Water Cycle Management Study

for Proposed 7 Lot Rural Subdivision and Boundary Adjustment at Lot 14 DP 750222 and Lot B 33573, off Ivor Jones Drive, Wonboyn Lake, NSW.

Prepared by:

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7 April, 2010

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Document Certification

This report has been developed based on agreed requirements as understood by SEEC at the time of investigation. It applies only to a specific task on the nominated lands. Other interpretations should not be made, including changes in scale or application to other projects.

Any recommendations contained in this report are based on an honest appraisal of the opportunities and constraints that existed at the site at the time of investigation, subject to the limited scope and resources available. Within the confines of the above statements and to the best of my knowledge, this report does not contain any incomplete or misleading information.

Mark Passfield
Director
SEEC

7 April 2010

Executive Summary

It is proposed to develop a 7 lot rural subdivision and boundary adjustment at Lot 14 DP 750222 and Lot B 33573 off Ivor Jones Drive, Wonboyn Lake, NSW.. This Water Cycle Management Plan shows how wastewater and stormwater will be managed to ensure there is no appreciable (or measurable) effect on the water quality in Wonboyn Lake and, therefore, the requirements of SEPP62 Clause 15D (NSW Oyster Industry Sustainable Aquaculture Strategy) are met.

The study is a revision of an earlier one dated 22nd February 2008, also prepared by SEEC. It replies to the NSW Department of Planning's Issues of Submissions. For a summary of where the additional information and/or replies can be found refer to the table prepared by The Planning Group P/L.

In summary, onsite wastewater will be managed by providing a suitably sized effluent management area (EMA) in which pathogens, viruses, nitrogen and phosphorous will be contained. Those EMAs are designed according to Bega Valley Shire Council's (BVSC) DCP 5 and will be located at least 150 m from the banks of the lake.

Water Sensitive Design will be incorporated to infiltrate and treat stormwater runoff from all "urbanised" surfaces. Modelling shows that phosphorous and suspended solids export will be less than now. There is predicted to be a very small increase in nitrogen export (6-12 kg/year), which amounts to an approximate increase in nitrogen concentrations in the lake's catchment of less than 0.05 percent (i.e. below a measurable difference). The total flow from the site, and the site's general hydrology, will remain essentially unaltered. The target pollutant exports required by BVSC DCP36 (which applies to adjoining land with the same receiving waters) are exceeded by a considerable degree.

The MUSIC modelling incorporates the latest (draft) modelling guidelines prepared by the Sydney Catchment Authority, as they represent the latest NSW-specific recommendations and provide a conservative approach. It is appreciated that the site is not an area administered by the SCA but we (and SCA) believe there is no reason why much of their work cannot be adopted elsewhere in NSW.

Contents

1 Introduction

SEEC have been commissioned by Mr Doug Hemmingway of Picnic Point P/L to provide this Water Cycle Management Study (WCMS). It is required to accompany an application to subdivide Lot 14 of DP 750222 and part Lot B 33573, off Ivor Jones Drive, Wonboyn Lake ("the site" Figure 1) into seven new rural lots as shown on the layout plan in Figure 2, prepared by RW Surveying (reference 0833 B Rev 16 (dated 31/01/2010).). It includes:

(i) an investigation into the existing water cycle;

(ii) an assessment of how the proposed development will affect that water cycle;

(iii) a plan for managing the water cycle to ensure there will be no appreciable effect on the water quality of Wonboyn Lake.

The site is in the Wonboyn Lake Catchment (360 km^2). The lake is an important oyster growing and recreational estuary.

