Newton Denny Chapelle
SURVEYORS PLANNERS ENGINEERS

ATTACHMENT 2

On-site Sewage and

Wastewater Management Report

BCA Check

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ON-SITE SEWAGE CONSIDERATIONS REPORT

PROPOSED SUBDIVISION
"ORAVIEW"
Lot 2 DP 572347
25 Ellems Bridge Road PIORA

Client: SG and JH Lane

Reference 05043
October 2006
Revised March 2009

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1.0 SUMMARY

The proposed development comprises the formation of 30 rural residential allotments and one residual agricultural allotment (Lot 27). An existing dwelling and sewage management facility are located on proposed Lot 20. The site and soils are suitable for on-site disposal of effluent. Soils require amelioration to prevent soil degradation. The site constraints have been identified.

Site constraints and limitations are summarised as follows:

1. Medium/heavy clay sub-soils;
2. Proximity to intermittent gullies, and dams;
3. Low soil pH
4. Convergent landform.

Secondary treatment of effluent and soil amelioration is required on the majority of allotments to address site and soil limitations.

2.0 INTRODUCTION

The purpose of this report is to assess the suitability of the site for onsite sewage management to assist Richmond Valley Council in determining the development application for the proposed subdivision. Specific site conditions for each proposed allotment have been considered and proposed land application areas have been determined based on nutrient, pathogen and water balance calculations. This report identifies site constraints and site suitability for on-site sewage management systems for a typical four bedroom (five person) residence.

Environmental objectives of Council's On-Site Sewage Management Strategy are as follows:

1. ensure the protection of the surrounding environment including ground water; surface water; land and vegetation;
2. aid in the prevention of public health risk from on-site sewage disposal;
3. maintain and improve community amenity;
4. ensure maximum re-use of resources;
5. ensure ecologically sustainable development;

Appendix A contains site plans indicating the site limitations, allotment configuration and suggested land application areas. At dwelling construction stage a detailed soil survey is required for each site to determine the most suitable land application area. Effluent disposal envelopes are not recommended as most sites have several areas suitable for effluent disposal.

Design Criteria

Water Supply:	**Roof water harvesting**
Wastewater Quantity:	**4 bedrooms + 1 = 5 persons**

	140L/person/day = 700L/day
Water Saving Devices:	**Standard** (water conserving automatic washing machine, dual flush 6/3 toilets, low flow shower heads, aerator taps)

3.0 SITE DESCRIPTION

3.1 Surface

The site is located at the corner of Ellems Bridge Road and the Bruxner Highway at Piora. The site is accessed from Ellems Bridge Road which is to be realigned as part of the development. An old railway easement winds through the site in an east west direction and forms part of the proposed access road.

Field work was carried out on 6 May 2005 and included 31 machine augured bore holes to 1.0m in depth at the most suitable land application areas for each allotment and a visual inspection of the site and surrounding areas. The bore logs are presented in Appendix B. The site is generally well drained, some evidence of water logging was found in gullies and drainage lines. The site has previously been cleared and supports scattered trees and is currently utilized for grazing. Past cultivation is evident by shallow excavations along fence lines. Adjoining properties are used for agricultural purposes.

Site gradients at proposed land application areas range from 5% to 15%. A spring fed dam is located on proposed Lot 4. A 100m buffer has been applied to the dam with 40m buffers to the drainage gullies. A dwelling exists on proposed lot 20. The site evaluation is provided below.

Site Assessment	Constraint
Climatic Variations	Moderate rainfall
Land Area	1 ha to 3.5 ha
Flood Potential	Not subject to flooding
Aspect/exposure	Excellent aspect and exposure
Slope/landform	Less than 5-15% slope, divergent/convergent
Run-on and seepage	Diversion drains required upslope
Surface rocks	Small floaters require removal
Erosion potential	Care required
Site drainage	Good
Vegetation Indicating Water logging	Grasses evident in gullies and drainage lines.
Fill	Along the old railway line and around dams
Groundwater vulnerability	Groundwater contamination unlikely due to clay subsoils
Buffer distances from land application area	
Well/bore for domestic supply 250m down slope	Nearest licensed bore 370m to the south west of the nearest land application area

Permanent waters 100m	Reduced buffer proposed to the spring fed dam of 60m for secondary treated effluent
Ephemeral stream 40m	Buffer achieved
Other sensitive environments 100m	Nil
Boundary of premises 12m & 6m	Buffer achieved
Buildings 6m down & 3m up slope	Buffer achieved
Power lines	Outside easement or 10m from centreline where no easement exists

3.2 Sub-surface

Site investigations indicate shallow to moderately deep clay based soils. Shallow weathered bedrock was encountered in bore holes on some allotments and was unpredictable in location, however, where this occurred suitable land application areas were established on the allotment with soil depth in excess of 1m. It is likely that several alternate land application areas will be available on each of the allotments due to the large size of the holdings. Soils were stonier and shallower on ridges.

Chocolate soils consisting of up to 300mm of brown/black clay loam overlies 300-600mm of brown/dark brown clay. This layer overlies a weathering front of strongly weathered bedrock. Lots 1, 2, 17, 18 & 19 indicated a Sandy Podzolic classification comprising brown sandy loam top soils overlying brown sandy medium clays. At a depth of 400mm most sites were classified as category 6 medium to heavy clay soils. Bore logs are presented in Appendix B.

Laboratory testing was undertaken to assess nutrient removal characteristics and conditions for plant growth. Samples were tested for phosphorus sorption, electrical conductivity, CEC, and exchangeable sodium potential. Texture, structure and pH were also determined. Water table depth is estimated at greater than 2m. Results are presented in Appendix D and discussed in Section 4. Ground water was not encountered in any of the boreholes. Bore hole locations are shown in Appendix A.

Soil Assessment	**Details**
Depth to bedrock/hardpan (m)	400mm to >1000mm, each site has areas where soil depth is greater than 1000mm
Depth to high soil water table (m)	>2m
Rock/coarse fragments (%)	Medium gravel 2-20mm < 20% in some boreholes
Soil type Soil structure Soil texture Soil category	Chocolate to Sandy Duplex Strong Sandy loams to clay A horizon Medium-heavy clays B horizon Top soil 2-5, sub soil 5-6

Permeability category	Moderate to high, loam based top soils Moderate to low, clay based soils
pH	5.29- 5.58 (6-8 low limitation)
P sorption capacity	21400- 23786kg/ha/m (low limitation)
Electrical conductivity	1.3-1.5 (<4 low limitation)
Cation Exchange Capacity(CEC)	60.99-61.26 (>15 low limitation)
Exchangeable Sodium Potential (ESP)	0.8-1.3 (0-5 low limitation)
Bulk Density	<1.8g/cm (low limitation)
Hydraulic loading rate	LTAR 5mm/day, Design Irrigation Rate 15mm/week

4.0 DISCUSSION AND RECOMMENDATIONS

4.1 Site and Soils

Cation Exchange Capacity was found to be a low limitation indicating that the soils have the ability to retain specific pollutants. Sodicity (ESP) was low and confirmed by Emerson tests indication Class 2. Electrical conductivity indicated a low limitation, pH ranged from 5.29 to 5.58 being a medium limitation requiring the application of lime to increase pH and enhance conditions for plant growth.

Phosphorus sorption in these soils is known to be high. Soil analysis indicated 22000kg/ha/m P sorption. Councils computer model uses a conservative p sorption rate of 10000kg/ha/m depth. Overall P sorption is considered a low limitation due to the clay based subsoils. The large land application areas are well in excess of the required phosphorus areas.

Special design and distribution measures must be adopted to address the Long Term Acceptance Rate (LTAR) of the clay based soils. Improving the quality of the effluent will minimize the build up of the clogging layer and increase the long term acceptance rate of the soils. Disinfection and nutrient removal can be achieved with secondary treatment of effluent via installation of suitable reed beds or aerated wastewater treatment systems. For design purposes calculations have been based on aerated wastewater treatment systems as the required land application area is generally larger than with reed bed treatment. Reed beds however have the advantage of low maintenance costs and do not require electricity.

Soil types at a depth of 400mm were generally medium-heavy clays requiring secondary treatment of effluent. Lot 2 has sufficient depth of loam based top soil to allow the installation of a standard septic tank with ETA beds, however, having regard to the cumulative effect of on-site systems in the subdivision it is recommended that all systems achieve secondary treatment standards.

The clay soils have low water storage capacity and as such waste water disposal systems for the site must be based on evapotranspiration rather than absorption through the soils to prevent water logging. While it is possible to dispose of secondary treated effluent to evapotranspiration beds, it is considered that subsurface irrigation is the best possible option for the clay based soils. The soil texture is most suited to shallow sub-surface irrigation, with little soil disturbance. Application of gypsum to the land application areas will prevent soil degradation in the clay based soils.

Surface rocks and floaters require removal in and immediately surrounding the land application areas. Lots 4, 5, 6 & 7 require particular consideration if the proposed land application areas are located within the 100m buffer to the spring fed dam. Secondary treatment of effluent with disinfection is required to reduce the pathogen loading. It is expected that this type of system will provide sufficient nutrient removal and disinfection to adopt a reduced buffer of 50m to the dam. The use of subsurface irrigation over a large land application area will ensure even distribution of wastewater and help to prevent the movement of pathogens and nutrients via surface water runoff. However, the removal of the dam will allow greater utilisation of the allotments and should be considered. The dam water is not to be used for domestic purposes.

Recommended site and soil works include:

1. Improving the soils by raising the soil pH to around 6 to 7 by applying lime to the land application areas.
2. Improving the soils by applying gypsum to the land application areas.
3. Incorporating organic matter into the land application areas to improve the ability of sandy top soils to retain pollutants on lot 2.
4. Removing surface rocks from the land application areas.
5. Treating effluent to secondary standard with to improve the Long Term Acceptance Rate of the clay soils, and utilizing subsurface irrigation as the means of disposal.
6. Lots 4, 5, 6 & 7 require careful consideration as the proposed land application areas are located within the 100m buffer to the spring fed dam. Secondary treated effluent with disinfection and a minimum 50m buffer is recommended. Removal of the dam at subdivision stage should be considered.
7. The land application areas with sandy loam top soils are to be dip ripped to a depth of 750mm to aid percolation and prevent effluent shortcutting the land application areas.

4.2 Land Application Areas

Land application areas have been calculated based on a four bedroom (5 person) dwelling using roof water harvesting. A hydraulic load of 700 litres/day has been adopted. Nutrient and hydraulic loading calculations have been determined based on the soil types in accordance with Councils strategy. Base calculations are provided in Appendix C for the maximum land application area required for clay based soils with a percolation rate of 5mm/day. Calculations have been provided in Appendix C for the largest required land application areas including (380m^2) with no reductions applied for secondary treated effluent. A conservative subsurface irrigation area of 400m^2 has been determined to ensure there is adequate site area available.

A proposed effluent disposal land application area has been indicated on the limitations plan in Appendix A. An area of 800m^2 has been nominated and will cater for the maximum required land application area plus a reserve area for future replacement of irrigation areas or trenches.

5.0 HEALTH AND ENVIRONMENTAL CONSTRAINTS

The medium-heavy clay subsoils are a limitation to on-site effluent disposal particularly in periods of prolonged rainfall where water logging may occur. The use of subsurface irrigation will spread the wastewater over a large land application area reducing large point loads. It is unlikely that contaminants will be transferred directly to the water table via percolation due to the low permeability of the dense clay subsoils. The large land application areas will ensure that effluent is contained within the design area. Measures such as storm water diversion mounds/drains can be implemented to control surface water runoff from the land application areas and aid in reducing concentration of runoff from the convergent landforms.

6.0 CONCLUSION

This report provides preliminary investigations relating to the suitability of the proposed allotments for on-site disposal of effluent. Our investigations have revealed that it is possible to provide safe wastewater management systems on the proposed allotments as discussed. All site and soil limitations have been addressed to minimise any detrimental impacts on the environment or the amenity of the area.

7.0 DISCLAIMER

This report was prepared for the purposes and exclusive use of the stated client to accompany an application to Richmond Valley Council for the specific development application for subdivision of the subject land only, and is not to be used for any other purpose or by any other person or corporation. BCA Check Pty Ltd accepts no responsibility for any loss or damage suffered howsoever arising to any person or corporation who may use or rely on this report in contravention of the terms of this clause.

Testing and reporting has been based on the relevant Council guidelines, however, recommendations given in this report are based on our site investigation. Sampling patterns and reporting have been undertaken in a manner that we believe is representative of the site conditions. Exploration is however limited by time and economic constraints, and in some cases soil conditions may change dramatically over short distances where even detailed sampling programs may not locate all variations. The location of bore holes in relation to proposed boundaries is an estimate only as a detailed survey had not been conducted at the time of field work. This report provides an overview of the site constraints. Full individual site surveys and detailed reporting must be undertaken when dwelling details are known.

