APPENDIX A
MORSE MCVEY WATER QUALITY REPORT

Morse McVey
& ASSOCIATES

Water Quality Report

for a proposed urban development
at Lot 21, 22,23 DP 867221, Dolphin Point

Prepared by:

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1 Introduction

This conceptual *Water Quality Report* relates to a proposed urban development at Lot 21, 22, 23, DP 867721 at Dolphin Point ("the site") (figure 1). A plan of subdivision has been prepared by Rygate and West and drawing U11840 Sheet 25 shows the layout and drainage system. This report quantifies:

(i) the levels of the principal pollutants prior to the development;

(ii) the levels of the principal pollutants after the development; and

(iii) comparison of these pollutants in relation to ANZECC guidelines.

These calculations are derived with the help of a computer model MUSIC (Model for Urban Stormwater Improvement Conceptualisation) developed by the CRC for Catchment Hydrology. MUSIC contains algorithms based on the known performance characteristics of common stormwater quality improvement structures used in Australia. These data, derived from research undertaken by the CRC and others.

The program is used to evaluate designs of stormwater management systems to ensure they are appropriate for their catchments. By simulating the performance of stormwater quality improvement measures, MUSIC determines if proposed systems can meet specified water quality objectives.

Pollution data for all catchment have been modelled independently and the annual results are shown below.

The site is on the southern side of Burrill Lake about 4 kilometres south of Ulladulla. The lands were formerly pastoral land and are bordered:

- to the west by frontage to the Princes Highway;
- to the north by the main Dolphin Point Road;
- to the east by a residential land; and
- to the south by existing rural properties.

Currently, access is available from the Princes Highway.

Table 1 Anticipated Lot Yield

Catchment	Number of Lots	Area ha
North Catchment	9	0.6
South Catchment	62	6.8
Total yield	71	