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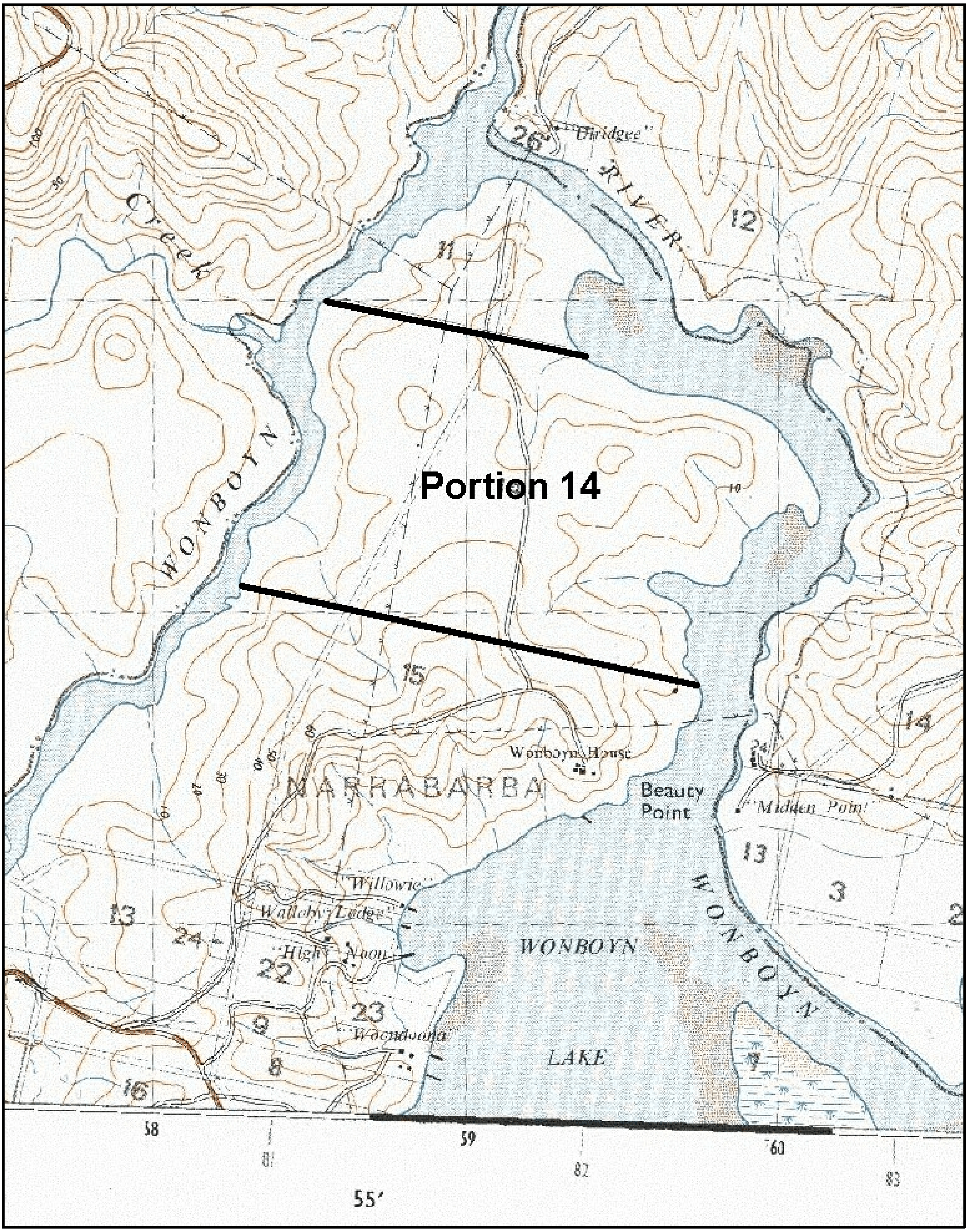

