC < 80 mS	ASCT	ASCT

[1] EAL – Environmental Analysis Laboratory, Southern Cross University, Lismore.

8.7 Earthworks Strategy

Excavations should be carried out in an efficient manner in order to limit the time available for oxidation and reduce the potential for acid to be released into the environment. This is particularly applicable to the topsoil stripping stage of the project. Areas of the site that are to be stripped shall have the first layer of fill (0.3 m) placed on the same day in order to prevent oxidation and subsequent acid generation. Therefore, works will need to be staged and limited to an achievable scale so they can be completed within the allowable timeframe.

In general, the earthworks strategy must always consider the fundamental principles for best practice including avoidance, minimisation and neutralisation. The client must also give sufficient notice prior to undertaking excavations and the earthworks strategy must provide sufficient time for testing and validation.

Treated soil that is to be removed from site must be taken to a council approved destination.

8.8 Lime Supplies and Storage

At least 188 tonnes of fine agricultural lime will be required for the treatment of ASS involved in the construction activities on site and quantity calculations are displayed in table 7.

Table 7: Fine agricultural lime supplies for the treatment of AS soils.

Excavated Soil	Earthworks Quantity/Area	Lime Application Rate	Total Lime (tonnes)
Topsoil	6 000 m^3	19 kg/m^3	114
Subsoil	3 700 m^3	16 kg/m^3	59
Extras*	1 500 m^2	10 kg/m^2	15
		TOTAL	**188**

* Allow extra for the stockpile guard layers and the liming of bund walls.

It can be difficult to estimate the quantity of hydrated lime that will be required to treat acidic waters as the occurrence of acidic waters can be significantly influenced by weather resulting in fluctuations of the water table and the amount of run-off produced on the site. Despite the uncertainty, a conservative estimation of the hydrated lime supplies has been calculated and is displayed in table 8 below.

Table 8: Hydrated lime supplies for the treatment of acidified water.

Neutralising Agent	Application Rate (g/L)	Estimated Volume of Treatment Waters (ML)	Quantity of Hydrated Lime Required (tonnes)
Hydrated Lime $Ca(OH)_2$	2	3	6

Agricultural lime shall be stored in a bunded area to prevent accidental release to waters. It shall also be covered with an impervious material such as plastic that is weighted down to prevent exposure to wind and rain. Agricultural lime has an approximate bulk density of 0.6 t/m^3, therefore a 1.5 m high, 188 t stockpile of aglime will require a storage area of approximately 210 m^2. A cross section of the proposed lime storage area has been included in Appendix D.

By comparison the storage area required for hydrated lime is only small. However, due to its very caustic nature it will need to be stored in locked and covered area such as a site shed or container.

Consideration of the issues regarding the storage, handling and incorporation of lime will need to be addressed as part of the client's OH&S policy. Particular cation should be taken with hydrated lime used to treat acidic water as it is a highly soluble, highly alkaline (pH 12) neutralising material. Personnel who handle hydrated lime will require protective clothing such as goggles, gloves and respirators to prevent contact with the skin and eyes and inhalation.

8.9 Remedial Action

Remedial Action will require the storing of additional lime onsite during the construction process. The additional lime shall be utilised if the pH levels of onsite stockpiles fall below the acceptable levels.

8.10 Restoration Action

When remedial action fails or monitoring identifies a failure of the management strategy to meet the agreed standards, the project shall cease to operate and action shall be taken to restore the site to an acceptable condition.

8.11 Records

All details of treatment and testing shall be contained in an environmental summary report that is to be kept onsite at all times. The environmental summary report is to include the following information:

- quantity of soil or water treated,
- origin of excavated material,
- the quantity and type of neutralising agent used,
- date of treatment,
- designated storage area,
- date of testing,
- name of testing personnel,
- laboratory identification number of testing equipment,
- calibration of testing equipment,
- test results
- laboratory (TPA) sample identification number,
- action taken.

The environmental summary report is to be made available for inspection by the relevant authorities. A copy of the proforma to be used for the environmental summary report has been included in Appendix E of this report.

8.12 Monitoring and Responsibilities

Monitoring shall be simple, cost effective and provide data in an effective and time efficient manner to allow the implementation of appropriate control measure.

ASCT shall be responsible for the continuous monitoring of excavated soil pH as well as the pH and TDS of water including run-off. Where the results are outside the required range the client will take immediate action to treat the soil and/or water as required in the ASS and water treatment measures.

ASCT shall be responsible for the onsite testing and will ensure the client complies with the appropriate measures and procedures necessary to produce the desired outcomes. All samples for laboratory analysis will be taken by ASCT and delivered to EAL, who will be responsible for the TPA and TDS analysis. Furthermore, observation and assessment of the client's handling and treatment of ASS will be monitored by ASCT and the neutralisation process will be assessed for completeness.

ASCT shall be responsible for maintaining the environmental summary report that is to be kept on site. However, the client shall be responsible for accurately monitoring the excavation quantities and water collection volumes in order to determine and control the neutralising agents and quantities. The client shall provide information pertaining to the excavation and neutralising quantities to ASCT who will be responsible for including this information in the treatment section of the environmental summary report. ASCT will also conduct the testing and shall be responsible for maintaining the testing component of the environmental summary report.