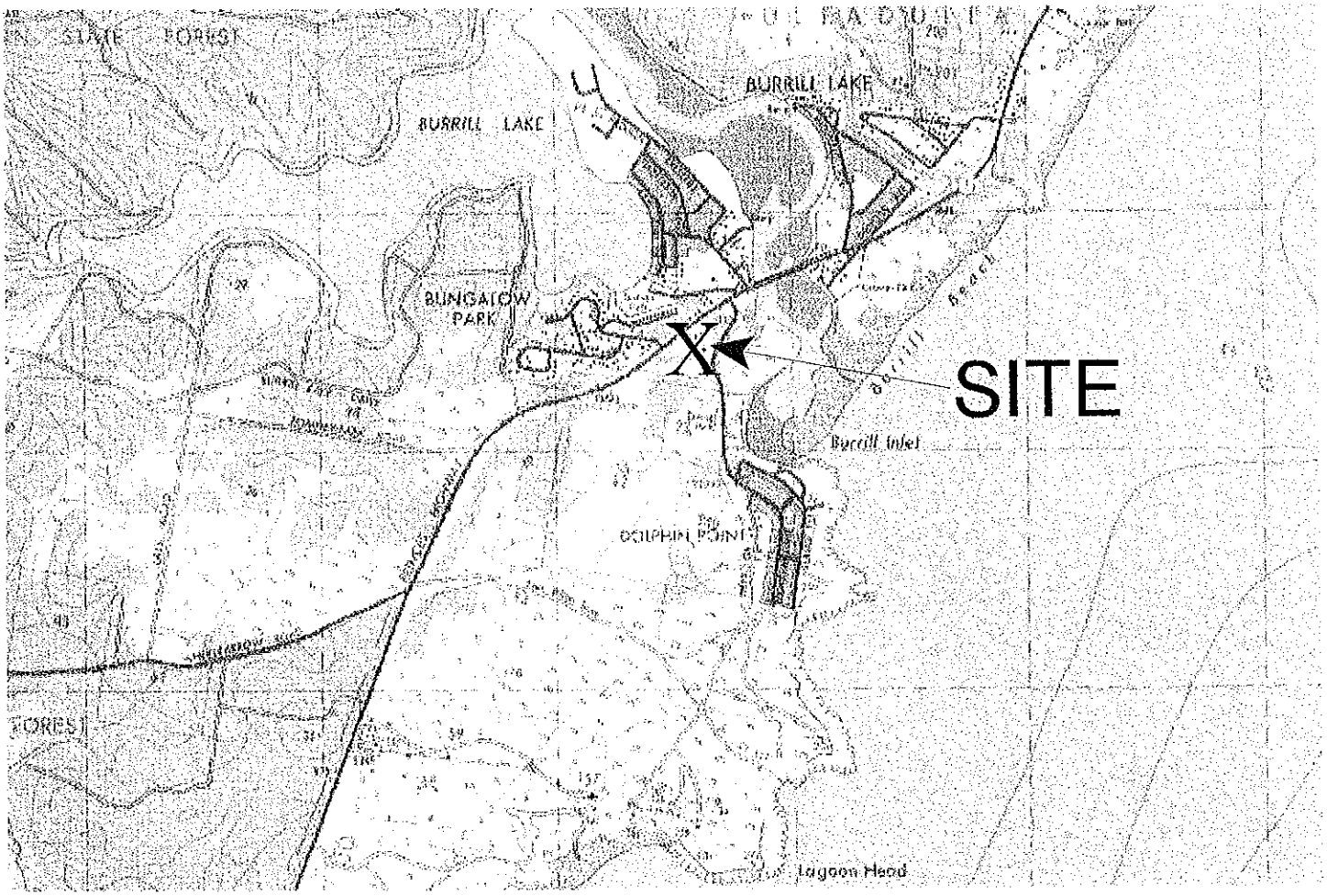

Figure 1: Site Location

The site has been separated into two catchments made up as follows:

North catchment: comprises 9 lots (64 to 71) and adjacent road. This catchment will collect stormwater and discharge to a water quality treatment system at the northern end of the site; and

South Catchment: comprises remainder of site and includes interallotment drainage from lots 1 to 6 at the northern end of the site. This area drains to the south and will discharge to a water quality control system that will include the existing dam.

2 Climate

2.1 Climate

Dolphin Point has a cool temperate climate, with a median rainfall of 960.3 mm (Ulladulla Rainfall Station) and a pan evaporation of 1,330 mm (Nowra).

2.2 Rainfall Data

Creation of a MUSIC catchment file requires an associated meteorological data file. The data used here is that for Port Kembla for 1997 in 6 minute time steps. Port Kembla was chosen because it has the closest relatively complete data set in the same rainfall zone as Burrill Lake (Rosewell and Turner, 1992), while 1997 data was chosen because that year seemed to have data nearest to being typical for Burrill Lake in terms of annual load and rainfall pattern. A time-series graph for the data is shown at figure 2 while basic rainfall and evaporation statistics are in Table 3.

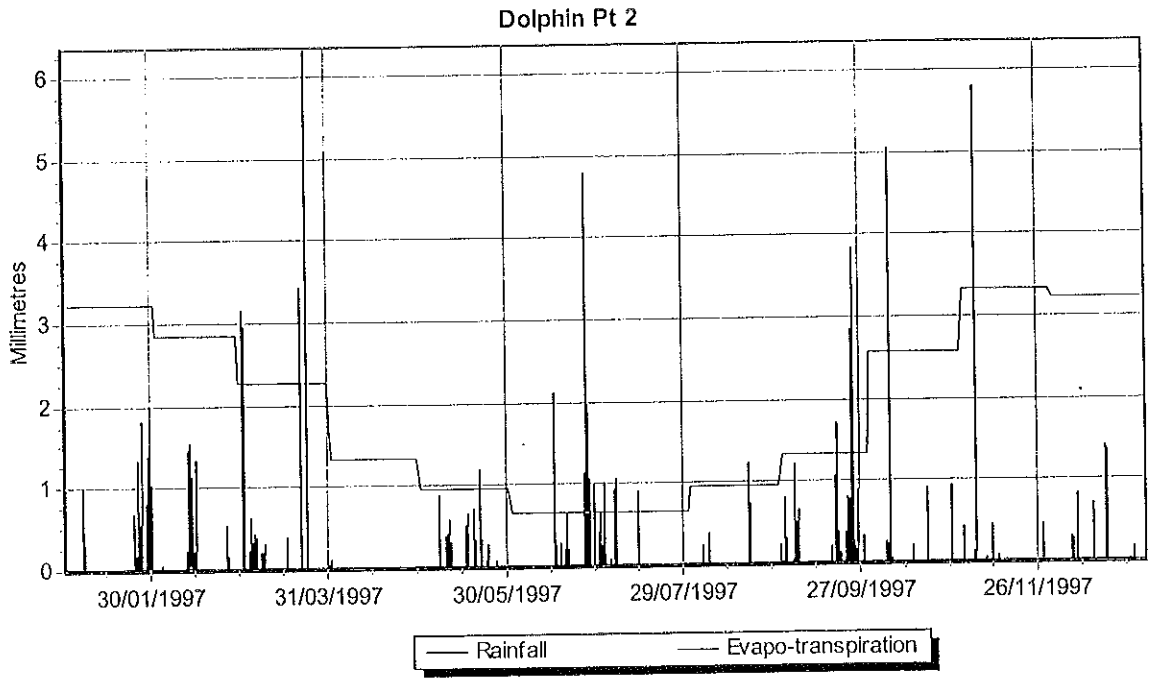

Figure 2: Time - series graph for rainfall

2.3 Water Quality Objectives

MUSIC incorporates the ability to display the accepted probabilistic water quality conditions at the receiving waters for Total Suspended Solids (TSS), Total Phosphorus (TP) and Total Nitrogen (TN). The standards adopted here are:

ANZECC/ARMCANZ (2000) -- among the default criteria in MUSIC:

- TSS, 50th percentile ≤ 6.0 mg/L
- TP, 50th percentile ≤ 0.037 mg/L
- TN, 50th percentile ≤ 1.6 mg/L

The water quality standards are specified in the form of a threshold water quality concentration value and a required compliance frequency for that value. Shown here are daily mean cumulative frequency graphs (the flow-weighted mean concentration for each day) (mg/L) and mean annual load statistics (kg/yr).

2.4 Source Nodes

Two source nodes are used here, agriculture and urban. Default setting were accepted for all values apart from those listed below:

(i) proportion impervious – 5 percent impervious for agriculture and 40% for urban area;

(ii) soil properties:

- all soils are designated as shallow
- field capacity, 50 mm
- infiltration capacity coefficient - a, 50.00
- infiltration capacity coefficient - b, 2.00
- rainfall threshold, 1.00 mm
- shallow soil area capacity, 150.00 mm
- shallow soil area initial storage, 25%
- groundwater daily recharge rate, 0.65%
- groundwater daily drainage rate, 0.85%
- initial depth, 50 mm.

2.5 Water Quality Structure Properties

It is proposed to use the following water quality strategies in this development:

(i) Northern Catchment

- Sediment Basin 1
  - Surface Area: 50 square metres
  - Extended Detention depth: 2 metres
  - Permanent Pool Volume: 50 cubic metres
  - Outlet Pipe 100 mm
  - Overflow weir width 2 metres
- Bio-retention System 1
  - Extended Detention depth: 1 metre
  - Surface Area: 30 square metres
  - Filter Area: 30 square metres
  - Filter Depth: 1 metre
  - Filter Particle Diameter 2 mm
  - Saturated Hyd. Conductivity 100 mm/hr
  - Overflow weir width 2 metres

(ii) Southern catchment

- Sediment Basin 2
  - Surface Area: 10 000 square metres
  - Extended Detention depth: 2 metres
  - Permanent Pool Volume: 5 000 cubic metres
  - Outlet Pipe 100 mm
  - Overflow weir width 2 metres
- Bio-retention System 1
  - Extended Detention depth: 0.5 metre
  - Surface Area: 10 square metres
  - Filter Area: 10 square metres
  - Filter Depth: 1 metre
  - Filter Particle Diameter 5 mm
  - Saturated Hyd. Conductivity 100 mm/hr
  - Overflow weir width 2 metres
  -
- Wetland
  - Surface Area: 1 500 square metres
  - Extended Detention depth: 0.5 metre
  - Permanent Pool Volume: 1 000 cubic metres
  - Outlet Pipe 40 mm
  - Overflow weir width 3 metres

3 Results of Modelling

The modelling clearly shows a neutral or beneficial effect on the receiving waters in terms of both mean annual loads and concentrations of the measured parameters in discharged stormwater (Table 4 and figures 3 and 4). More than that, the data show that the lands were not meeting the requirements of the more stringent ANZECC/ ARMCANZ (2000) guidelines pre-development for total phosphorus and total suspended solids whereas all parameters could be met post development.

Further, the load requirements of these guidelines could be met well beyond the required 50th percentile event post development to:

- the 90th percentile event for total phosphorus in the northern catchment and 55% in the southern catchment;
- the 90th percentile event for total suspended solids in both catchments; and
- the 90th percentile event for total nitrogen in both catchments.

This is mainly because stormwater is not presently being treated properly. Post development, these inadequacies can be corrected.

Table 4 Mean Annual Load Pollutant Statistics

Catchment	Water Reuse ML/yr	Export of Nutrients					
		Pre Development			Post Development		
		T P (kg/yr)	TN (kg/yr)	Flow (ml/yr)	TP (kg/yr)	TN (kg/yr)	Flow (ml/yr
Northern	Nil	1.21	8.57	2.27	0.354	3.53	3.10
Southern	Nil	14.4	102	26.9	3.85	44.6	36.7

The mean annual pollutant statistics in Table 4 above show a significant decrease in the post development of export of both nitrogen and phosphorus.