Figure 1 - The site, topographic map © Dept Lands

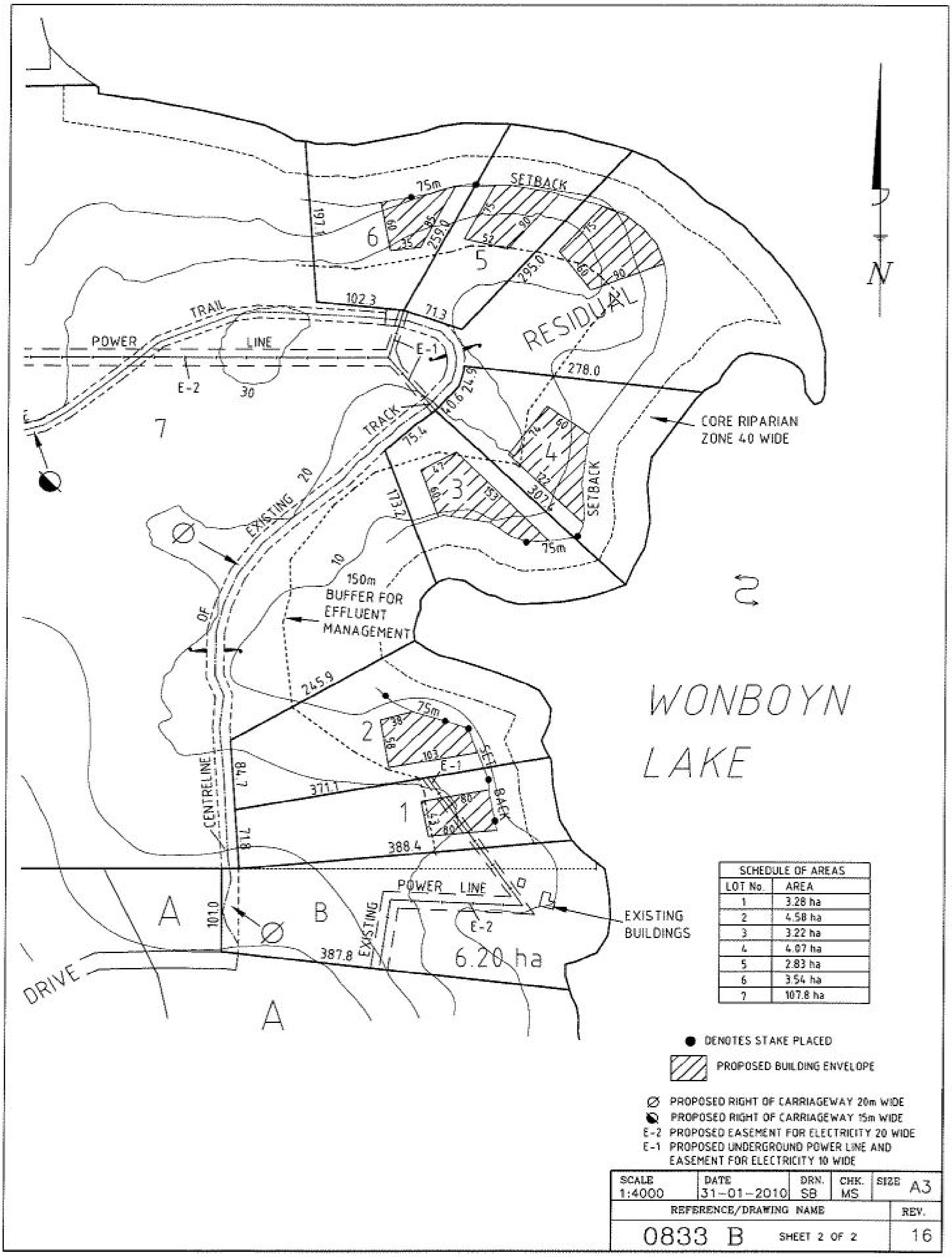

Figure 2 – The Proposed Subdivision

2 The Proposed Development

The proposed development involves (Figure 2):

(i) subdividing the site into seven new rural lots as follows:

- Lot 1 at 3.28 ha
- Lot 2 at 4.58 ha
- Lot 3 at 3.22 ha
- Lot 4 at 4.07 ha
- Lot 5 at 2.83 ha
- Lot 6 at 3.54 ha; and
- Lot 7 = residual (107.8 ha).

(ii) building a new right of carriageway (ROW) to access each new lot (see SEEC drawing number 07000168-01);

(iii) building seven new driveways from the ROW to access each home site; and

(iv) building a new fire trail from the end of the ROW to Portion 11 (Picnic Point) (Figure 2).

Note that due to bushfire issues the initial lot layout was altered slightly after our site visit and some of the selected dwelling envelopes have moved slightly. This applies to Lots 1, 2 and 3 only. As the topography in this area is quite consistent, this has not posed a problem for this report (Appendix 1). The site is not connected to reticulated water or sewer.

3 The Site

3.1 General Topographic Conditions

Portion 14 occupies part of a peninsula of land located on the western shore of Wonboyn Lake (Figure 1). It is bound in the east and west by the Wonboyn River. Most of the proposed development will be on the east of the peninsula but the fire trail will be built in the central north of the site (Figure 2).