The acid sulfate soil management activities have been summarised into an action plan that is displayed in table 9.

Table 9: Action Plan

Activity	Management	Comments
Training & Supervision	Initial training session/s & ongoing supervision	An ASCT representative will conduct initial training session/s prior to the commencement of earthworks on the site to ensure workers are aware of their responsibilities and the requirements that relate to the management of ASS. ASCT will provide ongoing supervision for the duration of the earthworks.
Treatment/ Storage Areas	Compacted clay layer of 0.3 m (min) depth Place a guard layer of 10 kg lime/m^2 on top of clay. Bunding	Storage/treatment area shall also have a perimeter drain & a sump inside the bund wall and run-off collected and treated if required. Compacted clay layer and bunding are to be constructed with non-ASS material.
Treatment Application Process	Spread loose soil in 0.3m (max) layers. Lime topsoil at 19 kg/m^3 & subsoil at 16 kg/m^3. Mix thoroughly.	The treatment application process must take place in the designated treatment/storage area. Soils will require drying and should be mixed several times before the placement of subsequent layers. Mixing should be conducted using an excavator or backhoe.
Liming Rates	Topsoil (0.0 – 0.3 m) ➢ 19 kg aglime/m^3 Subsoil (below 0.3 m) ➢ 16 kg aglime/m^3 Water ➢ 2g hydrated lime/L	Contractor is responsible for monitoring excavation quantities & applying the correct amount of lime. A slurry of 2g hydrated lime/L of water must be made up and sprayed on to acidic water with care not to overdose.
Lime Supplies	188 tonnes of aglime. 6 tonnes hydrated lime. Distribution equipment.	Aglime shall be stored in a covered and bunded area to prevent accidental release to the environment. Hydrated lime shall be stored in a covered facility that can be locked (eg. Site shed or container). Hydrated lime is very caustic and workers should exercise caution whilst handling, including the use of protective clothing such as gloves, goggles and respirators.
Earthworks & Management	Fill stripped areas immediately, stage works. Use best practices. Allocate time for testing & validation. Allow for storage & treatment space.	Neutralisation (good), Minimisation (better), Avoidance (best). Excavations are to be carried out efficiently to limit the amount of time soil is exposed. The first layer of fill must be placed on stripped areas immediately (same day as stripping) in order to limit oxidation of PASS and the generation of acid. Climate, seasonal conditions & soil textures may affect drying times & treatment efficiencies, therefore allow time for neutralisation and testing results. Soil removed from site must go to council approved destination.
Verification Testing	Soils ➢ 1 pH_{fox} per 500m^3 ➢ 1 TPA per 2500m^3 Water (permanent samples) ➢ 1 pH & EC weekly Water (Stockpiles) ➢ 1 pH & EC before discharge	Lime treatment for soils will be deemed successful when 8.5 < pH_{fox} > 6.5 and TPA > 6.5. Treatment for water will be deemed successful if 8.5 < pH > 6.5 and EC < 80 mS. If materials fail testing they shall be re-treated and retested.
Records	Treatment Testing	The contractor shall be responsible for supplying information relating to the treatment process. ASCT shall be responsible for supplying information relating to testing. Information shall be entered into the environmental summary report kept on site.

8.13 Limitations

This report relies on information supplied by the client and the results of investigations conducted in accordance with accepted practices and standards. The report is intended to represent a reasonable interpretation of the appropriate legislation and the condition of the site at the time of the investigation. However, due to these elements being subject to change over time the report under no circumstances can be considered to represent the definitive state of the site at all times.

Finally, should any problem or concern arise that needs clarification or assistance the client should not hesitate to call this office.

Yours Faithfully,
Australian Soil and Concrete Testing Pty. Ltd.

Ben Hart
Environmental Officer
B. App. Sc

Brian Dick
Managing Director

9. References

Australian and New Zealand Environment and Conservation Council (1992). *Australian Water Quality Guidelines for Fresh and Marine Waters.*

Dear, SE, Moore NG, Dobos SK, Watling KM, and Ahern CR (2002). *Queensland Acid Sulfate Soil Technical Manual 2002. Soil Management Guidelines, Version 3.8*.

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Stone, Y, Ahern C R, and Blunden B (1998). *Acid Sulfate Soils Manual 1998. Acid Sulfate Soil Management Advisory Committee* (ASSMAC), Wollongbar, NSW, Australia.

APPENDIX A – Boreholes Logs

AUSTRALIAN SOIL AND CONCRETE TESTING P/L A.B.N. 49 050 539 930

Unit 7/17 Southern Cross Drive, Ballina 2478. Telephone: (02)66868 567, Fax:(02)66868 396

ASCT Doc. No. W40 Rev. No. 02 -8/3/00 BD

BOREHOLE LOG REPORT

Client : De Groot Benson	**Project No :** 1159 - 001	**Project :** Hogues lane, Maclean
Lab No : 8272	**Report No :** 1159 - 001-001	**Borehole No:** 1

Borehole Inclination :90°	**Borehole Direction :** Vertical	**Date drilled :** 14/11/07
Surface Elevation : NA	**Borehole location :** Proposed Development Site	**Drill type :** Auger
Drilling Method : Yanmar Drill Rig		