The graphs at figures 3 and 4 show that the exported levels of TP and TN for the developed site do not meet the ANZECC water quality guidelines for either catchment in the 50th percentile event without treatment. Following construction of the water quality control system the water quality objectives will be met.

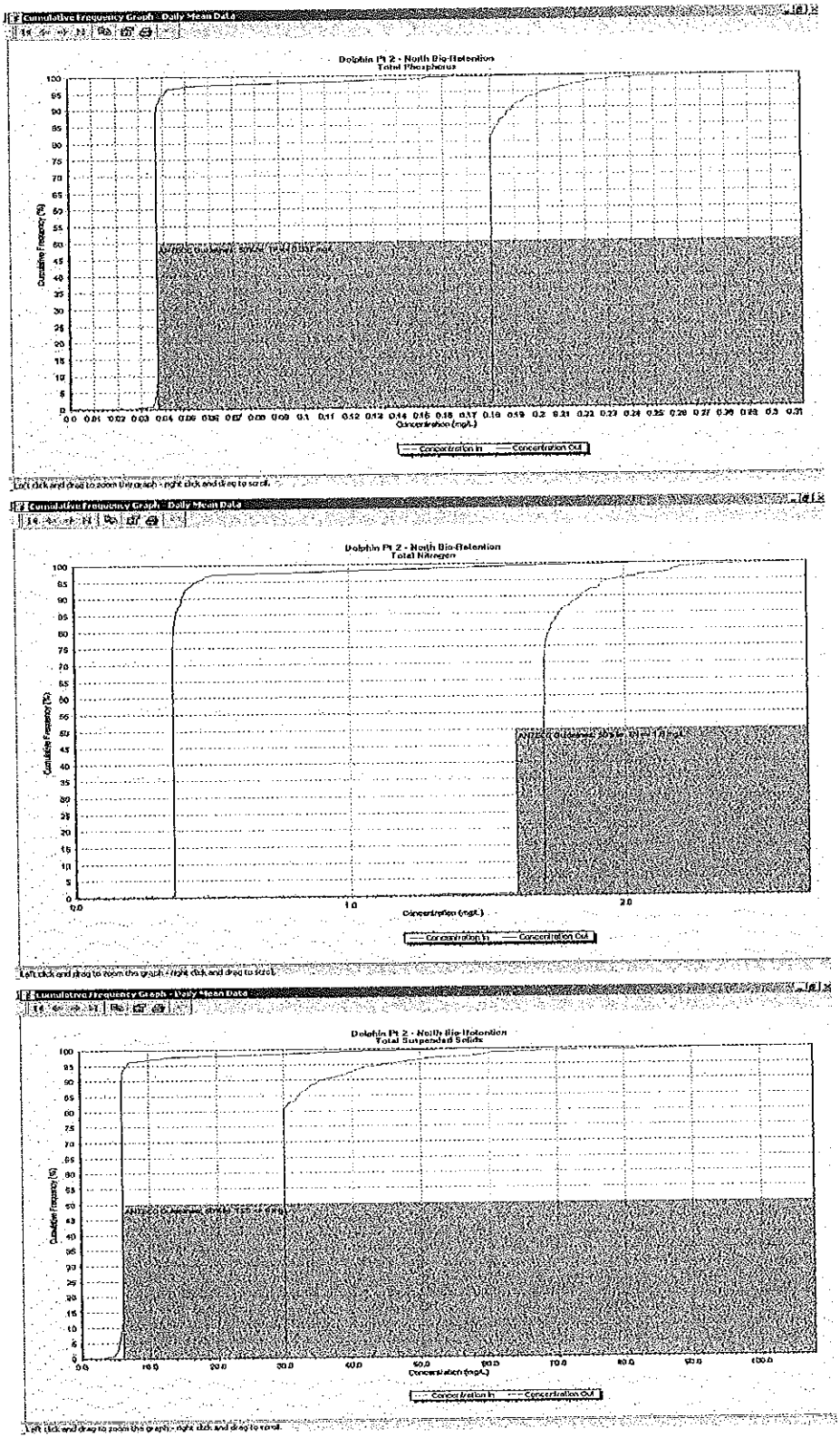

Figure 3: Developed Northern Catchment Stochastic Pollution Export

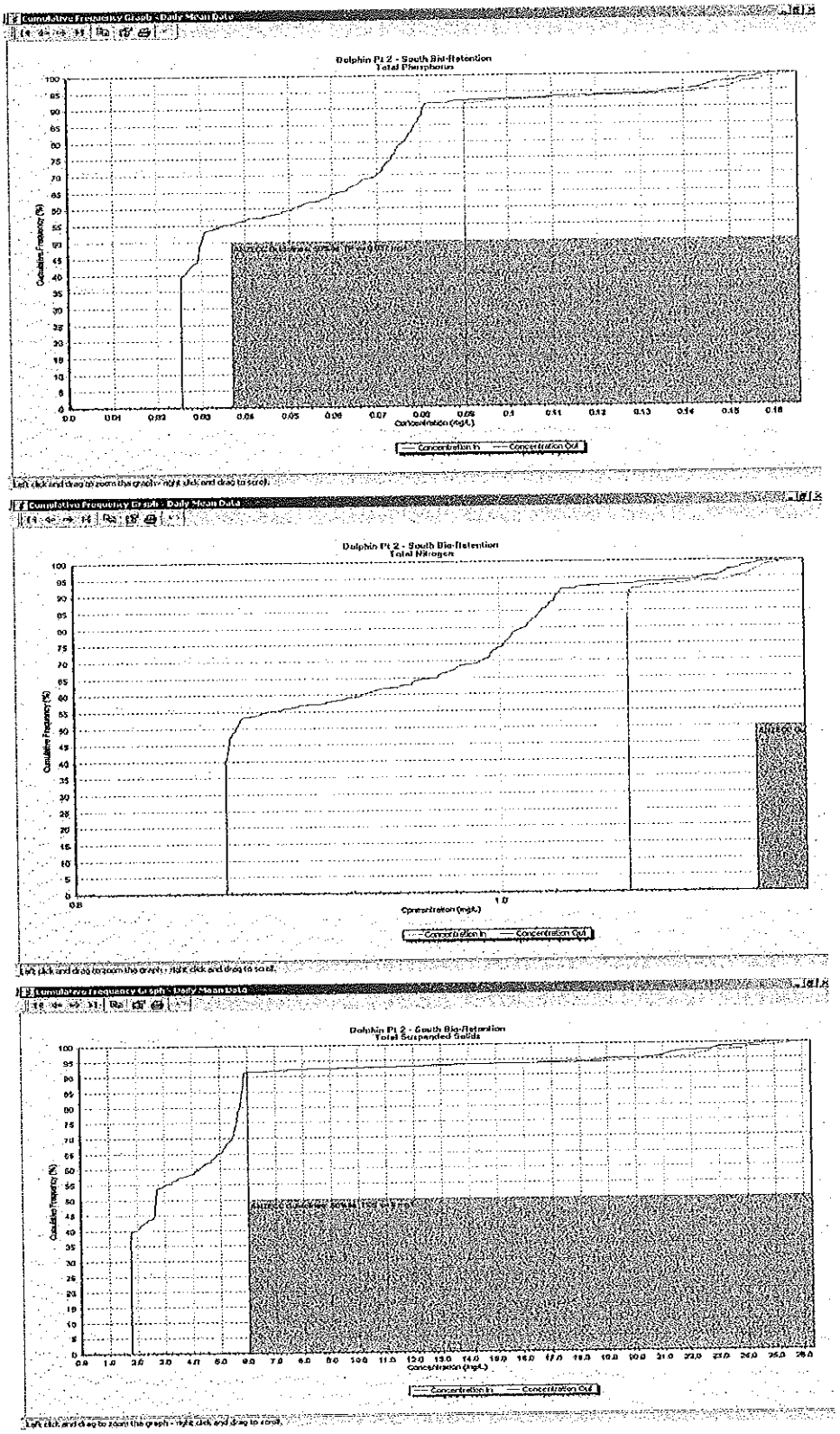

Figure 4: Developed Southern Catchment Stochastic Pollution Export

4 Construction Phase Pollution

As discussed above, modelling the pollutant loads during construction is not possible because MUSIC cannot model sediment basins as required by Department of Housing (1998) (the "Blue Book"). Even so, the design of all works on the site meet the requirements of the Blue Book and more. For example, it states that the "75th percentile, 5-day rainfall is recommended" for normal usage. The structures will be designed for the 75th percentile, 5-day depth.

The MUSIC modelling shows at Table 4 that the development of the site will significantly decrease the annual pollutant loads to the Burrill Lake System.