Much of Portion 14 occupies a broad plateau with slope gradients less than 10 percent. Most of the proposed ROW and the fire trail will be in this area. The proposed dwelling envelopes will be located on the east-facing side slope of Wonboyn Lake. Here the slope varies from 6-7 percent on Lots 1 to 4 to 20 percent on Lots 5 to 7. Figures 3 and 4 show the typical conditions in the proposed development areas. A site summary has been prepared for each proposed building envelope in Appendix 1.

Figure 3 – Typical Conditions around proposed home sites on Lots 1 and 2

3.2 Soils and Geology

3.2.1 Mapping

Soil landscape mapping for this area was conducted by M. Tulau (2005), Department of Natural Resources (DNR, now part of the Department of Environment and Climate Change and Water, DECCW). It shows that Portion 14 lies on four soil landscapes (Figure 5). Site and soil investigations by SEEC staff was limited to the areas proposed for development, i.e. the ROW and the dwelling envelopes. Here we confirmed the mapping to be mostly accurate.

Figure 4 – Proposed dwelling envelope, Lot 7

The four soil landscapes mapped on the development site are:

(i) The Bournda SL in the west;

(ii) The Timbillica SL in the centre and centre-east;

(iii) The Merrica SL in the east; and

(iv) The Wonboyn Lake SL in a small area in the far east of Lot 7.

All of the identified dwelling envelopes, plus most of the proposed ROW, are mapped on the Merrica Soil Landscape, facet "mec". This is a colluvial soil landscape derived on the Merimbula Group sandstones and siltstones. The soil landscape descriptions note the "mec" soil material as very rocky on steep slopes but that is not the case here – none of the lands inspected had rock outcrop (except on the lakes' foreshore) and the soils had a low to moderate percentage of coarse fragments. Therefore, I believe the soil soil materials actually present here are:

(i) me2 (a brown sandy loam); and

(ii) me3 (a dull yellowish sandy clay loam to light clay).

Subsoils on the Merrica SL can vary within short distances and can be dispersive. M. Tulau (2005) recommends that these soils be site-specific tested before earthworks, and that has been undertaken here (Section 3.2.3). The soils are noted as having a moderate susceptibility to erosion by concentrated flow but a low susceptibility to erosion by wind or sheet flow. However, the erosion hazard is high in urban development.

A small part of the ROW, and most of the fire trail, will be on the Timbillica Soil Landscape. It consists of coarse grained sandy topsoils and sandy clay subsoils derived on Tertiary fluvial sediments. Generally this soil landscape is very similar to the Merrica SL, although where it was sampled (on the proposed road alignment, near to Lot 2) the clay subsoil was absent (replaced with a clayey sand). Texturally the Bournda soil landscape, although derived on volcanic rock, is also similar, with sandy loam topsoil over clay subsoil.