TEST DATA

Soil Description	Depth (M)	Slope %	Graphic Symbol	Group Symbol	Consistency /Strength	Sample
SILTY CLAY TOPSOIL : brown grey, medium plastic, medium dry strength, some organic matter, firm, moist.				CL	F	
SILTY CLAY : mottled brown, orange brown, medium to high plastic, medium dry strength, firm to stiff, moist.	0.25			CL/CH	F/St	
SILTY CLAY : mottled brown, grey orange, medium to high plastic, medium dry strength, firm to stiff, moist.	0.8			CL/CH	F/St	
	1.0					
SILTY CLAY : brown grey, medium plastic, medium dry strength, some fine sand, firm to soft, very moist.	1.2			CL	F/S	
Stopped no change	1.6					
	2.0					

AUSTRALIAN SOIL AND CONCRETE TESTING P/L A.B.N. 49 050 539 930
Unit 7/17 Southern Cross Drive, Ballina 2478. Telephone: (02)66868 567, Fax:(02)66868 396

ASCT Doc. No. W40 Rev. No. 02 -8/3/00 BD

BOREHOLE LOG REPORT

Client : De Groot Benson	**Project No :** 1159 - 001	**Project :** Hogues lane, Maclean
Lab No : 8272	**Report No :** 1159 - 001-001	**Borehole No:** 2

Borehole Inclination :90°	**Borehole Direction :** Vertical	**Date drilled :** 14/11/07
Surface Elevation : NA	**Borehole location :** Proposed Development Site	**Drill type :** Auger
Drilling Method : Yanmar Drill Rig		

TEST DATA

Soil Description	Depth (M)	Slope %	Graphic Symbol	Group Symbol	Consistency /Strength	Sample
SILTY CLAY TOPSOIL : grey brown, medium plastic, medium dry strength, some organic matter, soft to firm, moist.	0.25			CL	S/F	
SILTY CLAY : mottled brown grey, orange brown, medium to high plastic, medium dry strength, firm, moist.	1.0 1.1			CL/CH	F	
SANDY CLAY : mottled brown, grey orange, medium plastic, medium dry strength, fine sand, firm to soft, moist.	1.6			CL	F/S	
Stopped no change	2.0					

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ASCT Doc. No. W40 Rev. No. 02 -8/3/00 BD

BOREHOLE LOG REPORT

Client : De Groot Benson	**Project No :** 1159 - 001	**Project :** Hogues lane, Maclean
Lab No : 8272	**Report No :** 1159 - 001-001	**Borehole No:** 3

Borehole Inclination :90°	**Borehole Direction :** Vertical	**Date drilled :** 14/11/07
Surface Elevation : NA	**Borehole location :** Proposed Development Site	**Drill type :** Auger
Drilling Method : Yanmar Drill Rig		

TEST DATA

Soil Description	Depth (M)	Slope %	Graphic Symbol	Group Symbol	Consistency /Strength	Sample
SILTY CLAY TOPSOIL : grey brown, medium plastic, medium dry strength, some organic matter, soft to firm, moist.	0.25			CL	S/F	
SILTY CLAY : mottled brown, orange brown, medium to high plastic, medium dry strength, soft to firm, moist.	1.0 1.1			CL/CH	S/F	
CLAY : mottled grey orange brown, high plastic, high dry strength, firm to stiff, very moist to wet below 1.3m.	1.6			CH	F/St	
Stopped no change	2.0					

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Unit 7/17 Southern Cross Drive, Ballina 2478. Telephone: (02)66868 567, Fax:(02)66868 396

ASCT Doc. No. W40 Rev. No. 02 -8/3/00 BD

BOREHOLE LOG REPORT

Client : De Groot Benson	**Project No :** 1159 - 001	**Project :** Hogues lane, Maclean
Lab No : 8272	**Report No :** 1159 - 001-001	**Borehole No:** 4

Borehole Inclination :90°	**Borehole Direction :** Vertical	**Date drilled :** 14/11/07
Surface Elevation : NA	**Borehole location :** Proposed Development Site	**Drill type :** Auger
Drilling Method : Yanmar Drill Rig		

TEST DATA

Soil Description	Depth (M)	Slope %	Graphic Symbol	Group Symbol	Consistency /Strength	Sample
SILTY CLAY TOPSOIL : dark grey brown, medium plastic, medium dry strength, some organic matter, soft to firm, moist.	0.25			CL	S/F	
SILTY CLAY / CLAY : mottled brown, orange grey, medium to high plastic, medium dry strength, soft to firm, moist.	1.0 1.2			CL/CH	S/F	
SANDY CLAY : grey , medium to high plastic, medium dry strength, fine sand, soft, wet.	1.6			CL/SC	S	
Stopped no change	2.0					

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Unit 7/17 Southern Cross Drive, Ballina 2478. Telephone: (02)66868 567, Fax:(02)66868 396

ASCT Doc. No. W40 Rev. No. 02 -8/3/00 BD

BOREHOLE LOG REPORT

Client : De Groot Benson	**Project No :** 1159 - 001	**Project :** Hogues lane, Maclean
Lab No : 8272	**Report No :** 1159 - 001-001	**Borehole No:** 5