REFERENCES

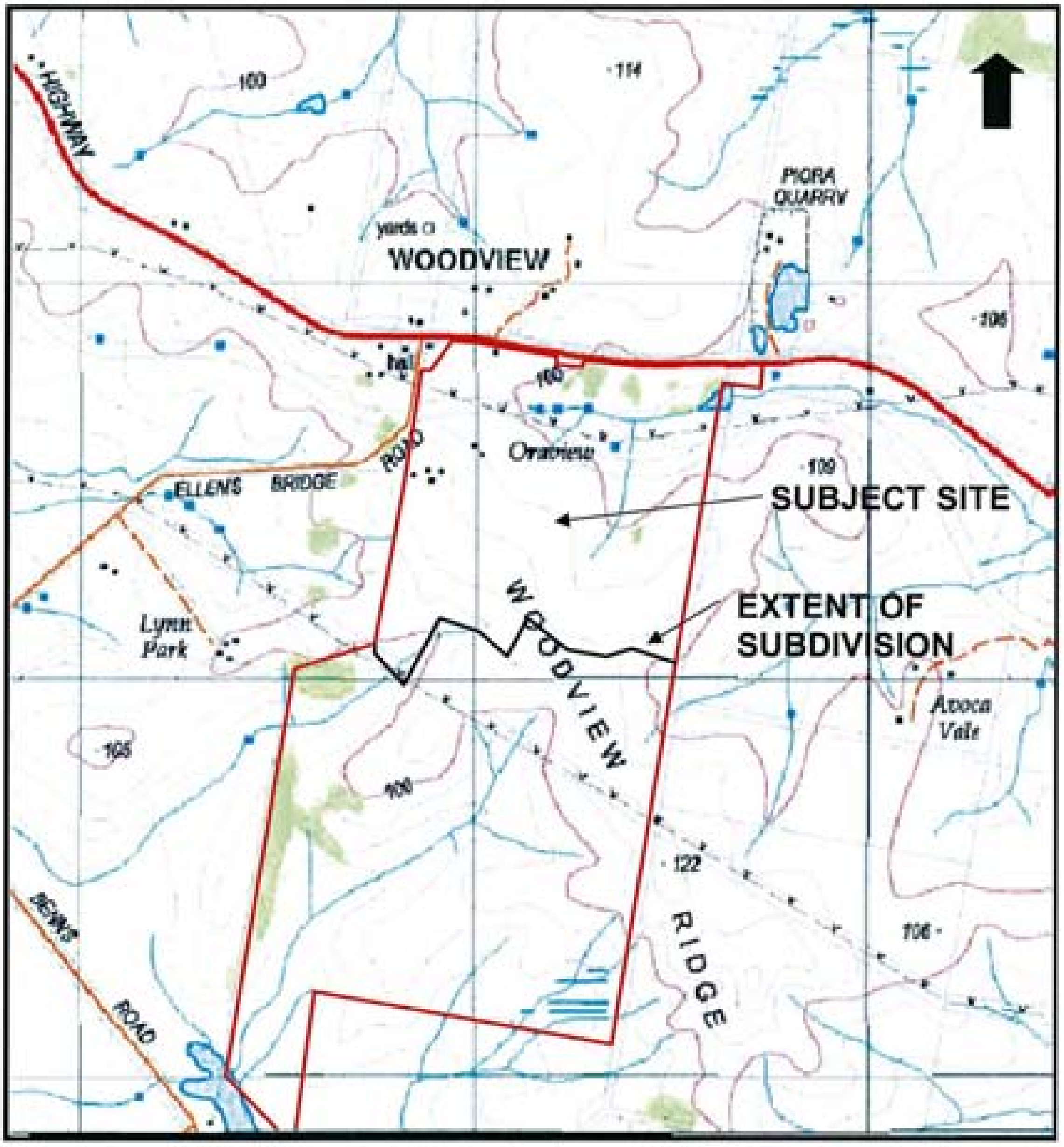
1. Australian Standard 1547 - 2000, *On-Site Domestic Wastewater Management*
2. NSW Government Guidelines - *On-Site Sewage Management for Single Households*
3. Richmond Valley Council's – *On-Site Sewage and Wastewater Management Strategy.*

APPENDIX A

Locality Map

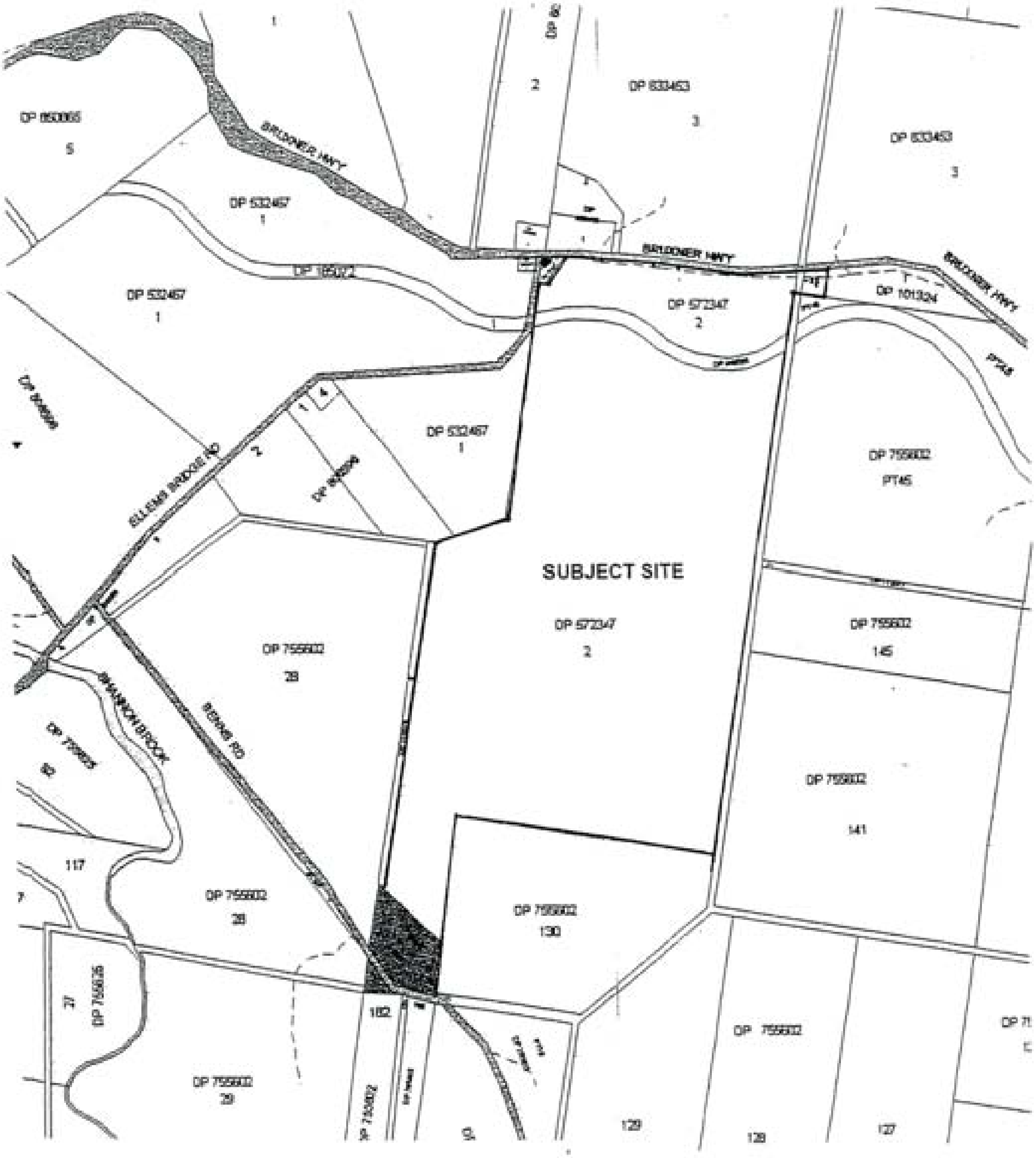
Site Layout and Limitations

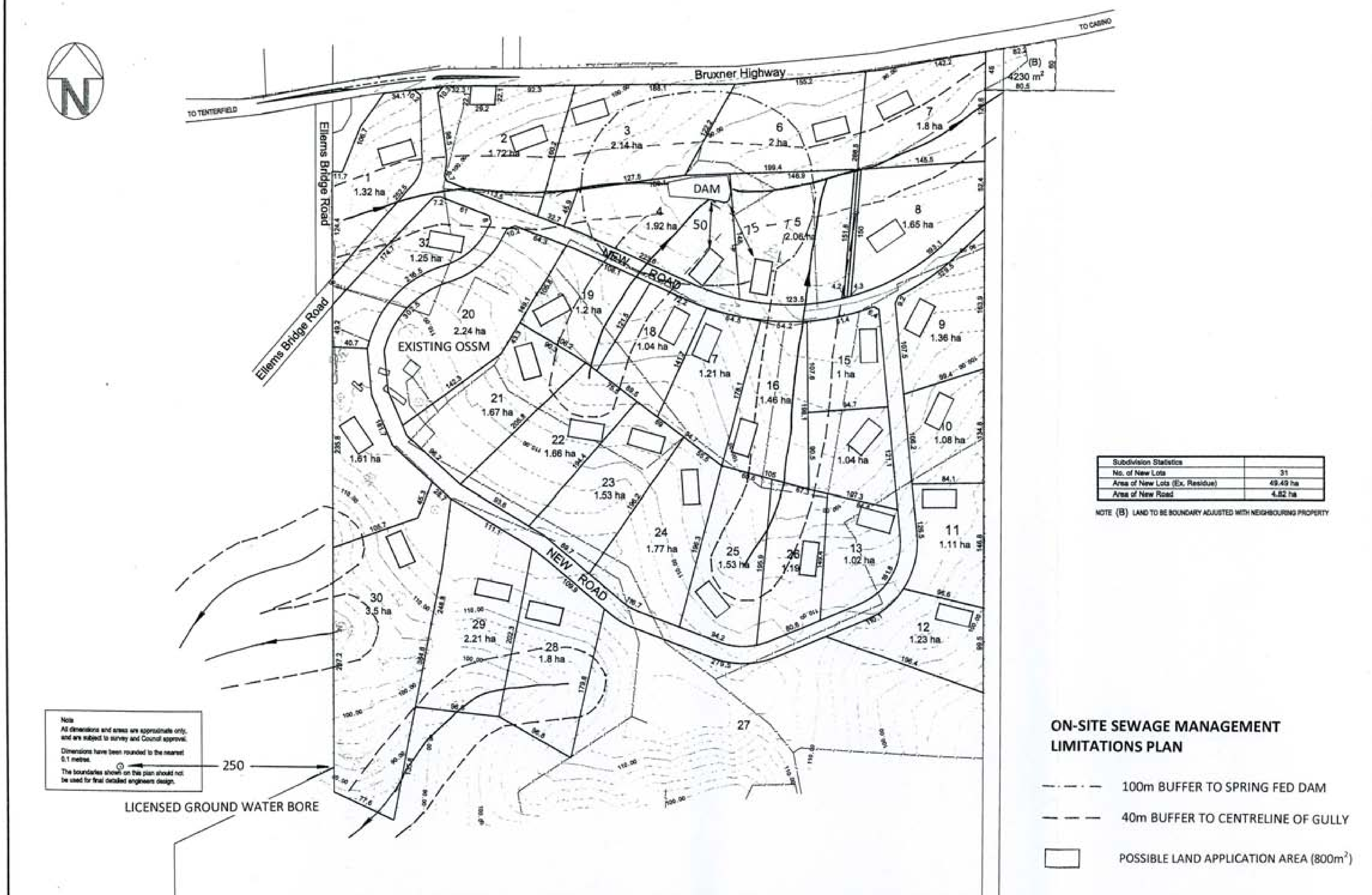
Ground Water Bore Search Map


HIGHWAY
100
114
PIORA
QUARRY
yards
WOODVIEW
106
hall
100
Oraview
109
ELLENS BRIDGE ROAD
SUBJECT SITE
EXTENT OF
SUBDIVISION
WOODVIEW
Lynn
Park
Avoca
Vale
105
100
122
RIDGE
106
BENN'S ROAD

LOCALITY MAP

25 Ellems Bridge Road
Piora





Subdivision Statistics	
No. of New Lots	31
Area of New Lots (Ex. Residue)	49.49 ha
Area of New Road	4.82 ha

NOTE (B) LAND TO BE BOUNDARY ADJUSTED WITH NEIGHBOURING PROPERTY

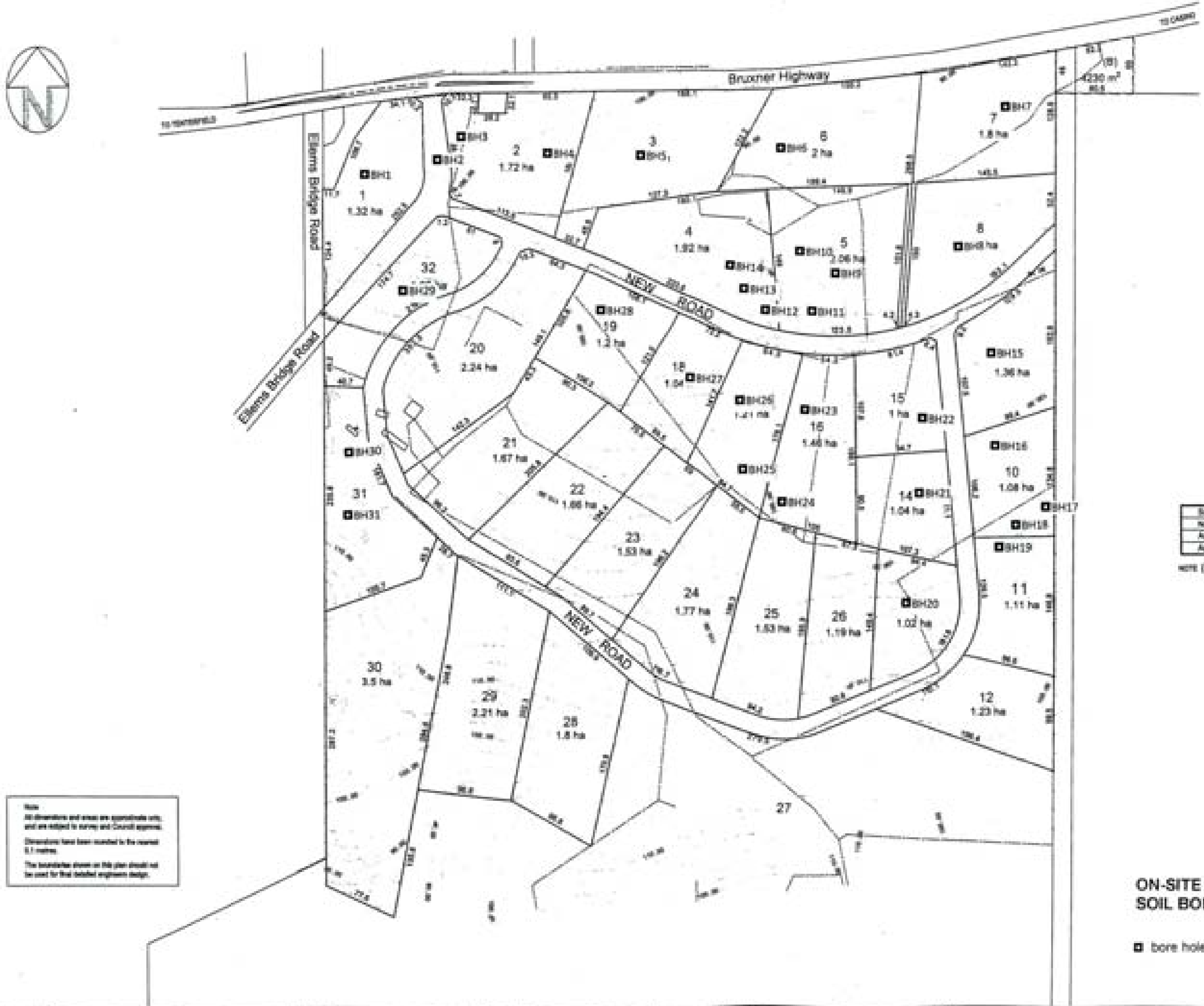
ON-SITE SEWAGE MANAGEMENT LIMITATIONS PLAN