The strategies proposed for reduction of sediment pollution in runoff from the site during the construction phase are:

(i) earth banks to collect runoff water and divert runoff to a sediment basin in each catchment to control sediment pollution during works;

(ii) construction of a temporary sediment basins in the northern catchment to control sediment pollution during works;

(iii) use of the existing dam in the southern catchment as a sediment trap to control sediment pollution during works;

(iv) sediment fence downslope of all works

(v) temporary sediment basins that capture the total storm runoff for the 70th percentile 5 day storm event as described in *Managing Urban Stormwater: Soils and Construction* Department of Housing (1998);

(vi) pipe discharge to the natural drainage line with energy dissipater.

These features together with the works schedule, monitoring system and maintenance requirements will ensure that water quality will not be compromised during the construction phase.

The minimum size sediment basins for the construction phase are shown in Table 5 below.

Table 5: Sediment Basin Capacities

Site	Cv	R 75th ile 5 day	Catchment Area A ha	Settling Zone Volume m3	Sediment Storage Volume m3	Total Basin Volume m3
Basin 1	0.50	22.9	0.6	70	20	90
Basin 2	0.50	22.9	6.8	780	165	945

5 Conclusions

5.1 The Water Quality Plan prepared by Morse McVey & Associates includes the following features:

(i) construction of pipe drainage in accordance with drawings prepared by Rygate and West;

(ii) construction of permanent sediment basins in each catchment upslope of the bio-retention systems to remove sediment from storm flows;

(iii) construction of a artificial wetland in the southern catchment to control nutrient and sediment pollution post construction and to provide onsite stormwater detention; and

(iv) construction of a bioretention filters in each catchment to control nutrient and sediment pollution post construction and to provide onsite stormwater detention.

5.2 The water quality measures will significantly reduce nutrient pollution to downstream waterways following construction of the proposed water quality control structures in the proposed subdivision.

6 References

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Department of Housing (1998). *Managing Urban Stormwater: Soils and Construction.*

Gosford City Council Environment Program (1997). *Best Practice Guideline: Nutrient Control.*

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Rosewell, C.J. and Edwards, K. (1988). *SOILOSS: A program to assist in the selection of Management Practices to reduce Erosion,* Technical Handbook No. 11, Soil Conservation Service, Sydney.

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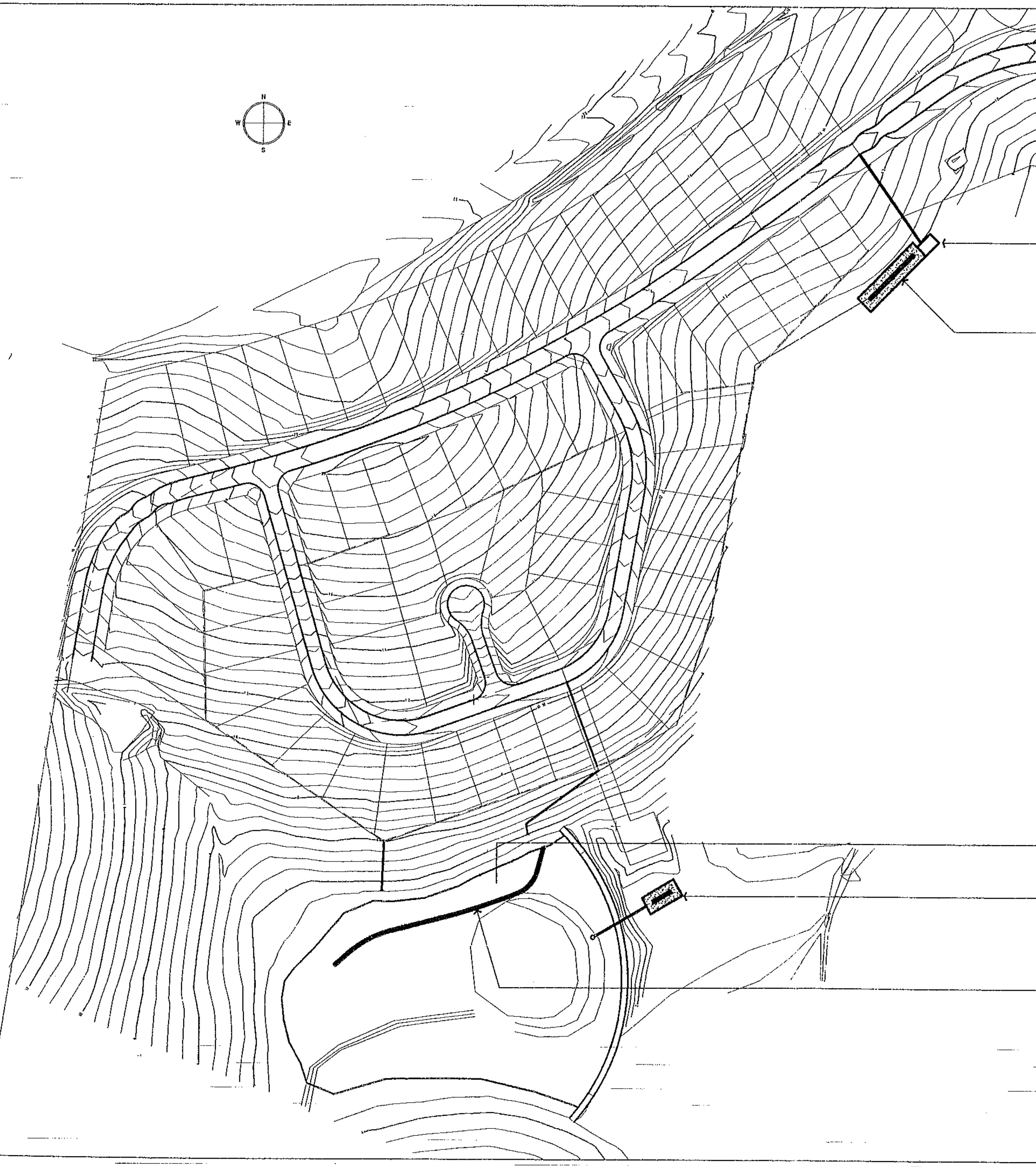
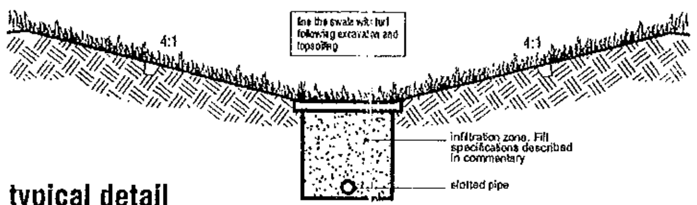