Borehole Inclination :90°	**Borehole Direction :** Vertical	**Date drilled :** 14/11/07
Surface Elevation : NA	**Borehole location :** Proposed Development Site	**Drill type :** Auger
Drilling Method : Yanmar Drill Rig		

TEST DATA

Soil Description	Depth (M)	Slope %	Graphic Symbol	Group Symbol	Consistency /Strength	Sample
SILTY CLAY TOPSOIL : dark brown, medium plastic, medium dry strength, some organic matter, firm, moist.				CL	F	
	0.3					
SILTY CLAY : mottled brown, grey orange, medium to high plastic, medium dry strength, firm, moist to very moist.				CL/CH	F	
	0.8					
SANDY CLAY : grey , medium plastic, medium dry strength, fine sand, firm to soft, wet.				CL/SC	F/S	
	1.0					
	1.6					
Stopped no change						
	2.0					

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Unit 7/17 Southern Cross Drive, Ballina 2478. Telephone: (02)66868 567, Fax:(02)66868 396

ASCT Doc. No. W40 Rev. No. 02 -8/3/00 BD

BOREHOLE LOG REPORT

Client : De Groot Benson	**Project No :** 1159 - 001	**Project :** Hogues lane, Maclean
Lab No : 8272	**Report No :** 1159 - 001-001	**Borehole No:** 6

Borehole Inclination :90°	**Borehole Direction :** Vertical	**Date drilled :** 14/11/07
Surface Elevation : NA	**Borehole location :** Proposed Development Site	**Drill type :** Auger
Drilling Method : Yanmar Drill Rig		

TEST DATA

Soil Description	Depth (M)	Slope %	Graphic Symbol	Group Symbol	Consistency /Strength	Sample
SILTY CLAY TOPSOIL : dark grey, medium plastic, medium dry strength, some organic matter, soft, very moist to wet.	0.3			CL	S	
SILTY CLAY : mottled grey orange brown, high plastic, medium dry strength, soft to firm, moist to very moist.	0.5			CH	S/F	
SANDY CLAY : grey brown , medium plastic, medium dry strength, fine sand, soft, wet.	0.8 1.0 1.2			CL/SC	S	
SILTY CLAY : grey, high plastic, high dry strength, some fine sand, soft, wet.	2.0 2.1			CH	S	
Stopped no change						

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ASCT Doc. No. W40 Rev. No. 02 -8/3/00 BD

BOREHOLE LOG REPORT

Client : De Groot Benson	**Project No :** 1159 - 001	**Project :** Hogues lane, Maclean
Lab No : 8272	**Report No :** 1159 - 001-001	**Borehole No:** 7

Borehole Inclination :90°	**Borehole Direction :** Vertical	**Date drilled :** 14/11/07
Surface Elevation : NA	**Borehole location :** Proposed Development Site	**Drill type :** Auger
Drilling Method : Yanmar Drill Rig		

TEST DATA

Soil Description	Depth (M)	Slope %	Graphic Symbol	Group Symbol	Consistency /Strength	Sample
SILTY CLAY TOPSOIL : dark grey brown, high plastic, high dry strength, some organic matter, soft to firm, very moist.	0.3			CH	S/F	
SANDY CLAY : brown grey, medium plastic, medium dry strength, fine sand, soft, very moist to wet.	0.7			CL/SC	S	
SILTY CLAY : grey, medium to high plastic, medium dry strength, some fine sand, soft, wet.	1.0 1.2			CL/CH	S	
SILTY CLAY : grey, high plastic, high dry strength, trace of fine sand and organic matter, soft, wet.	2.0 2.1			CH	S	
Stopped no change						

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ASCT Doc. No. W40 Rev. No. 02 -8/3/00 BD

BOREHOLE LOG REPORT

Client : De Groot Benson	**Project No :** 1159 - 001	**Project :** Hogues lane, Maclean
Lab No : 8272	**Report No :** 1159 - 001-001	**Borehole No:** 8

Borehole Inclination :90°	**Borehole Direction :** Vertical	**Date drilled :** 14/11/07
Surface Elevation : NA	**Borehole location :** Proposed Development Site	**Drill type :** Auger
Drilling Method : Yanmar Drill Rig		

TEST DATA

Soil Description	Depth (M)	Slope %	Graphic Symbol	Group Symbol	Consistency /Strength	Sample
SILTY CLAY TOPSOIL : dark grey brown, medium to high plastic, medium to high dry strength, soft, moist to very moist.	0.3			CL/CH	S	
SILTY CLAY : mottled grey brown orange, medium to high plastic, medium dry strength, some fine sand, soft to firm, very moist.	0.7			CL/CH	S/F	
SANDY CLAY : grey brown, medium plastic, medium dry strength, fine sand, soft, wet.	1.0 1.2			CL	S	
SILTY CLAY : grey, medium to high plastic, medium dry strength, some fine sand, soft, wet.	1.9			CL/CH	S	
SILTY CLAY : grey, high plastic, high dry strength, trace of fine sand, soft, wet.	2.0 2.6			CH	S	
Stopped no change						

AUSTRALIAN SOIL AND CONCRETE TESTING P/L A.B.N. 49 050 539 930

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ASCT Doc. No. W40 Rev. No. 02 -8/3/00 BD