100m BUFFER TO SPRING FED DAM

40m BUFFER TO CENTRELINE OF GULLY

POSSIBLE LAND APPLICATION AREA (800m²)

Amendments	Notes:	Design: / Survey: / Drawn: GPR / Approved / Datum: Assumed (2.0m Contour Interval)	Date FEB 2008 / Scale 1:2000 @ A1	Newton Denny Chapelle Consulting Surveyors & Planners	Client: SID LANE "ORAVIEW"	Project: PROPOSED SUBDIVISION LOT 2 DP 572347 & LOT 1 DP 449328 ELLEMS BRIDGE ROAD - PIORA



Subdivision Statistics	
No. of New Lots	31
Area of New Lots (Ex. Residue)	49.49 ha
Area of New Road	4.82 ha

NOTE (B) LAND TO BE BOUNDARY ADJUSTED WITH NEIGHBOURING PROPERTY

Note:
All dimensions and areas are approximate only, and are subject to survey and Council approval.
Dimensions have been rounded to the nearest 0.1 metres.
The boundaries shown on this plan should not be used for final detailed engineering design.

ON-SITE SEWAGE MANAGEMENT
SOIL BORE HOLE PLAN

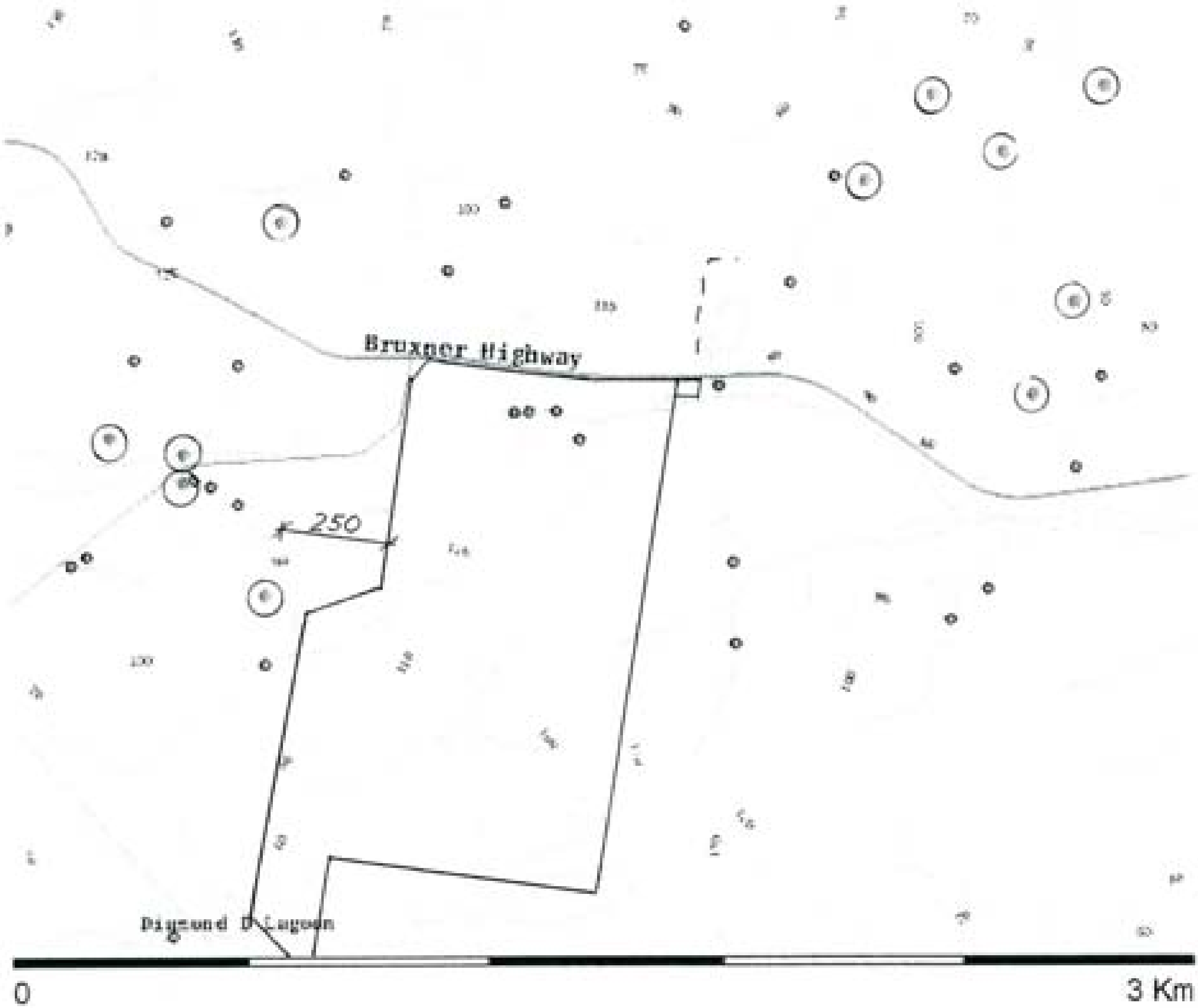
◘ bore hole location

Newton Denny Chapelle

Client: SID LANE

Project: PROPOSED SUBDIVISION
LOT 2 DP 572347 & LOT 1 DP 449328

GROUND WATER BORE SEARCH MAP - PIORA



Legend

Symbol	Layer
	Groundwater bores
	Major rivers
Town Primary/arterial road Motorway/freeway Railway Runway Contour Background	Topographic base map (Topoweb)

APPENDIX B

Soil Bore Logs
Soil Analysis - Laboratory Results

Bore Hole	Lot	Soils
1	**1**	Surface cobbles evident to 100mm diameter, 0-300 brown-black medium clay strongly structured, 300-600 brown medium-heavy clay strongly structured, 600-900 pale brown weathered rock. 15% slope.
2	**road**	Brown loam 0-200, brown moderately structured clays to 900. Slope 8%.
3	**2**	Brown weakly structured loam 0-300, brown moderately structured sandy clays to 300-900. Floater evident at the surface near fence line. Stones and boulders placed along fence line. Slope 8%
4	**2**	Brown weakly structured loam 0-600, brown moderately structured grey medium clays mottled orange 600-1000. Slope 10%
5	**3**	Brown moderately structured clay loam 0-100, brown moderately structured heavy clay mottled orange 100-1000. Slope 11%
6	**6**	Brown-black heavy clays 0-1000, no horizon differentiation. Slope 6%.
7	**7**	Surface cobbles evident to 100mm in diameter. Brown-black strongly structured heavy clay to 0-1200. Slope 7%.
8	**8**	Brown-black heavy clays 0-1000, no horizon differentiation, Slope 4%.
9	**5**	Dark brown light clay 0-300, brown clays 300-600 terminated on rock.
10	**5**	Brown clay loam 0-250, brown clays 300-600 terminated on rock.
11	**5**	Brown clay loam 0-300, brown strongly structured medium clay 300-1000. Slope 10%
12	**4**	Brown clay loam over brown clays, terminated at 500mm on rock
13	**4**	Brown clay loam over brown clays, terminated at 400mm on rock
14	**4**	Pale brown silty loam 0-300, 300-1000 grey sandy clay mottled orange, moderately structured, slope 9%.
15	**9**	Dark brown light clay 0-100, dark brown medium clays 100-700, 700-1000 pale brown weathered rock. Slope 8%
16	**10**	Dark brown clay loam 0-50, brown medium-heavy clay 50-1000, slope 10%
17	**10**	Dark brown clay 0- 200mm over brown clay. Terminated at 500mm on rock, Slope 12%
18	**10**	Brown clay 0- 500mm weathered rock 500-700. Terminated at 700mm on rock.
19	**11**	Brown medium clay 0-500mm, 500-1000 weathered rock.
20	**13**	Dark brown medium-heavy clay, no profile differentiation 0-1000. Slope 10%.
21	**14**	Surface cobbles evident to 100mm on lower slopes, dark brown clay loam 0-100, dark brown medium clay 100-800, pale brown weathered bedrock 800-1000, slope 10%
22	**15**	Surface cobbles evident. Brown-black medium clays 0-700, 700-1000 pale brown weathered bedrock. Slope 7%
23	**16**	Brown medium clay 0-200mm, 200-600 brown strongly structured medium clays, terminated on rock,
24	**16**	Brown medium clay 0- 200mm, 200-1000 brown medium clays, slope 8%
25	**17**	Brown fine sand 0-300mm, 300-600 grey medium clay mottled orange, terminated on rock. Slope 10%
26	**17**	Brown fine sand 0-300mm, 300-1000 grey medium clay mottled orange. Slope 10%
27	**18**	Brown fine sand 0-300, 300-1000 grey medium clay mottled orange. Slope 8%
28	**19**	Orange-brown medium clay 0-400, brown medium clay 400-700, pale weathered bedrock. Slope 7%
	20	Existing Dwelling
29	**1**	Dark brown medium clay 0-200, brown medium clay 200-1000, few medium gravels. Slope 9%
30	**31**	Surface cobbles to 100mm diameter, red brown clay loam 0-300, red light clay 300-700, weathered rock 700-1000. Cobbles in soil profile. Slope 5%
31	**31**	Surface cobbles to 100mm diameter, red brown clay loam 0-300, red light clay 300-700, weathered rock 700-1000. Cobbles in soil profile. Slope 5%

SEPTIC DISPOSAL SOIL ASSESSMENT (Page 1 of 1)

2 soil samples from Ba Check supplied on 29th April, 2005 - Lab Job No. E3702
Analysis requested by Hayley Thornton.

	Ellems Bridge Bore Hole 1	Ellems Bridge Bore Hole 2
Description	Loam	Loam
Lab. Bulk Density (tonne/m3)	0.93	1.30
Soil pH (1:5 $CaCl_2$)	5.58	5.29
Soil Conductivity (1:5 water dS/m)	0.137	0.167
Soil Conductivity (as EC_e dS/m)[note 10]	1.302	1.587
Native NaOH Phosphorus (mg/Kg P)	85.6	48.8

Residual phosphorus remaining in solution from the initial phosphate phosphorus		
Initial Phosphorus concentration (ppm P)	**25**	**25**
72 hour - 3 Day (ppm P)	1.377	2.43
120 hour - 5 Day (ppm P)	1.082	2.10
168 hour - 7 Day (ppm P)	1.144	1.69
Equilibrium Phosphorus (ppm P)	0.89	1.24

EXCHANGEABLE CATIONS		
Sodium ($cmol^+$/Kg)	0.77	0.48
Potassium ($cmol^+$/Kg)	0.35	0.29
Calcium ($cmol^+$/Kg)	29.17	31.23
Magnesium ($cmol^+$/Kg)	30.87	28.88
Hydrogen ($cmol^+$/Kg)	0.00	0.00
Aluminium ($cmol^+$/Kg)	0.11	0.12
ECEC (effective cation exchange capacity)(cmol+/Kg)	61.26	60.99
Exchangeable Sodium Percentage (ESP)	1.3	0.8
Calcium/ Magnesium Ratio	0.94	1.08

Notes:

1 : ECEC = Effective Cation Exchange Capacity = sum of the exchangeable Mg, Ca, Na, K, H and Al
2 Exchangeable bases determined using standard Gilman and Sumpter (1989) digest (Method 15E1) with no pretreatment for soluble salts. When Conductivity ≥0.25 dS/m soluble salts are removed (Method 15E2).
3 ppm = mg/Kg dried soil
4 Insitu P determined using 0.1M NaOH and shaking for 24 hrs before determining phosphate
5 Soils were crushed using a ceramic grinding head and mill; five 1g subsamples of each soil were used to which 40ml of 0.1M NaCl with Xppm phosphorus was added to each. The samples were shaken on an orbital shaker
6 Exchangeable sodium percentage (ESP) is calculated as sodium ($cmol^+$/Kg) divided by ECEC
7 All results as dry weight DW - soils were dried at 6OC for 48hrs prior to crushing and analysis.
8 Phosphorus Capacity method from Ryden and Pratt, 1980.
9 Aluminium detection limit is 0.05 $cmol^+$/Kg; Hydrogen detection limit is 0.1 $cmol^+$/Kg. However for calculation purposes a value of 0 is used.
10. For conductivity 1 dS/m = 1 mS/cm = 1000 μS/cm; EC_e conversions: sand loam 14, loam 9.5; clay loam 8.6; heavy clay 5.8
11. 1 $cmol^+$/Kg = 1 meq/100g

checked: ......