sediment basin 1

volume	50m³
open discharge to basin from pipe drainage	
open discharge to Bio-Retention System 1	

Bio-Retention Basin 1

infiltration zone	1m x 1m x 30m long
side batters	4:1, turfed
outlet pipe	Ø100mm PVC connected to slotted pipe
overflow	to sheet to downslope lands



typical detail
Bio-Retention system
not to scale

construction notes
Bio-Retention basin

Construct along gradient as specified.

Avoid removing trees and shrubs if possible.

Drains to be of parabolic or trapezoidal cross section as opposed to V-shaped.

Earth banks to be adequately compacted in order to prevent failure and to be free of projections or other irregularities that will impede normal flow.

Permanent stabilisation to be completed within 10 days of construction.

sediment basin 2

volume	945m³

Bio-Retention Basin 2

infiltration zone	1m x 1m x 10m long
side batters	4:1, turfed
outlet pipe	Ø100mm PVC with riser
overflow	to sheet to downslope lands

earth wall

crest width	1m

Morse McVey & ASSOCIATES

NOWRA
PICTON

DRAWING TITLE
WATER QUALITY PLAN

PROJECT
PROPOSED URBAN DEVELOPMENT
LOTS 21, 22, 23 DP867221
DOLPHIN POINT

DRAWING SCALE	DRAWN	CHECKED
1:1000 @ A1	A. Ball	G. McVey

DATE	DRAWING No
December 2002	002444-B1

APPENDIX 1: MUSIC OUTPUT DATA FILE

Source nodes

North Catchment (ID = 1),

South Catchment (ID = 2)

North Agricultural (ID = 7)

South-Agricultural (ID = 8)

Total Area (ha),0.6,7.1,0.6,7.1

Area Impervious (ha),0.241526315789474,2.82660964912281,0.0288947368421053,0.37742105263158

Area Shallow Soils (ha),0.179236842105263,2.1366951754386,0.285552631578947,3.36128947368421

Area Deep Soils (ha),0.179236842105263,2.1366951754386,0.285552631578947,3.36128947368421

Field Capacity (mm),50,50,50,50

Infiltration Capacity coefficient,50,50,50,50

Infiltration Capacity exponent,2,2,2,2

Rainfall Threshold (mm),1,1,1,1

Shallow Soil Capacity (mm),150,150,150,150

Shallow Soil initial storage (mm),37.5,37.5,37.5,37.5

Deep Soil Capacity (mm),150,150,150,150

Deep Soil initial storage (mm),37.5,37.5,37.5,37.5

Groundwater Daily Recharge Rate (%),0.65,0.65,0.65,0.65

Groundwater Daily Drainage Rate (%),0.85,0.85,0.85,0.85

Groundwater Initial Depth (mm),50,50,50,50

Stormflow Total Suspended Solids Mean (log mg/L),2.2,2.2,2.3,2.3

Stormflow Total Suspended Solids Standard Deviation (log mg/L),0.32,0.32,0.31,0.31