BOREHOLE LOG REPORT

Client : De Groot Benson	**Project No :** 1159 - 001	**Project :** Hogues lane, Maclean
Lab No : 8272	**Report No :** 1159 - 001-001	**Borehole No:** 9

Borehole Inclination :90°	**Borehole Direction :** Vertical	**Date drilled :** 14/11/07
Surface Elevation : NA	**Borehole location :** Proposed Development Site	**Drill type :** Auger
Drilling Method : Yanmar Drill Rig		

TEST DATA

Soil Description	Depth (M)	Slope %	Graphic Symbol	Group Symbol	Consistency /Strength	Sample
SILTY CLAY TOPSOIL : dark grey brown, high plastic, high dry strength, some organic matter, soft, very moist.	0.3			CH	S	
SILTY CLAY : mottled grey brown orange, high plastic, high dry strength, soft to firm, moist.	0.7			CH	S/F	
SANDY CLAY : grey brown, medium plastic, medium dry strength, fine sand, soft, wet.	1.0 1.2			CL	S	
SILTY CLAY : grey, medium to high plastic, medium dry strength, some fine sand, soft, wet.	2.0 2.6			CL/CH	S	
Stopped no change						

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ASCT Doc. No. W40 Rev. No. 02 -8/3/00 BD

BOREHOLE LOG REPORT

Client : De Groot Benson	**Project No :** 1159 - 001	**Project :** Hogues lane, Maclean
Lab No : 8272	**Report No :** 1159 - 001-001	**Borehole No:** 10

Borehole Inclination : 90°	**Borehole Direction :** Vertical	**Date drilled :** 14/11/07
Surface Elevation : NA	**Borehole location :** Proposed Development Site	**Drill type :** Auger
Drilling Method : Yanmar Drill Rig		

TEST DATA

Soil Description	Depth (M)	Slope %	Graphic Symbol	Group Symbol	Consistency /Strength	Sample
SILTY CLAY TOPSOIL : dark grey brown, medium plastic, medium dry strength, some organic matter, soft, very moist.	0.3			CL	S	
SILTY CLAY : mottled grey orange brown, high plastic, high dry strength, soft to firm, very moist.	0.5			CH	S/F	
SILTY CLAY : grey, medium to high plastic, medium dry strength, some fine sand, soft, wet.	1.0 2.0 2.5			CH	S	
Stopped no change						

APPENDIX B – Soil Analysis Results

RESULTS OF ACID SULPHATE SOIL ANALYSIS (Page 1 of 2)

10 samples supplied by Australian Soil & Concrete Testing on 16th November, 2007 - Lab. Job No. E8319
Analysis requested by Brian Dick - **Your Project: Hogues Lane, Maclean. Project# 1159-001**

Sample Site	Depth (m)	EAL lab code	Texture (note 7)	Lab. Bulk Density tonne DW/m^3	Extractable Sulphate Sulphur %S_{kcl}	Extractable Calcium %Ca_{kcl}	Extractable Magnesium %Mg_{kcl}	Oxidisable Sulphur %S_{pos} (as %S_p - %S_{kcl})	Oxidisable Sulphur S_{pos} mole H$^+$/tonne	Oxidisable Calcium %Ca_A (%Cap - %Cakcl)	Oxidisable Magnesium %Mg_A (%Mgp - %Mgkcl)
Method No.					*23C*	*23V*	*23S*	*23E*	*a-23E*	*23X*	*23U*
BH1	1.5	E8319/1	Fine	1.40	0.02	0.11	0.12	0.00	0	0.00	0.00
BH2	0.5	E8319/2	Fine	1.40	0.01	0.23	0.05	0.00	1	0.01	0.00
BH3	Topsoil	E8319/3	Fine	1.40	0.01	0.22	0.03	0.01	8	0.03	0.00
BH5	0.5	E8319/4	Fine	1.10	0.03	0.10	0.09	0.03	17	0.02	0.01
BH6	Topsoil	E8319/5	Fine	0.90	0.10	0.12	0.09	0.20	125	0.07	0.03
BH6	1.0	E8319/6	Fine	1.00	0.05	0.08	0.06	0.07	41	0.08	0.04
BH7	2.0	E8319/7	Fine	0.90	0.11	0.10	0.09	0.83	517	0.17	0.10
BH9	1.5	E8319/8	Fine	1.30	0.06	0.08	0.08	0.04	24	0.08	0.04
BH9	2.5	E8319/9	Fine	1.10	0.09	0.10	0.08	1.42	888	0.17	0.15
BH10	0.5	E8319/10	Fine	1.20	0.11	0.09	0.10	0.11	69	0.26	0.11