PHOSPHORUS SORPTION TRIAL (Page 1 of 1)

2 soil samples from Ba Check supplied on 29th April, 2005 - Lab Job No. E3702
Analysis requested by Hayley Thornton.

Calculations for Equilibrium Absorption Maximum for Soil provided

I.D.	JOB NO.	Equilibrium P mg P/L (in solution)	Added P mg P/L	P Sorb at Equil. mg P/Kg	Native P mg P/Kg	Equilibrium P Sorption Level µg P/g soil	Divide Ø (from Table)	Equilibrium Absorption Maximum (B) µg P/g soil
Ellems Bridge Bore Hole 1	E3702/1	0.89	25	965	85.64	1050	0.46	**2,280**
Ellems Bridge Bore Hole 2	E3702/2	1.24	25	950	48.76	999	0.50	**2,018**

Calculations for phosphorus sorption capacity

	JOB NO.	Equilibrium Absorption Maximum (B) µg P/g soil	multiply by theta of wastewater to be applied (=X)	minus the native P (=Y)	**Kg P sorption / hectare (to a depth of 15cm)** (1.95 is a correction factor for density, etc)	**Kg P sorption / hectare (to a depth of 100cm)** (1.95 is a correction factor for density, etc)
Ellems Bridge Bore Hole 1	E3702/1	2280	(=B x theta)	(=X -native P)	(=Y x 1.95)	(=Y x 1.95 x 100/15)
Ellems Bridge Bore Hole 2	E3702/2	2018	(=B x theta)	(=X - native P)	(=Y x 1.95)	(=Y x 1.95 x 100/15)

EXAMPLE 1 - Calculations for phosphorus sorption capacity using a wastewater phosphorus of 15mg/L P

	JOB NO.	Equilibrium Absorption Maximum (B) µg P/g soil	multiply by theta of wastewater to be applied (ie. 0.84)	minus the native P (=Y)	**Kg P sorption / hectare (to a depth of 15cm)** (1.95 is a correction factor for density, etc)	**Kg P sorption / hectare (to a depth of 100cm)** (1.95 is a correction factor for density, etc)
Ellems Bridge Bore Hole 1	E3702/1	2280	1915	1830	**3,568**	**23,786**
Ellems Bridge Bore Hole 2	E3702/2	2018	1695	1646	**3,210**	**21,400**

APPENDIX C

Land Application Area Calculations

Lismore CC On-site Wastewater Model (Single Rural Households)
OSmodel200808.xls Printed 17-3-2009

			Default	User-defined
Client				
Address	Ellems Bridge Road			
Site	Block size (m2)			900000
	Buffer (m) from land application area to	gully	>40	
	Water (L/p.d) from	Roof water harvesting	140	
	Persons			5
	☐ Internal wastewater sources split?	☐ Multiple households? How many? 1		
Wastewater components/system	Toilet	☑		
	Bathroom	☑		
	Laundry	☑		
	Kitchen	☑		
	Total wastewater flow (L/d) [needs caution if user-defined]		700	
Treatment system	Secondary: AWTS			
	Nitrogen removal %		20%	
	Wetted depth of reed bed (m)			
	Maximum N allowed to go down from system (kg/yr)		15.00	
Land application	Land application type	Subsurface drip irrigation		
	Design depth of root zone (mm)		300	
			0	
Soil information	Morand code	Duplex Soils = ba, cc, ck, cl, mi, ni		
	Phosphorus sorption (kg/ha.m)		8000	
	Depth to water table or bedrock (for P calcs) (m)			1
	Texture/structure	Med. to heavy clays - strong. Structure		
		Maximum deep drainage rate (mm/d)	3.9	
Area calculations	Hydraulic area (m2) (or enter SSI industry estimate)		346.0	
	Nitrogen area (m2) [allowing export of 15.00 kg/yr]		0.0	
	Phosphorus area (m2)		300.0	
	Required land application area (m2)		**346.0**	

ATTACHMENT 3

Stormwater Management Plan

Newton Denny Chapelle

• JOHN NEWTON B. Surv; M.I.S. Aust. • TONY DENNY B. Surv. (Hons); M.I.S. Aust. • DAMIAN CHAPELLE BTP. CPP.

Stormwater Management Plan

For Proposed Rezoning of Lands for
Rural Residential Subdivision
at 25 Ellems Bridge Road, Piora

ON BEHALF OF S LANE

Our Ref: 04/102 - Rev B Aug 09

NewtonDennyChapelle
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Executive Summary

Newton Denny Chapelle were engaged to undertake the preparation of a Stormwater Management Plan (SMP) at Ellems Bridge Road, Piora, being Lot1 DP 449328 and Lot 2 DP 572347, for a proposed rezoning of lands to facilitate a 31 Lot rural residential subdivision.

Proposed 31 Lot Subdivision

The SMP identifies that the implementation of the following measures will result in achieving the stormwater and sensitive urban design objective of minimising impacts of development on the natural water cycle. Measures to be adopted include:

(a) Installation of rainwater tanks
(b) Provision of grass buffers to the main gully flow path
(c) Swales in road reserves where grades permit
(d) Retention of the large existing farm dam
(e) Utilisation of water saving devices within dwellings
(f) Implement erosion and sediment controls during construction;

Measures to be implemented

In addressing stormwater quality, a MUSIC software model was developed to demonstrate that the incorporation of the above stormwater measures achieved a positive outcome. Such modelling was dependant upon baseline assessments, to which various assumptions where required given that no field data from existing stream flows are evident and particularly given the dry condition of the catchments.

MUSIC model derived from theoretical data

1 Background Information

This report is also to be read in conjunction with the Town Planning Report which provides all the necessary detailed information as to the specific site context, the development objectives and the proposal generally. In brief, the proposed development would comprise in the order of twenty three rural residential allotments as shown on the indicative layout plan. There are currently four existing dwellings within the land rezoning area.

Of the 31 allotments shown, it is anticipated that 20% of the lots would exceed 2ha with the balance 80% of the lots would exceed 1 ha..

Lot sizes range from 10,000m2 to over 20,000m2

There is an existing large farm dam in the middle of the development site and a dam on the eastern perimeter. It is proposed that these dam shall be retained for the purposes of stormwater management whilst the existing gully line be retained with grass buffers.

Retain existing large dam on private property

The road system shall be of a sealed rural road standard with typically no kerb and guttering and grass verges linked to swales. Where road grades exceed 5%, conventional pipe drainage shall be required as swale systems would be susceptible to erosion.

2 Stormwater Objectives

The stormwater management objectives for the development proposal are to implement measures consistent with the newly adopted Richmond Valley Council Water Sensitive Urban Design Development Control Plan (DCP 9)

Implement DCP measures

It is interpreted that DCP 9 does not applies to the subdivision as lots are not less than 1 hectare in size as per *Section 2.3 Development To Which This Plan Applies*. Notwithstanding this, implementation of good design practices do apply.

Minor Variations Under DCP 9 Provisions

It is recognised that DCP 9 specifically seeks new development to have a net reduction in any pollutant loads compared to the existing state. Given the difficulties in trying to establish background parameters and the broad range of agricultural land uses that can impact upon and significantly vary baseline data, approval is sought through this SMP under DCP 9 *Section 2.6 Departures* to permit minor variations from the nominated targets. This request is based upon the SMP demonstrating appropriate implementation measures of the general principles and objectives contained within the development control plan.

This SMP addresses issues of water quality, water demand use, water quantity and erosion and sediment control.

3 Stormwater Quality & Quantity

Stormwater quality impacts were assessed via the software modelling tool MUSIC (v3) which is well recognised as a contemporary aid to assess the performance of stormwater quality systems.

The key baseline assumptions used in data inputs were as follows:

(i) Catchments were assessed as being a mix of agricultural and forest activities as it was noted that adopting agricultural only land use pollutant loads appeared excessive given the well grassed nature of the site.

mix of Forest & Agriculture Land Use

(ii) The large existing dam was included in the baseline as ponds.

Likewise key developed assumptions used in data inputs were:

(iii) Each lot was assessed with $450m^2$ impervious area

$450m^2$ Impervious

(iv) A minimum 20,000L tank on site storage capacity with 545 L/day average demand (min 4.6ML ie 20kL x 23 Lots, conservative being ¾ of the total development)

20,000L tank available capacity

(v) Dam area of $1300m^2$ with nominal 1.5m extension depth of waters during flow events

Retain Dam

(vi) Nominal 300m of grass swales.

300m of Swales

Stormwater rainfall runoff periods were chosen for a 5 year interval between 1975 to 1980 as being indicative to assess performance. Rainfall and evapo-transpiration default data used in the MUSIC model was based upon Grafton Bureau of Meteorology records.

5 year design period

A computer listing of the data sets used in the developed case scenario complete with summary comparison tables are included as Appendix 1 – Complete Music Output Results whilst a comparison summary table between existing and developed case is shown below. Generally, a 0% indicates negligible impact or no change, -ve% indicates a reduction whilst a +ve% represents an increase.

All MUSIC results in Appendix 1

Inflow	mean	standard deviation	median	max	min	10 percentile	90 percentile
Flow (cubic metres/sec)	-11%	5%	0%	22%	0%	0%	-26%
TSS Concentration (mg/L)	-74%	-72%	0%	-88%	0%	0%	-58%
TP Concentration (mg/L)	-66%	-54%	0%	-86%	0%	0%	-41%
TN Concentration (mg/L)	-56%	-23%	0%	-87%	0%	0%	-19%
TSS Load (kg/12 Minutes)	-30%	-17%	0%	-6%	0%	0%	-33%
TP Load (kg/12 Minutes)	-23%	-15%	0%	1%	0%	0%	-25%
TN Load (kg/12 Minutes)	-13%	-7%	0%	-12%	0%	0%	-21%
Gross Pollutant Load (kg/12 Minutes)	0%	0%	0%	0%	0%	0%	0%

SUMMARY TABLE OF EXISTING Vs DEVELOPED FLOWS

As shown by the MUSIC model outputs, there will be limited occasions when the development does increase runoff conditions. This occurs primarily for maximum flow rates and total phosphorous It is noted via the On-Site Sewage and Wasterwater Management Report (by BCA Check) the soil analysis shows that the natural soil mediums have a high capacity to absorb any surplus phosphorous thereby further limiting opportunity for impacts downstream. It is also raised that the default software modelling values for agricultural land use maybe on the high side, hence treatment results seem overly effective in the developed case. To offset this, part of the catchment (9Ha) was modelled as forest. Notwithstanding, given the limited field baseline data, the treatment train process being proposed for the site will result in a satisfactory water quality outcome. Refer to Appendix 2 for Stormwater Flow Path Concept Plan.

Total Phosphorous 1% increase on maximum peaks

Natural soils high capacity to absorb phosphorous

An effective treatment train for rural residential land use can be provided

4 Water Demand Use

Due to the rural residential nature of the development, water conservation is typically a highly implemented measure by most householders due to reliance upon rainfall.

To facilitate such conservation, it is recommended that landowners be encouraged to incorporate water efficient fixtures. The best method to achieve this, would be to notify new home owners that such measures would need to be consistent with meeting the NSW Building Sustainability Index (BASIX) requirements. This would rely upon educational programs via Water Wise programs facilitated by Council.

Encourage water efficient fixtures

5 Erosion & Sedimentation Control

The control of sediments during both the construction of the dwellings and the subdivision itself will be required to be undertaken.

It is anticipated that Erosion and Sedimentation Control plans shall be required to accompany all construction certificate works. Whilst dwelling building works are not within the control of the typical developer, subdivisional construction activity is able to be suitably administered.

Erosion and Control Plan required to be submitted with Engineering Drawings

For this development, it is proposed that an Erosion and Sedimentation Control Plan be developed and submitted with the accompanying engineering certificate drawings. The plan would need to be prepared in accordance with the Managing Urban Stormwater - Soil and Construction Manual (Blue Book). Measures to be implemented to include:

Comply with Blue Book Controls

(i) Installation of erosion and sediment barriers prior to commencement of any works.

(ii) Maintain and keep construction equipment a minimum of 20m from natural drainage gullies to keep grass cover intact as a buffer.

(iii) Direct clean water around disturbed earthworks areas

(iv) Stabilise and seed earthwork areas immediately earthwork profiles are achieved.

(v) Stockpile materials in protected locations from overland flow paths and employ sediment fence boundaries.

(vi) Minimise the number of site access points.

6 Road Design Swale Concept

The development road design shall incorporate grassed buffer areas and swales to provide the necessary filtering to meet the minimum 300m of swales calculated in the MUSIC model.

300m of swales desirable

With the road access cutting across the catchment and due to the rolling hill nature of the site, the roads shall convey large flows and gradients over 5% at times. Hence swales maybe susceptible to scour. To control this, flows would need to be intercepted at regular intervals by road cross drainage and pipe work or concrete inverts used on steep grades. The outlets of the pipe work would then need to be discharged into an overland swale through private allotments at a gradient less than 5%. Such swales would be need to be contained within an easement and then discharge to the main gully grass buffer. Where there is limited runoff volumes, it is proposed that the design of the road verge shall be performed more in a manner to try and use the verge as a grass filter buffer and locate the swale more adjacent to the property boundary. An example of the design outcomes being sought is best shown by the following photographs of an existing subdivision at Manifold Road north of Casino.