Stormflow Total Suspended Solids Estimation Method,Stochastic,Stochastic,Stochastic,Stochastic

Stormflow Total Phosphorus Mean (log mg/L),-0.45,-0.45,-0.27,-0.27

Stormflow Total Phosphorus Standard Deviation (log mg/L),0.25,0.25,0.3,0.3

Stormflow Total Phosphorus Estimation Method,Stochastic,Stochastic,Stochastic,Stochastic

Stormflow Total Nitrogen Mean (log mg/L),0.42,0.42,0.59,0.59

stormflow Total Nitrogen Standard Deviation (log mg/L),0.19,0.19,0.26,0.26

Stormflow Total Nitrogen Estimation

Method,Stochastic,Stochastic,Stochastic,Stochastic

Baseflow Total Suspended Solids Mean (log mg/L),1.1,1.1,1.4,1.4

Baseflow Total Suspended Solids Standard Deviation (log mg/L),0.17,0.17,0.13,0.13

Baseflow Total Suspended Solids Estimation
Method,Stochastic,Stochastic,Stochastic,Stochastic

Baseflow Total Phosphorus Mean (log mg/L),-0.82,-0.82,-0.88,-0.88

Baseflow Total Phosphorus Standard Deviation (log mg/L),0.19,0.19,0.13,0.13

Baseflow Total Phosphorus Estimation

Method,Stochastic,Stochastic,Stochastic,Stochastic

Baseflow Total Nitrogen Mean (log mg/L),0.32,0.32,0.074,0.074

Baseflow Total Nitrogen Standard Deviation (log mg/L),0.12,0.12,0.13,0.13

Baseflow Total Nitrogen Estimation

Method,Stochastic,Stochastic,Stochastic,Stochastic

USTM treatment nodes

North Bio-Retention (ID = 3),South Bio-Retention (ID = 4)

Sedimentation Basin (ID = 5),Wetland (ID = 6),Sedimentation Basin (ID = 9)

Lo-flow bypass rate (cum/sec),0,0,0,0,0

Hi-flow bypass rate (cum/sec),100,100,100,100,100

Inlet pond volume,,,0,0,0

Area (sqm),30,10,50,1500,10000

Extended detention depth (m),1,0.5,2,0.5,2

Permanent pool volume (cum),,,50,1000,5000

Proportion vegetated,,,0,0.5,0

Equivalent pipe diameter (mm),,,300,40,100

Orifice discharge coefficient,,,0.6,0.6,0.6

Overflow weir width (m),2,2,2,3,2

Weir coefficient,1.7,1.7,1.7,1.7,1.7

Number of CSTR cells,3,3,1,5,1

Total Suspended Solids k (m/yr),1000,1000,15000,5000,15000

Total Suspended Solids C* (mg/L),12,12,30,6,30

Total Suspended Solids C** (mg/L),,,30,6,30

Total Phosphorus k (m/yr),500,500,12000,2800,12000

Total Phosphorus C* (mg/L),0.13,0.13,0.18,0.09,0.18

Total Phosphorus C** (mg/L),,,0.18,0.09,0.18

Total Nitrogen k (m/yr),50,50,1000,500,1000
Total Nitrogen C* (mg/L),1.3,1.3,1.7,1.3,1.7
Total Nitrogen C** (mg/L),,,1.7,1.3,1.7
Threshold hydraulic loading for C** (m/yr),,,3500,3500,3500
Extraction for reuse,Off,Off,Off,Off,Off

Annual reuse demand (ML) Nil
Filter area (sqm),30,10,,,
Filter depth (m),1,1,,,
Filter particle effective diameter (mm),2,5,,,
Saturated hydraulic conductivity (mm/hr),100,100,,,
Voids ratio,0.3,0.3,,,

No Generic treatment nodes

No Other nodes

Links
Drainage Link,Drainage Link,Drainage Link,Drainage Link,Drainage Link
Source node,North Catchment (ID = 1),Sedimentation Basin (ID = 5),Wetland (ID = 6),South Catchment (ID = 2),Sedimentation Basin (ID = 9)
Target node,Sedimentation Basin (ID = 5),North Bio-Retention (ID = 3),South Bio-Retention (ID = 4),Sedimentation Basin (ID = 9),Wetland (ID = 6)
Muskingum-Cunge Routing,Not Routed,Not Routed,Not Routed,Not Routed,Not Routed
Muskingum K,,,,,
Muskingum theta,,,,,