NOTE:
1 - All analysis is Dry Weight (DW) - samples dried and ground immediately upon arrival (unless supplied dried and ground)
2 - Samples analysed by SPOCAS method 23 (ie Suspension Peroxide Oxidation Combined Acidity & Sulphate) and '**Chromium Reducible Sulphur' technique** (Scr - Method 22B)
3 - Methods from Ahern, CR, McElnea AE , Sullivan LA (2004). ***Acid Sulfate Soils Laboratory Methods Guidelines.*** QLD DNRME.
4 - Bulk density was determined immediately on arrival to laboratory (insitu bulk density is preferred)
5 - **ABA Equation: Net Acidity = Potential Sulfidic Acidity (ie. Scrs or Sox) + Actual Acidity + Retained Acidity - measured ANC/FF**
6 - The neutralising requirement does not include a safety margin for complete neutralisation (a factor of 1.5 is often recommended)
7 - For Texture: coarse = sands to loamy sands; medium = sandy loams to light clays; fine = medium to heavy clays and silty clays
8 - Neutralisation Calculation for neutralisation of actual and potential acidity (ie. sum of calculation based on Crs and TAA)
9 - .. Denotes not requested or required
10 - TAA is NATA certified but other SPOCAS is validated but awaiting full NATA certification

(Classification of potential acid sulphate material if: coarse Scr≥0.03%S or 19mole H$^+$/t; **medium Scr≥0.06%S** or 37mole H+/t; **fine Scr≥0.1%S** or 62mole H+/t)

* Projects that disturb >1000 tonnes of ASS soils with ≥0.03% S, a detailed management plan may be required.

checked: ....

RESULTS OF ACID SULPHATE SOIL ANALYSIS (Page 2 of 2)

10 samples supplied by Australian Soil & Concrete Testing on 16th November, 2007 - Lab. Job No. E8319
Analysis requested by Brian Dick - **Your Project: Hogues Lane, Maclean. Project# 1159-001**

Sample Site	Depth (m)	EAL lab code	Texture (note 7)	Lab. Bulk Density tonne DW/m^3	TAA pH_{KCl}	Titratable Actual Acidity (TAA) mole H$^+$/tonne (to pH 6.5)	TPA pH_{Ox}	TPA pH_{TPA}	Titratable Potential Acidity (TPA) mole H$^+$/tonne (to pH 6.5)	Titratable Sulphidic Acidity (TSA) mole H$^+$/tonne	NET ACIDITY SPOCAS Suite mole H$^+$/tonne (based on %Spos)	NET ACIDITY TPA Only mole H$^+$/tonne (based on TPA)	LIME CALCULATION SPOCAS Suite kg $CaCO_3$/tonne DW (includes 1.5 safety Factor)	LIME CALCULATION TPA Only kg $CaCO_3$/tonne DW (includes 1.5 safety Factor)
Method No.					23A	23F	23B		23G	23H	note 5	note 5	note 5	note 5
BH1	1.5	E8319/1	Fine	1.40	4.72	21	7.08	5.46	17	-4	21	17	2	1
BH2	0.5	E8319/2	Fine	1.40	5.19	17	7.13	5.78	18	1	18	18	1	1
BH3	Topsoil	E8319/3	Fine	1.40	4.96	25	6.80	5.67	20	-6	33	20	2	1
BH5	0.5	E8319/4	Fine	1.10	4.30	56	4.17	4.54	70	14	73	70	6	5
BH6	Topsoil	E8319/5	Fine	0.90	4.29	134	3.66	4.35	277	144	259	277	19	21
BH6	1.0	E8319/6	Fine	1.00	4.50	32	4.05	4.99	40	8	73	40	6	3
BH7	2.0	E8319/7	Fine	0.90	4.53	39	2.20	3.19	615	576	556	615	42	46
BH9	1.5	E8319/8	Fine	1.30	5.59	7	5.03	6.01	7	0	31	7	2	0
BH9	2.5	E8319/9	Fine	1.10	4.24	92	2.04	2.88	893	802	980	893	74	67
BH10	0.5	E8319/10	Fine	1.20	5.30	11	3.76	4.13	176	166	80 Refer Note 6 & 7	176 Refer Note 6 & 7	6	13

NOTE:

1 - All analysis is Dry Weight (DW) - samples dried and ground immediately upon arrival (unless supplied dried and ground)
2 - Samples analysed by SPOCAS method 23 (ie Suspension Peroxide Oxidation Combined Acidity & Sulphate) and **'Chromium Reducible Sulphur' technique** (Scr - Method 22B)
3 - Methods from Ahern, CR, McElnea AE , Sullivan LA (2004). ***Acid Sulfate Soils Laboratory Methods Guidelines.*** QLD DNRME.
4 - Bulk density was determined immediately on arrival to laboratory (insitu bulk density is preferred)
5 - **ABA Equation: Net Acidity = Potential Sulfidic Acidity (ie. Scrs or Sox) + Actual Acidity + Retained Acidity - measured ANC/FF**
6 - The neutralising requirement does not include a safety margin for complete neutralisation (a factor of 1.5 is often recommended)
7 - For Texture: coarse = sands to loamy sands; medium = sandy loams to light clays; fine = medium to heavy clays and silty clays
8 - Neutralisation Calculation for neutralisation of actual and potential acidity (ie. sum of calculation based on Crs and TAA)
9 - .. Denotes not requested or required
10 - TAA is NATA certified but other SPOCAS is validated but awaiting full NATA certification

(Classification of potential acid sulphate material if: coarse Scr≥0.03%S or 19mole H$^+$/t; **medium Scr≥0.06%S** or 37mole H+/t; **fine Scr≥0.1%S** or 62mole H+/t)
* Projects that disturb >1000 tonnes of ASS soils with ≥0.03% S, a detailed management plan may be required.

checked: ....