Swales not to be steeper than 5%

Plate 1 - Grass buffer in road reserve at Manifold Road (for small runoff areas)

Plate 2 –
Conventional
Grass Swale

Plate 3 –
Pipe outlet into a
Swale Treatment
and bund when
grades exceed 5%

APPENDIX 1

Complete MUSIC (v3) Output Results

ELLEMS BRIDGE ROAD REZONING - LOT 1 DP 449328 & LOT 2 DP 572347
SUMMARY OF MUSIC (v3) OUTPUT TABLES

04102EllemsBridgeRoadUndeveloped - Exit Node - UnDeveloped - All Data Statistics
Existing Land Use Modelled on a Mix of Agriculture and Wooded Forest

Inflow	mean	standard deviation	median	maximum	minimum	10 percentile	90 percentile
Flow (cubic metres/sec)	2.25E-03	3.31E-02	4.42E-06	3.8	0	0	3.57E-03
TSS Concentration (mg/L)	22.6	45.8	16.4	2.15E+03	0	0	33.9
Log [TSS] (mg/L)	1.34	0.232	1.29	3.33	0.863	1.13	1.56
TP Concentration (mg/L)	0.111	0.123	0.102	4.99	0	0	0.177
Log [TP] (mg/L)	-0.909	0.167	-0.963	0.698	-1.38	-1.04	-0.728
TN Concentration (mg/L)	1.06	0.871	1.11	32.4	0	0	1.63
Log [TN] (mg/L)	8.81E-02	0.142	6.25E-02	1.51	-0.459	-4.61E-02	0.237
TSS Load (kg/12 Minutes)	0.202	5	7.77E-05	654	0	0	4.13E-02
TP Load (kg/12 Minutes)	5.70E-04	1.30E-02	4.12E-07	1.46	0	0	2.66E-04
TN Load (kg/12 Minutes)	4.40E-03	8.99E-02	3.68E-06	11.1	0	0	3.12E-03
Gross Pollutant Load (kg/12 Minutes)	2.41E-05	1.04E-03	0	0.132	0	0	0

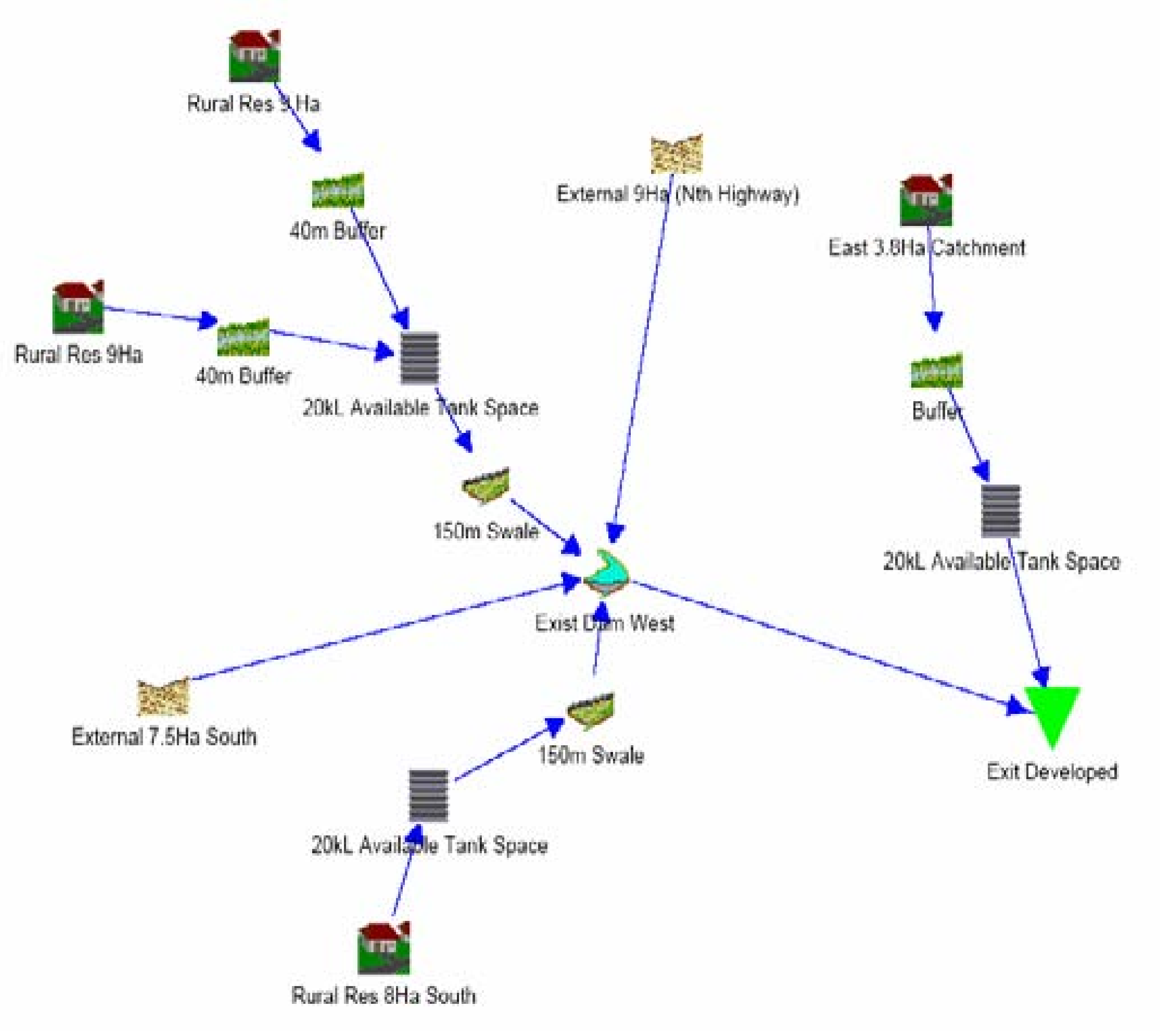
04102EllemsBridgeRoadDeveloped - Exit Developed - All Data Statistics
Rural Residential of Nominal 23 Lots - Treatment include Retain Dam, 40m wide grassed gully buffer, 300m swales and modelled on 20kL Rainwater Tank Capacity Available (ie 50% of 40kL)

Inflow	mean	standard deviation	median	maximum	minimum	10 percentile	90 percentile
Flow (cubic metres/sec)	2.01E-03	3.47E-02	0	4.62	0	0	2.64E-03
TSS Concentration (mg/L)	5.89	12.7	0	266	0	0	14.3
Log [TSS] (mg/L)	1.16	0.166	1.1	2.43	1.08	1.08	1.26
TP Concentration (mg/L)	3.78E-02	5.69E-02	0	0.71	0	0	0.104
Log [TP] (mg/L)	-0.99	0.101	-1.03	-0.149	-1.05	-1.04	-0.918
TN Concentration (mg/L)	0.47	0.673	0	4.34	0	0	1.32
Log [TN] (mg/L)	0.109	9.43E-02	8.69E-02	0.638	5.12E-05	2.92E-02	0.219
TSS Load (kg/12 Minutes)	0.141	4.13	0	615	0	0	2.76E-02
TP Load (kg/12 Minutes)	4.39E-04	1.11E-02	0	1.47	0	0	1.99E-04
TN Load (kg/12 Minutes)	3.82E-03	8.33E-02	0	9.74	0	0	2.48E-03
Gross Pollutant Load (kg/12 Minutes)	0	0	0	0	0	0	0

Percentage Difference Between Base Case Model and Developed Case Model with Mitigation Measures
(-ve indicates a reduction and +ve an increase)

Inflow	mean	standard deviation	median	maximum	minimum	10 percentile	90 percentile
Flow (cubic metres/sec)	-11%	5%	0%	22%	0%	0%	-26%
TSS Concentration (mg/L)	-74%	-72%	0%	-88%	0%	0%	-58%
Log [TSS] (mg/L)	-13%	-28%	-15%	-27%	25%	-4%	-19%
TP Concentration (mg/L)	-66%	-54%	0%	-86%	0%	0%	-41%
Log [TP] (mg/L)	9%	-40%	7%	-121%	-24%	0%	26%
TN Concentration (mg/L)	-56%	-23%	0%	-87%	0%	0%	-19%
Log [TN] (mg/L)	24%	-34%	39%	-58%	-100%	-163%	-8%
TSS Load (kg/12 Minutes)	-30%	-17%	0%	-6%	0%	0%	-33%
TP Load (kg/12 Minutes)	-23%	-15%	0%	1%	0%	0%	-25%
TN Load (kg/12 Minutes)	-13%	-7%	0%	-12%	0%	0%	-21%
Gross Pollutant Load (kg/12 Minutes)	0%	0%	0%	0%	0%	0%	0%

MUSIC MODEL – DEVELOPED CASE "ORAVIEW" SUBDIVISION



DEVELOPED CASE - DATA FILES

Source nodes

Location	External 9Ha (Nth Highw	External 7.5Ha South	Rural Res 9 Ha	Rural Res 9Ha	Rural Res 8Ha Sou	East 3.8Ha Catchment
ID	3	4	12	13	14	18
Node Type	AgriculturalSourceNode	AgriculturalSourceNode	UrbanSourceNode	UrbanSourceNode	UrbanSourceNode	UrbanSourceNode
Total Area (ha)	9	7.5	1	9	8	3.8
Area Impervious (ha)	0.074805263	0.062171053	0.079166667	0.752368421	0.633333333	0.300833333
Area Pervious (ha)	8.925394737	7.437828947	0.920833333	8.247631579	7.366666667	3.499166667
Field Capacity (mm)	80	80	80	80	80	80
Pervious Area Infiltration Capacity coefficient - a	200	200	200	200	200	200
Pervious Area Infiltration Capacity exponent - b	1	1	1	1	1	1
Impervious Area Rainfall Threshold (mm/day)	1	1	1	1	1	1
Pervious Area Soil Storage Capacity (mm)	120	120	120	120	120	120
Pervious Area Soil Initial Storage (% of Capacity)	30	30	30	30	30	30
Groundwater Initial Depth (mm)	10	10	10	10	10	10
Groundwater Daily Recharge Rate (%)	25	25	25	25	25	25
Groundwater Daily Baseflow Rate (%)	5	5	5	5	5	5
Groundwater Daily Deep Seepage Rate (%)	0	0	0	0	0	0
Stormflow Total Suspended Solids Mean (log mg/L)	2.3	2.3	2.2	2.2	2.2	2.2
Stormflow Total Suspended Solids Standard Deviation (log mg/L)	0.31	0.31	0.32	0.32	0.32	0.32
Stormflow Total Suspended Solids Estimation Method	Stochastic	Stochastic	Stochastic	Stochastic	Stochastic	Stochastic
Stormflow Total Suspended Solids Serial Correlation	0	0	0	0	0	0
Stormflow Total Phosphorus Mean (log mg/L)	-0.27	-0.27	-0.45	-0.45	-0.45	-0.45
Stormflow Total Phosphorus Standard Deviation (log mg/L)	0.3	0.3	0.25	0.25	0.25	0.25
Stormflow Total Phosphorus Estimation Method	Stochastic	Stochastic	Stochastic	Stochastic	Stochastic	Stochastic
Stormflow Total Phosphorus Serial Correlation	0	0	0	0	0	0
Stormflow Total Nitrogen Mean (log mg/L)	0.59	0.59	0.42	0.42	0.42	0.42
Stormflow Total Nitrogen Standard Deviation (log mg/L)	0.26	0.26	0.19	0.19	0.19	0.19
Stormflow Total Nitrogen Estimation Method	Stochastic	Stochastic	Stochastic	Stochastic	Stochastic	Stochastic
Stormflow Total Nitrogen Serial Correlation	0	0	0	0	0	0
Baseflow Total Suspended Solids Mean (log mg/L)	1.4	1.4	1.1	1.1	1.1	1.1
Baseflow Total Suspended Solids Standard Deviation (log mg/L)	0.13	0.13	0.17	0.17	0.17	0.17
Baseflow Total Suspended Solids Estimation Method	Stochastic	Stochastic	Stochastic	Stochastic	Stochastic	Stochastic
Baseflow Total Suspended Solids Serial Correlation	0	0	0	0	0	0
Baseflow Total Phosphorus Mean (log mg/L)	-0.88	-0.88	-0.82	-0.82	-0.82	-0.82
Baseflow Total Phosphorus Standard Deviation (log mg/L)	0.13	0.13	0.19	0.19	0.19	0.19
Baseflow Total Phosphorus Estimation Method	Stochastic	Stochastic	Stochastic	Stochastic	Stochastic	Stochastic
Baseflow Total Phosphorus Serial Correlation	0	0	0	0	0	0
Baseflow Total Nitrogen Mean (log mg/L)	0.074	0.074	0.32	0.32	0.32	0.32
Baseflow Total Nitrogen Standard Deviation (log mg/L)	0.13	0.13	0.12	0.12	0.12	0.12
Baseflow Total Nitrogen Estimation Method	Stochastic	Stochastic	Stochastic	Stochastic	Stochastic	Stochastic
Baseflow Total Nitrogen Serial Correlation	0	0	0	0	0	0
OUT - Mean Annual Flow (ML/yr)	17.3	14.4	2.33	21	18.7	8.87
OUT - TSS Mean Annual Load (kg/yr)	2.82E+03	2.20E+03	325	3.00E+03	2.81E+03	1.28E+03
OUT - TP Mean Annual Load (kg/yr)	8.03	6.37	0.786	7.07	6.44	2.95
OUT - TN Mean Annual Load (kg/yr)	56.2	47.7	6.14	55.1	50.7	23.7
OUT - Gross Pollutant Mean Annual Load (kg/yr)	2.5	2.08	31.9	287	255	121

No Imported Data Source nodes

USTM treatment nodes

Location	Exist Dam West	150m Swale	Buffer	40m Buffer	20kL Available Tan	40m Buffer	20kL Avail	20kL Avail	150m Swale
ID	2	5	6	7	8	9	10	11	15
Node Type	PondNode	SwaleNode	BufferNode	BufferNode	RainWaterTankNod	BufferNode	RainWater	RainWater	SwaleNode
Lo-flow bypass rate (cum/sec)	0	0			0		0	0	0
Hi-flow bypass rate (cum/sec)	20				1		1	1	
Inlet pond volume	0				0		0	0	
Area (sqm)	600		782.1666667	47.5	10	376.1842105	10	5	
Extended detention depth (m)	2	0.5			0.2		0.2	0.2	0.5
Permanent pool volume (cum)	250				220		120	60	
Proportion vegetated	0.1				0		0	0	
Equivalent pipe diameter (mm)	100				90		90	90	
Overflow weir width (m)	5				10		10	10	
Notional Detention Time (hrs)	10.1				6.58E-02		6.58E-02	3.29E-02	
Orifice discharge coefficient	0.6				0.6		0.6	0.6	
Weir coefficient	1.7				1.7		1.7	1.7	
Number of CSTR cells	2	10			2		2	2	10
Total Suspended Solids k (m/yr)	400	8000			400		400	400	8000
Total Suspended Solids C* (mg/L)	12	20			12		12	12	20
Total Suspended Solids C** (mg/L)	12	14			12		12	12	14
Total Phosphorus k (m/yr)	300	6000			300		300	300	6000
Total Phosphorus C* (mg/L)	0.09	0.13			0.13		0.13	0.13	0.13
Total Phosphorus C** (mg/L)	0.09	0.13			0.13		0.13	0.13	0.13
Total Nitrogen k (m/yr)	40	500			40		40	40	500

Total Nitrogen C* (mg/L)	1	1.4			1.4		1.4	1.4	1.4
Total Nitrogen C** (mg/L)	1	1.4			1.4		1.4	1.4	1.4
Threshold hydraulic loading for C** (m/yr)	3500	3500			3500		3500	3500	3500
Extraction for Re-use	Off	Off	Off	Off	On	Off	On	On	Off
Annual Re-use Demand - scaled by daily PET (ML)					2.002		1.092	0.546	
Constant Daily Re-use Demand (kL)					0		0	0	
User-defined Annual Re-use Demand (ML)					2.002		1.092	0.546	
Percentage of User-defined Annual Re-use Demand Jan					10.1910191		10.42	9.921984	
Percentage of User-defined Annual Re-use Demand Feb					9.430943094		8.41	8.90178	
Percentage of User-defined Annual Re-use Demand Mar					7.910791079		7.69	8.141626	
Percentage of User-defined Annual Re-use Demand Apr					7.910791079		7.69	8.141626	
Percentage of User-defined Annual Re-use Demand May					7.910791079		7.69	8.141626	
Percentage of User-defined Annual Re-use Demand Jun					7.150715072		6.88	6.891376	
Percentage of User-defined Annual Re-use Demand Jul					6.900690069		6.82	6.891376	
Percentage of User-defined Annual Re-use Demand Aug					6.900690069		7.13	6.821324	
Percentage of User-defined Annual Re-use Demand Sep					7.910791079		7.89	8.141628	
Percentage of User-defined Annual Re-use Demand Oct					7.910791079		7.89	8.141628	
Percentage of User-defined Annual Re-use Demand Nov					9.940994099		9.92	9.681932	
Percentage of User-defined Annual Re-use Demand Dec					9.930993099		10.17	10.42208	
Filter area (sqm)									
Filter depth (m)									
Filter median particle diameter (mm)									
Saturated hydraulic conductivity (mm/hr)									
Voids ratio									
Length (m)		150							150
Bed slope		0.02							0.02
Base Width (m)		1							1
Top width (m)		5							5
Vegetation height (m)		0.25							0.25
Proportion of upstream impervious area treated			0.95	0.95		0.5			
Seepage Rate (mm/hr)	0.5	10	10	0	0	0	0	0	10
Evap Loss as proportion of PET	1				0		0	0	
Depth in metres below the drain pipe									
IN - Mean Annual Flow (ML/yr)	61.6	16.8	6.67	2.33	23.3	21	18.7	4.86	20.1
IN - TSS Mean Annual Load (kg/yr)	6.52E+03	2.48E+03	1.28E+03	325	2.28E+03	3.00E+03	2.81E+03	366	1.96E+03
IN - TP Mean Annual Load (kg/yr)	20.2	5.74	2.95	0.766	8.15	7.07	6.44	1.18	5.29
IN - TN Mean Annual Load (kg/yr)	171	45.5	23.7	6.14	52.9	55.1	50.7	10.8	45.7
IN - Gross Pollutant Mean Annual Load (kg/yr)	4.58	0.224	121	31.9	319	287	255	72.6	0.454
OUT - Mean Annual Flow (ML/yr)	59.2	13.4	4.68	2.33	20.1	21	16.8	4.2	16.7
OUT - TSS Mean Annual Load (kg/yr)	5.78E+03	758	366	163	1.96E+03	2.11E+03	2.49E+03	312	737
OUT - TP Mean Annual Load (kg/yr)	18.1	2.74	1.18	0.51	5.29	5.64	5.74	0.998	3.04
OUT - TN Mean Annual Load (kg/yr)	162	32.1	10.6	4.78	45.7	48.1	45.5	9.18	35
OUT - Gross Pollutant Mean Annual Load (kg/yr)	0	0	72.6	31.9	0.454	287	0.224	0	0

No Generic treatment nodes

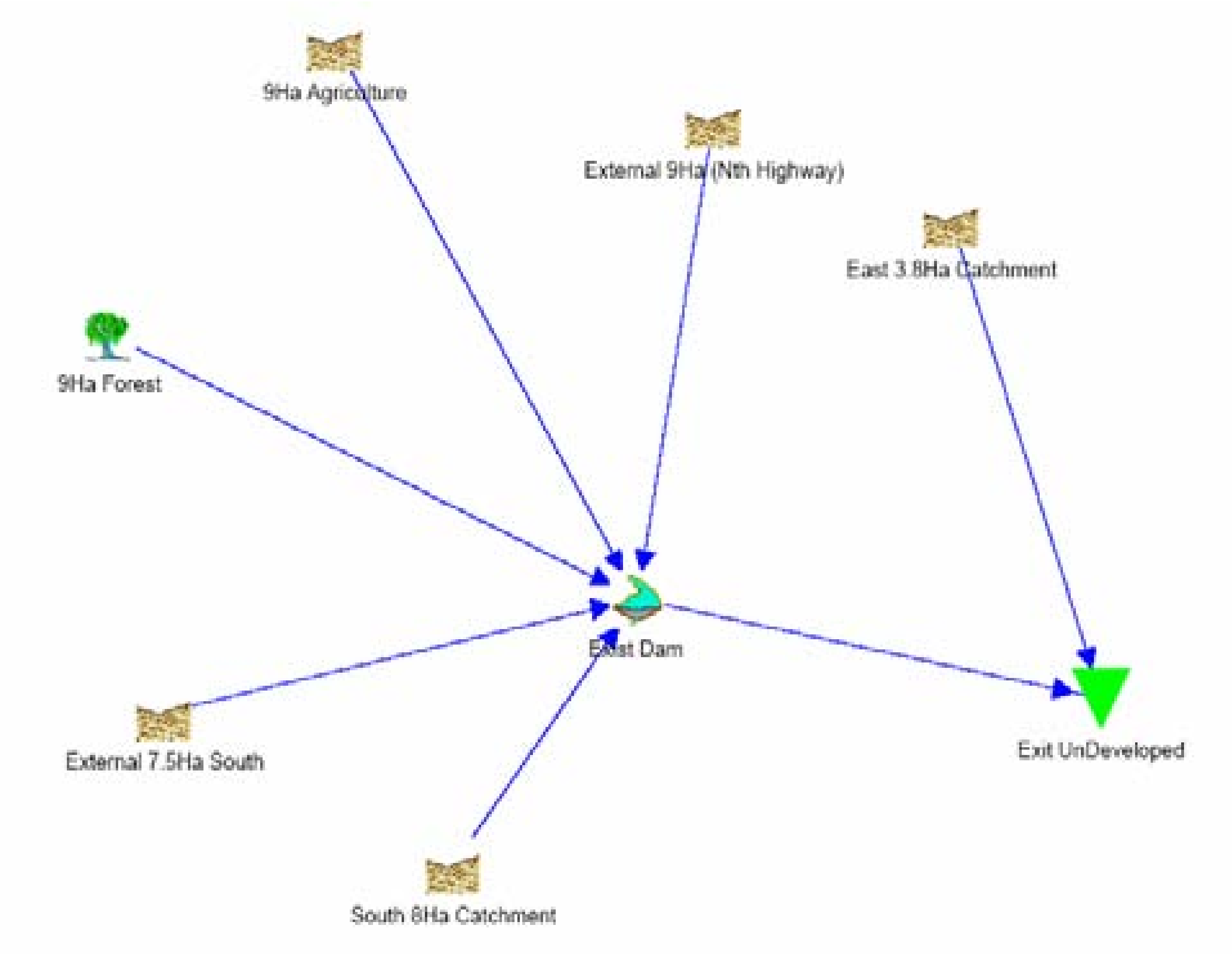
Other nodes	
Location	Exit Developed
ID	1
Node Type	ReceivingNode
IN - Mean Annual Flow (ML/yr)	63.4
IN - TSS Mean Annual Load (kg/yr)	6.09E+03
IN - TP Mean Annual Load (kg/yr)	19.1
IN - TN Mean Annual Load (kg/yr)	171
IN - Gross Pollutant Mean Annual Load (kg/yr)	0
OUT - Mean Annual Flow (ML/yr)	0
OUT - TSS Mean Annual Load (kg/yr)	0
OUT - TP Mean Annual Load (kg/yr)	0

OUT - TN Mean Annual Load (kg/yr)	0
OUT - Gross Pollutant Mean Annual Load (kg/yr)	0

Links

Location	Drainage Link	Drainage Link	Drainage Link	Drainage Link	Drainage Link	Drainage Link	Drainage L	Drainage L	Drainage L	Drainage L	Drainage L	Drainage L	Drainage L	Drainage L	Drainage Link
Source node ID	2	3	5	4	7	9	10	6	11	13	12	14	8	15	16
Target node ID	1	2	2	2	8	6	5	11	1	9	7	10	15	2	6
Muskingum-Cunge Routing	Not Routed	Not Routed	Not Routed	Not Routed	Not Routed	Not Routed	Not Route	Not Route	Not Route	Not Route	Not Route	Not Route	Not Route	Not Route	Not Routed
Muskingum K															
Muskingum theta															
IN - Mean Annual Flow (ML/yr)	59.2	17.3	13.4	14.4	2.33	21	16.8	4.88	4.2	21	2.33	18.7	20.1	16.7	6.87
IN - TSS Mean Annual Load (kg/yr)	5.78E+03	2.82E+03	756	2.20E+03	163	2.11E+03	2.49E+03	386	312	3.00E+03	325	2.61E+03	1.96E+03	737	1.28E+03
IN - TP Mean Annual Load (kg/yr)	18.1	8.03	2.74	6.37	0.51	5.64	5.74	1.16	0.988	7.07	0.786	6.44	5.29	3.04	2.95
IN - TN Mean Annual Load (kg/yr)	182	56.2	32.1	47.7	4.78	48.1	45.5	10.6	9.16	55.1	6.14	50.7	45.7	35	23.7
IN - Gross Pollutant Mean Annual Load (kg/yr)	0	2.5	0	2.08	31.9	287	0.224	72.6	0	287	31.9	255	0.454	0	121
OUT - Mean Annual Flow (ML/yr)	59.2	17.3	13.4	14.4	2.33	21	16.8	4.88	4.2	21	2.33	18.7	20.1	16.7	6.87
OUT - TSS Mean Annual Load (kg/yr)	5.78E+03	2.82E+03	756	2.20E+03	163	2.11E+03	2.49E+03	386	312	3.00E+03	325	2.61E+03	1.96E+03	737	1.28E+03
OUT - TP Mean Annual Load (kg/yr)	18.1	8.03	2.74	6.37	0.51	5.64	5.74	1.16	0.988	7.07	0.786	6.44	5.29	3.04	2.95
OUT - TN Mean Annual Load (kg/yr)	182	56.2	32.1	47.7	4.78	48.1	45.5	10.6	9.16	55.1	6.14	50.7	45.7	35	23.7
OUT - Gross Pollutant Mean Annual Load (kg/yr)	0	2.5	0	2.08	31.9	287	0.224	72.6	0	287	31.9	255	0.454	0	121