APPENDIX C – Chain of Custody

AUSTRALIAN SOIL AND CONCRETE TESTING P/L A.B.N.49 050 539 930 OE8319.

Unit 7/17 Southern Cross Drive, P.O. Box 5120 Ballina NSW 2478. Telephone: 02 6686 8567, Fax: 02 6686 8396

ASCT Doc. No. A18 Rev. 03- 3/7/07 - CC

Laboratory Test Program

Client: De Groot & Benson	Project no: 1159-001	Project: Hogues lane, Maclean.
Location: Residential area + detention pond.	Requested By: ASCT	Test methods: EAL
Sampled By:	Sample Type: SOIL	Date Sampled: 14.11.07

Lab Sample No	Sample Source	Sample Description	Depth of Sample m		ASA (spocas)	lime Requirement
8272	BH 1	Silty Clay / Brown grey	1.5		\	\
"	BH 2	Silty Clay / Brown grey Orange brown	0.5		\	\
"	BH 3	Silty Clay / Grey Brown	Topsoil		\	\
"	BH 5	Silty Clay / Brown, Orange, G	0.5		\	\
"	BH 6	Silty Clay / Dark grey	Topsoil		\	\
"	"	Silty Clay / Grey Brown	1.0		\	\
"	BH 7	Silty clay / Grey	2.0		\	\
"	BH 9	Silty Clay / Grey	1.5		\	\
"	"	Silty Clay / Grey	2.5		\	\
"	BH 10	Silty Clay / Brown Grey	0.5		\	\

Comments:

Signed: [signature] (Approved Signatory) Date: 16.11.07

Signed: CDTandey (Receiving Authority) Date: 16 NOV 07.

Sampling performed at ASCT P/L Ballina
NATA Accredited Laboratory Number 3229

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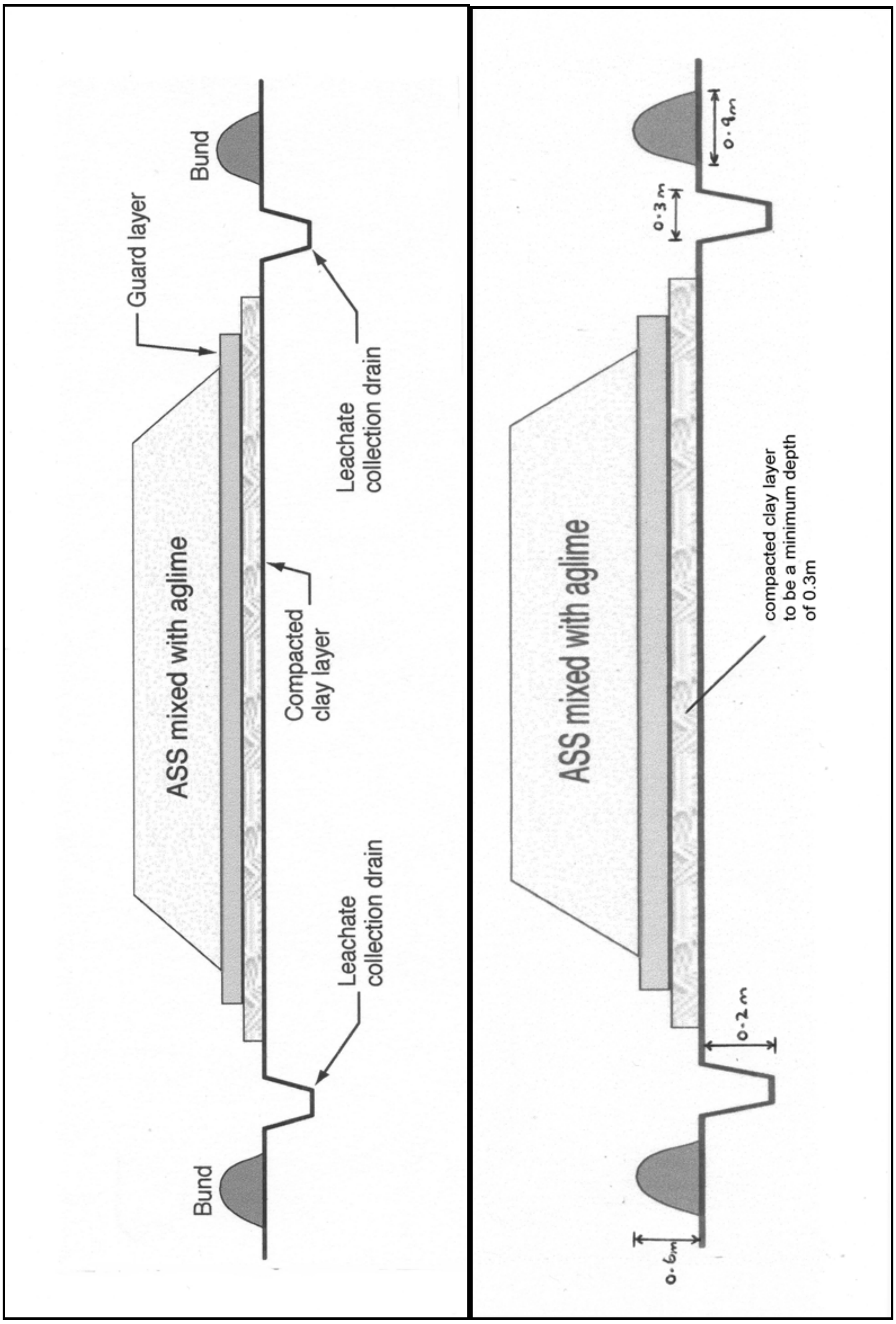
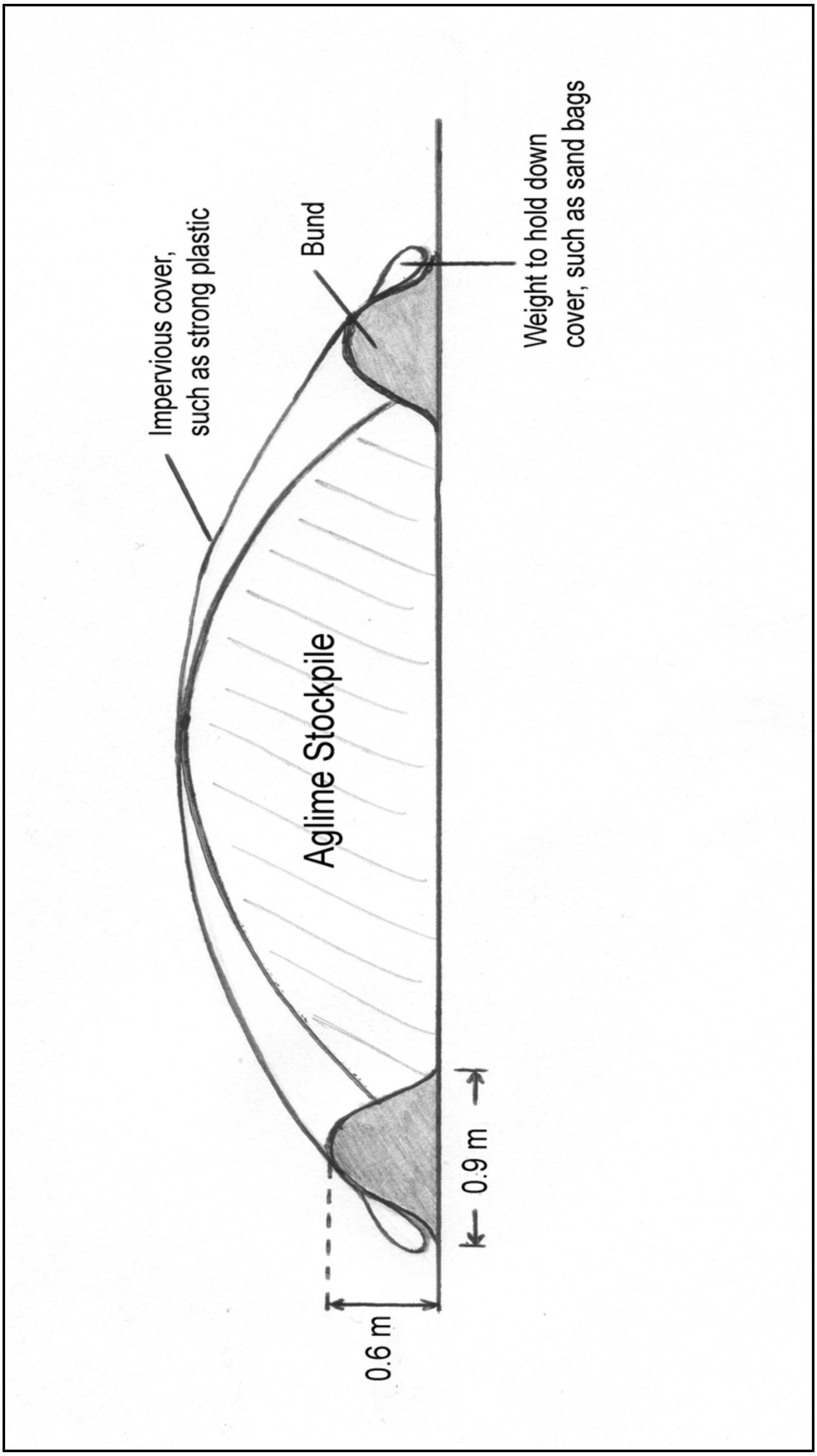
APPENDIX D – Cross Section of Stockpile Design



Schematic cross-section of an acid sulfate soil treatment pad/storage area, including a compacted clay layer, guard layer, leachate collection system and containment with bunding (source: Dear, Moore, Dobos, Watling and Ahern, 2002, p.24).



Schematic cross-section of agricultural lime storage area, including an impervious weighted down cover and bunding.

APPENDIX E - Environmental Summary Report Proforma

TREATMENT					TESTING									
Quantity of soil/water to be treated	Origin of material	Quantity & type of lime	Date treated	Storage area	Date tested	Test by	pH meter ID	pH calibration buffer		Field test result pH	Lab Sample ID	EC	Action taken	
								7.0	4.0					