MUSIC MODEL – UNDEVELOPED CASE “ORAVIEW” SUBDIVISION



UNDEVELOPED CASE - DATA FILES

Source nodes

Location	9Ha Forest	9Ha Agriculture	External 9Ha (Nth Highw	External 7.5Ha South	South 9Ha Catchment	East 3.8Ha Catchment
ID	3	4	5	6	7	8
Node Type	ForestSourceNode	AgriculturalSourceNode	AgriculturalSourceNode	AgriculturalSourceNode	AgriculturalSourceNode	AgriculturalSourceNode
Total Area (ha)	9	9	9	7.5	1	3.8
Area Impervious (ha)	0.119605263	0.114473684	0.074605263	0.062171053	0.012719298	0.048333333
Area Pervious (ha)	8.880394737	8.885526316	8.925394737	7.437828947	0.987280702	3.751666667
Field Capacity (mm)	80	80	80	80	80	80
Pervious Area Infiltration Capacity coefficient - a	200	200	200	200	200	200
Pervious Area Infiltration Capacity exponent - b	1	1	1	1	1	1
Impervious Area Rainfall Threshold (mm/day)	1	1	1	1	1	1
Pervious Area Soil Storage Capacity (mm)	120	120	120	120	120	120
Pervious Area Soil Initial Storage (% of Capacity)	30	30	30	30	30	30
Groundwater Initial Depth (mm)	10	10	10	10	10	10
Groundwater Daily Recharge Rate (%)	25	25	25	25	25	25
Groundwater Daily Baseflow Rate (%)	5	5	5	5	5	5
Groundwater Daily Deep Seepage Rate (%)	0	0	0	0	0	0
Stormflow Total Suspended Solids Mean (log mg/L)	2.1	2.3	2.3	2.3	2.3	2.3
Stormflow Total Suspended Solids Standard Deviation (log mg/L)	0.26	0.31	0.31	0.31	0.31	0.31
Stormflow Total Suspended Solids Estimation Method	Stochastic	Stochastic	Stochastic	Stochastic	Stochastic	Stochastic
Stormflow Total Suspended Solids Serial Correlation	0	0	0	0	0	0
Stormflow Total Phosphorus Mean (log mg/L)	-0.66	-0.27	-0.27	-0.27	-0.27	-0.27
Stormflow Total Phosphorus Standard Deviation (log mg/L)	0.26	0.3	0.3	0.3	0.3	0.3
Stormflow Total Phosphorus Estimation Method	Stochastic	Stochastic	Stochastic	Stochastic	Stochastic	Stochastic
Stormflow Total Phosphorus Serial Correlation	0	0	0	0	0	0
Stormflow Total Nitrogen Mean (log mg/L)	0.25	0.59	0.59	0.59	0.59	0.59
Stormflow Total Nitrogen Standard Deviation (log mg/L)	0.25	0.26	0.26	0.26	0.26	0.26
Stormflow Total Nitrogen Estimation Method	Stochastic	Stochastic	Stochastic	Stochastic	Stochastic	Stochastic
Stormflow Total Nitrogen Serial Correlation	0	0	0	0	0	0
Baseflow Total Suspended Solids Mean (log mg/L)	1.2	1.4	1.4	1.4	1.4	1.4
Baseflow Total Suspended Solids Standard Deviation (log mg/L)	0.13	0.13	0.13	0.13	0.13	0.13
Baseflow Total Suspended Solids Estimation Method	Stochastic	Stochastic	Stochastic	Stochastic	Stochastic	Stochastic
Baseflow Total Suspended Solids Serial Correlation	0	0	0	0	0	0
Baseflow Total Phosphorus Mean (log mg/L)	-1.19	-0.88	-0.88	-0.88	-0.88	-0.88
Baseflow Total Phosphorus Standard Deviation (log mg/L)	0.13	0.13	0.13	0.13	0.13	0.13
Baseflow Total Phosphorus Estimation Method	Stochastic	Stochastic	Stochastic	Stochastic	Stochastic	Stochastic
Baseflow Total Phosphorus Serial Correlation	0	0	0	0	0	0
Baseflow Total Nitrogen Mean (log mg/L)	-0.03	0.074	0.074	0.074	0.074	0.074
Baseflow Total Nitrogen Standard Deviation (log mg/L)	0.13	0.13	0.13	0.13	0.13	0.13
Baseflow Total Nitrogen Estimation Method	Stochastic	Stochastic	Stochastic	Stochastic	Stochastic	Stochastic
Baseflow Total Nitrogen Serial Correlation	0	0	0	0	0	0
OUT - Mean Annual Flow (ML/yr)	17.3	17.3	17.3	14.4	1.92	7.29
OUT - TSS Mean Annual Load (kg/yr)	1.53E+03	2.46E+03	2.70E+03	2.37E+03	287	1.17E+03
OUT - TP Mean Annual Load (kg/yr)	2.93	7.22	7.63	6.54	0.809	3.15
OUT - TN Mean Annual Load (kg/yr)	26.4	54.1	55.6	46.7	5.96	23
OUT - Gross Pollutant Mean Annual Load (kg/yr)	2.5	2.5	2.5	2.08	0.277	1.05

No Imported Data Source nodes

USTM treatment nodes

Location	Exist Dam
ID	2
Node Type	PondNode

Lo-flow bypass rate (cum/sec)		0
Hi-flow bypass rate (cum/sec)		10
Inlet pond volume		0
Area (sqm)		1300
Extended detention depth (m)		1.5
Permanent pool volume (cum)		250
Proportion vegetated		0.1
Equivalent pipe diameter (mm)		225
Overflow weir width (m)		5
Notional Detention Time (hrs)		3.75
Orifice discharge coefficient		0.6
Weir coefficient		1.7
Number of CSTR cells		2
Total Suspended Solids k (m/yr)		400
Total Suspended Solids C* (mg/L)		12
Total Suspended Solids C** (mg/L)		12
Total Phosphorus k (m/yr)		300
Total Phosphorus C* (mg/L)		0.09
Total Phosphorus C** (mg/L)		0.09
Total Nitrogen k (m/yr)		40
Total Nitrogen C* (mg/L)		1
Total Nitrogen C** (mg/L)		1
Threshold hydraulic loading for C** (m/yr)		3500
Extraction for Re-use	Off	
Annual Re-use Demand - scaled by daily PET (ML)		
Constant Daily Re-use Demand (kL)		
User-defined Annual Re-use Demand (ML)		
Percentage of User-defined Annual Re-use Demand Jan		
Percentage of User-defined Annual Re-use Demand Feb		
Percentage of User-defined Annual Re-use Demand Mar		
Percentage of User-defined Annual Re-use Demand Apr		
Percentage of User-defined Annual Re-use Demand May		
Percentage of User-defined Annual Re-use Demand Jun		
Percentage of User-defined Annual Re-use Demand Jul		
Percentage of User-defined Annual Re-use Demand Aug		
Percentage of User-defined Annual Re-use Demand Sep		
Percentage of User-defined Annual Re-use Demand Oct		
Percentage of User-defined Annual Re-use Demand Nov		
Percentage of User-defined Annual Re-use Demand Dec		
Filter area (sqm)		
Filter depth (m)		
Filter median particle diameter (mm)		
Saturated hydraulic conductivity (mm/hr)		
Voids ratio		
Length (m)		
Bed slope		
Base Width (m)		
Top width (m)		
Vegetation height (m)		
Proportion of upstream impervious area treated		
Seepage Rate (mm/hr)		0.5
Evap Loss as proportion of PET		1
Depth in metres below the drain pipe		

IN - Mean Annual Flow (ML/yr)	68.1
IN - TSS Mean Annual Load (kg/yr)	9.34E+03
IN - TP Mean Annual Load (kg/yr)	25.1
IN - TN Mean Annual Load (kg/yr)	189
IN - Gross Pollutant Mean Annual Load (kg/yr)	9.85
OUT - Mean Annual Flow (ML/yr)	63.7
OUT - TSS Mean Annual Load (kg/yr)	7.83E+03
OUT - TP Mean Annual Load (kg/yr)	21.8
OUT - TN Mean Annual Load (kg/yr)	176
OUT - Gross Pollutant Mean Annual Load (kg/yr)	0

No Generic treatment nodes

Other nodes

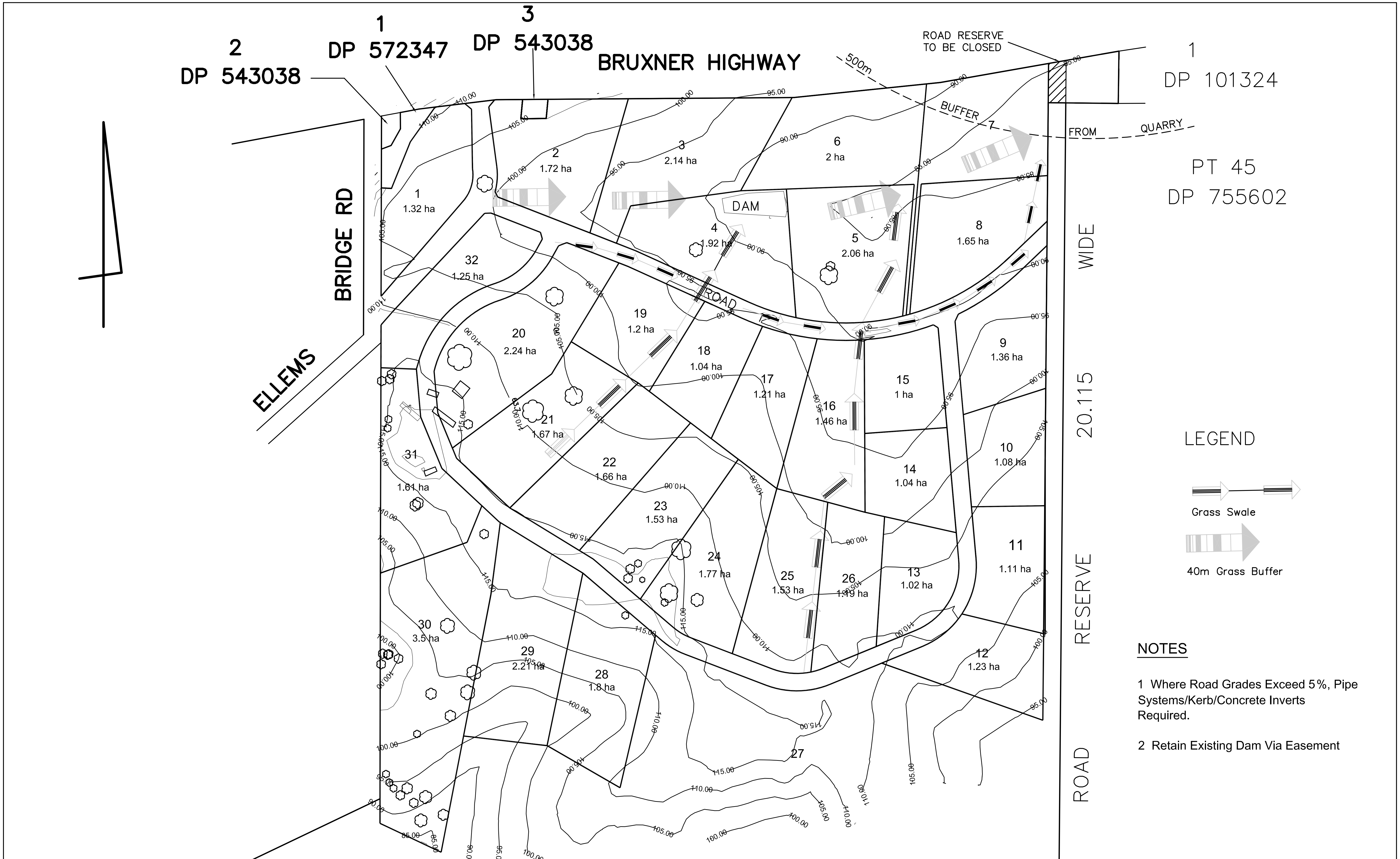
Location	Exit UnDeveloped
ID	1
Node Type	ReceivingNode
IN - Mean Annual Flow (ML/yr)	71
IN - TSS Mean Annual Load (kg/yr)	9.00E+03
IN - TP Mean Annual Load (kg/yr)	24.9
IN - TN Mean Annual Load (kg/yr)	199
IN - Gross Pollutant Mean Annual Load (kg/yr)	1.05
OUT - Mean Annual Flow (ML/yr)	0
OUT - TSS Mean Annual Load (kg/yr)	0
OUT - TP Mean Annual Load (kg/yr)	0
OUT - TN Mean Annual Load (kg/yr)	0
OUT - Gross Pollutant Mean Annual Load (kg/yr)	0

Links

Location	Drainage Link	Drainage Link	Drainage Link	Drainage Link	Drainage Link	Drainage Link	Drainage Link
Source node ID	2	5	6	4	3	8	7
Target node ID	1	2	2	2	2	1	2
Muskingum-Cunge Routing	Not Routed	Not Routed	Not Routed	Not Routed	Not Routed	Not Routed	Not Routed
Muskingum K							
Muskingum theta							
IN - Mean Annual Flow (ML/yr)	63.7	17.3	14.4	17.3	17.3	7.29	1.92
IN - TSS Mean Annual Load (kg/yr)	7.83E+03	2.70E+03	2.37E+03	2.46E+03	1.53E+03	1.17E+03	287
IN - TP Mean Annual Load (kg/yr)	21.8	7.63	6.54	7.22	2.93	3.15	0.809
IN - TN Mean Annual Load (kg/yr)	176	55.6	46.7	54.1	26.4	23	5.96
IN - Gross Pollutant Mean Annual Load (kg/yr)	0	2.5	2.08	2.5	2.5	1.05	0.277
OUT - Mean Annual Flow (ML/yr)	63.7	17.3	14.4	17.3	17.3	7.29	1.92
OUT - TSS Mean Annual Load (kg/yr)	7.83E+03	2.70E+03	2.37E+03	2.46E+03	1.53E+03	1.17E+03	287
OUT - TP Mean Annual Load (kg/yr)	21.8	7.63	6.54	7.22	2.93	3.15	0.809
OUT - TN Mean Annual Load (kg/yr)	176	55.6	46.7	54.1	26.4	23	5.96
OUT - Gross Pollutant Mean Annual Load (kg/yr)	0	2.5	2.08	2.5	2.5	1.05	0.277

APPENDIX 2

Stormwater Flow Path Concept Plan



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Amendments :

	Date	Changes
N	10.10.06	ALTERED SUBDIVISION LAYOUT
B	July 2009	ALTERED SUBDIVISION LAYOUT DUE TO RTA

Project :

Date: 28.07.09
Scale 1:4000
Ref No. 04/102N

STORMWATER FLOW PATH CONCEPT PLAN
LOT 1 DP 449328 & PT LOT 2 DP 572347
ELLEMS BRIDGE ROAD PIORA

Rev B

Stormwater Flow Path Calculations
2004102 – Ellems

Rational Method

Catcht.	Ac =	tc	I_{100}	C	Q100
ID	(ha)	(min)	(mm/hr)		(cumec)
1	10.8	13.44	174.4	0.84	4.4
2	14.4	12.81	180.8	0.84	6.1
Total	43.1	26.00	123.5	0.84	12.4

2004/169 - Ellems

Catch 1

Base Width (m)	0.1		
Longitudinal Slope (1in X)	17.2	5.81%	(check maximum grade as worst case)
Side Slope (1in X) Left	40	2.50%	(kerb slope)
Side Slope (1in X) Right	40	2.50%	(2% cross fall)
Mannings n	0.03		
Start Depth (m)	0.2		
Increment (m)	0.01		

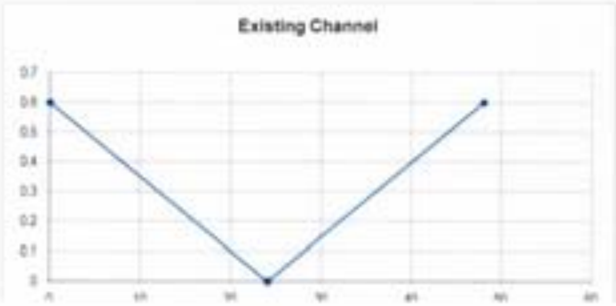
Q100-Q2=2.099m3/s

Graph

0	0.6
24	0
24.1	0
48.1	0.6

D (m)	Wt (m)	A (m2)	P (m)	R (m2/m)	Vel (m/s)	Flow (m3/s)	Vd
0.200	16.10	1.62	16.10	0.10	1.74	2.82	0.35
0.210	16.90	1.79	16.91	0.11	1.80	3.21	0.38
0.220	17.70	1.96	17.71	0.11	1.85	3.63	0.41
0.230	18.50	2.14	18.51	0.12	1.91	4.08	0.44
0.240	19.30	2.33	19.31	0.12	1.96	4.57	0.47
0.250	20.10	2.53	20.11	0.13	2.02	5.09	0.50
0.260	20.90	2.73	20.91	0.13	2.07	5.65	0.54
0.270	21.70	2.94	21.71	0.14	2.12	6.24	0.57
0.280	22.50	3.16	22.51	0.14	2.17	6.88	0.61
0.290	**23.30**	**3.39**	**23.31**	**0.15**	**2.22**	**7.55**	**0.65**
0.300	24.10	3.63	24.11	0.15	2.27	8.26	0.68
0.310	24.90	3.88	24.91	0.16	2.32	9.01	0.72
0.320	25.70	4.13	25.71	0.16	2.37	9.80	0.76
0.330	26.50	4.39	26.51	0.17	2.42	10.64	0.80
0.340	27.30	4.66	27.31	0.17	2.47	11.51	0.84
0.350	28.10	4.94	28.11	0.18	2.52	12.44	0.88
0.360	28.90	5.22	28.91	0.18	2.57	13.40	0.92
0.370	29.70	5.51	29.71	0.19	2.61	14.42	0.97
0.380	30.50	5.81	30.51	0.19	2.66	15.47	1.01
0.390	31.30	6.12	31.31	0.20	2.71	16.58	1.06
0.400	32.10	6.44	32.11	0.20	2.75	17.73	1.10

X-Section Profile - Section AA		
Offset	RL	
0	100	
67	98	2.0%
111	97.8	
156	98	
190	100	



2004/102 - Ellems

Catch 2

Base Width (m)	0.1		
Longitudinal Slope (1in X)	27.7	3.61%	(check maximum grade as worst case)
Side Slope (1in X) Left	32	3.13%	(kerb slope)
Side Slope (1in X) Right	32	3.13%	(2% cross fall)
Mannings n	0.03		
Start Depth (m)	0.3		
Increment (m)	0.01		

Q100-Q2=2.099m3/s

Graph

0	0.6
19.2	0
19.3	0
38.5	0.6

D (m)	Wt (m)	A (m2)	P (m)	R (m2/m)	Vel (m/s)	Flow (m3/s)	Vd
0.300	19.30	2.91	19.31	0.15	1.79	5.22	0.54
0.310	19.94	3.11	19.95	0.16	1.83	5.69	0.57
0.320	20.58	3.31	20.59	0.16	1.87	6.19	0.60
0.330	21.22	3.52	21.23	0.17	1.91	6.72	0.63
0.340	21.86	3.73	21.87	0.17	1.95	7.26	0.66
0.350	22.50	3.96	22.51	0.18	1.99	7.86	0.70
0.360	23.14	4.18	23.15	0.18	2.02	8.47	0.73
0.370	23.78	4.42	23.79	0.19	2.06	9.11	0.76
0.380	24.42	4.66	24.43	0.19	2.10	9.78	0.80
0.390	**25.06**	**4.91**	**25.07**	**0.20**	**2.13**	**10.47**	**0.83**
0.400	25.70	5.16	25.71	0.20	2.17	11.20	0.87
0.410	26.34	5.42	26.35	0.21	2.21	11.96	0.90
0.420	26.98	5.69	26.99	0.21	2.24	12.75	0.94
0.430	27.62	5.96	27.63	0.22	2.28	13.57	0.98
0.440	28.26	6.24	28.27	0.22	2.31	14.43	1.02
0.450	28.90	6.53	28.91	0.23	2.35	15.32	1.06
0.460	29.54	6.82	29.55	0.23	2.38	16.24	1.10
0.470	30.18	7.12	30.19	0.24	2.42	17.19	1.14
0.480	30.82	7.42	30.83	0.24	2.45	18.18	1.18
0.490	31.46	7.73	31.48	0.25	2.48	19.21	1.22
0.500	32.10	8.05	32.12	0.25	2.52	20.27	1.26

X-Section Profile - Section BB		
Offset	RL	
0	94	
27	92	2.8%
80	91.8	
134	92	
188	94	

2004/102 - Ellem

Catch Total

Base Width (m)	0.1	
Longitudinal Slope (1in X)	27.7	3.61% (check maximum grade as worst case)
Side Slope (1in X) Left	13	7.69% (kerb slope)
Side Slope (1in X) Right	13	7.69% (2% cross fall)
Mannings n	0.03	
Start Depth (m)	0.5	
Increment (m)	0.01	

Q100-Q2=2.099m3/s

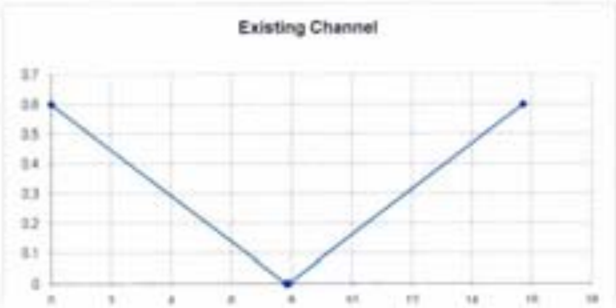
Graph

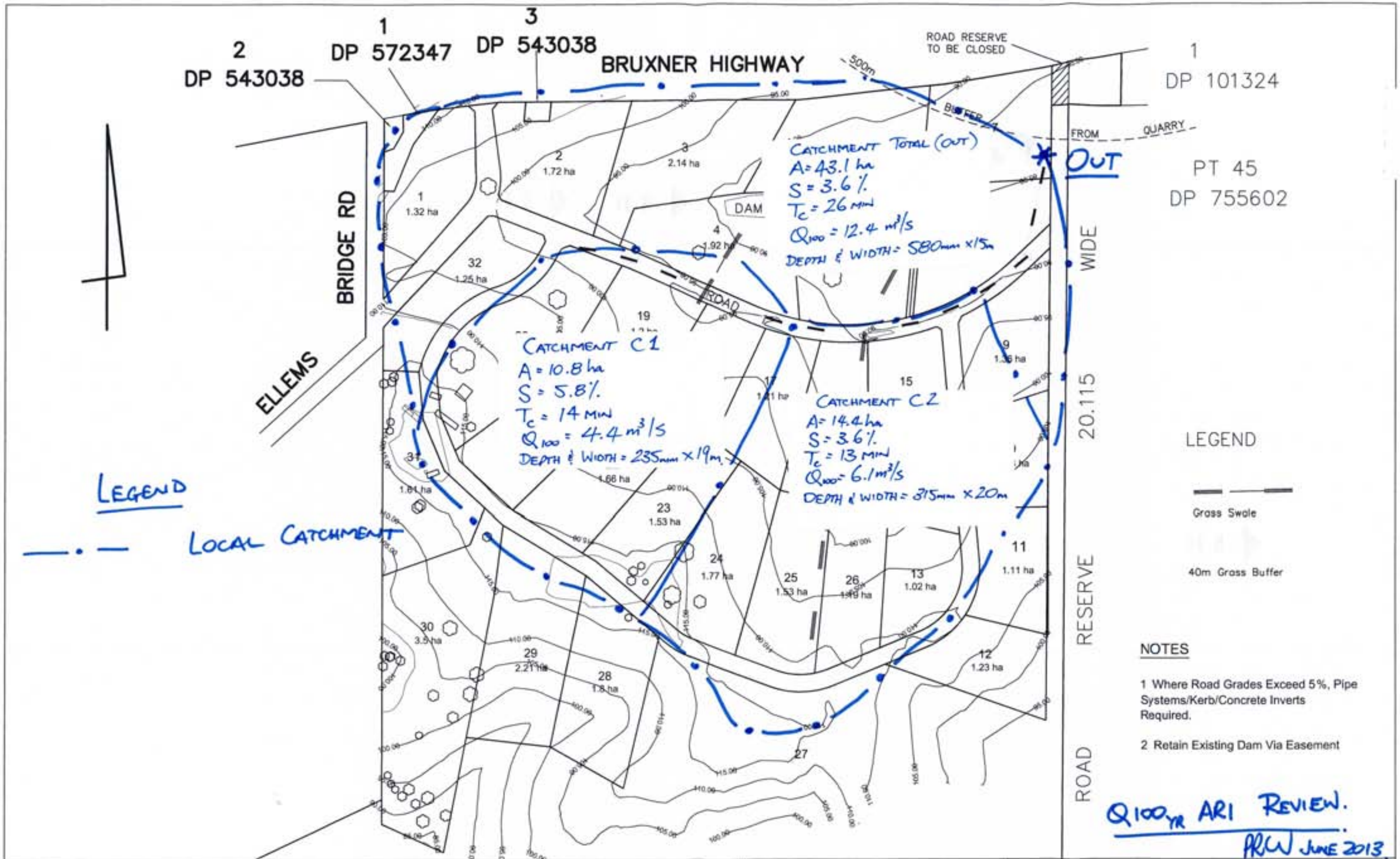
0	0.6
7.8	0
7.9	0
15.7	0.6

D (m)	Wt (m)	A (m2)	P (m)	R (m2/m)	Vel (m/s)	Flow (m3/s)	Vd
0.500	13.10	3.30	13.14	0.25	2.52	8.32	1.26
0.510	13.36	3.43	13.40	0.26	2.55	8.77	1.30
0.520	13.62	3.57	13.66	0.26	2.59	9.23	1.35
0.530	13.88	3.70	13.92	0.27	2.62	9.71	1.39
0.540	14.14	3.84	14.18	0.27	2.65	10.20	1.43
0.550	14.40	3.99	14.44	0.28	2.69	10.71	1.48
0.560	14.66	4.13	14.70	0.28	2.72	11.23	1.52
0.570	14.92	4.28	14.96	0.29	2.75	11.77	1.57
0.580	15.18	4.43	15.22	0.29	2.79	12.33	1.61
0.590	**15.44**	**4.58**	**15.49**	**0.30**	**2.81**	**12.90**	**1.66**
0.600	15.70	4.74	15.75	0.30	2.84	13.48	1.71
0.610	15.96	4.90	16.01	0.31	2.88	14.09	1.75
0.620	16.22	5.06	16.27	0.31	2.91	14.71	1.80
0.630	16.48	5.22	16.53	0.32	2.94	15.35	1.85
0.640	16.74	5.39	16.79	0.32	2.97	16.00	1.90
0.650	17.00	5.56	17.05	0.33	3.00	16.67	1.95
0.660	17.26	5.73	17.31	0.33	3.03	17.36	2.00
0.670	17.52	5.90	17.57	0.34	3.06	18.07	2.05
0.680	17.78	6.08	17.83	0.34	3.09	18.79	2.10
0.690	18.04	6.26	18.09	0.35	3.12	19.53	2.15
0.700	18.30	6.44	18.35	0.35	3.15	20.29	2.21

X-Section Profile - Section CC

Offset	RL	
0	88	
22	86	7.0%
49	84	
60	83.8	
70	84	
96	86	
136	88	





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Amendments :

	Date	Changes
N	10.10.06	ALTERED SUBDIVISION LAYOUT
B	July 2009	ALTERED SUBDIVISION LAYOUT DUE TO RTA

Project :

Date: 28.07.09
Scale 1: 4000
Ref No. 04/102N

STORMWATER FLOW PATH CONCEPT PLAN
LOT 1 DP 449328 & PT LOT 2 DP 572347
ELLEMS BRIDGE ROAD PIORA

Rev B