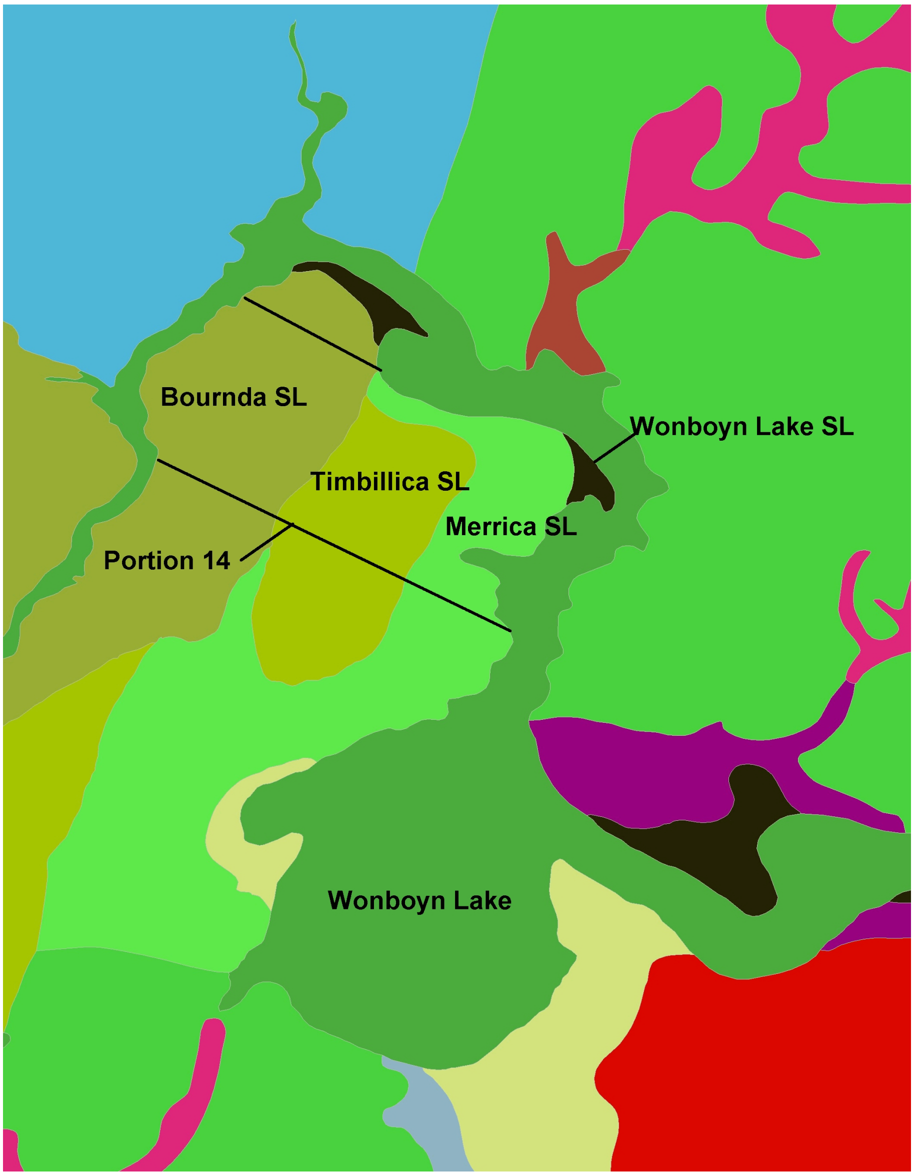

Figure 5 – Soil mapping of Portion 14

3.2.2 *Site Specific*

Several test pits were dug by hand and supplemented by Dynamic Cone Penetrometer (DCP) tests to prove depth to bedrock. The individual soil descriptions for each site are given in Appendix 1. All test pits except TP1 showed a consistent soil profile of:

0 - (200-300) mm	Grey sandy loam, massive
(200-300) - (800-900) mm	Yellow brown sandy clay loam to light clay, moderately pedal.

Bedrock was normally encountered at about 900 mm, although one DCP test (near Lots 5 and 6) proved a soil depth of 1,200 mm. *(Moderate Limitation)* [1]

TP1 represents the Timbillica Soil Landscape. It showed gritty and sandier soils than elsewhere. As these soils would be less erodible than the Merrica SL they were not sent for earthworks testing (i.e. we assumed the worst case).

3.2.3 *Laboratory Testing*

Soil samples representing the Merrica Soil Landscape were sent to Scone Research Laboratories for testing. Two suites of tests were undertaken:

(i) An "erosion and sediment control" suite of tests to:
- determine the particle size distribution;
- determine the erodibility (K-Factor); and
- determine the dispersion percentage.

(ii) An "effluent management" suite of tests to determine the suitability of the soils for onsite effluent disposal.

The results of these tests are given below in Table 1 and discussed below.

3.2.3.2 pH

pH is a measure of the alkalinity or acidity of a soil and influences nutrient availability. The measured pH was 5.1 to 5.6. Soils are, therefore, considered strongly acidic. (*Moderate limitation)*.

3.2.3.3 Electrical Conductivity

All tested soils had an electrical conductivity less than 0.05 dS/m so they are non saline (*Minor limitation*).

3.2.3.4 EAT test

An Emerson Aggregate Test (EAT) is a subjective test used to assess the potential for soils to disperse. Soils have an ETA class 2(1) (*Moderate limitation).*

1 The "limitation" refers to the classifications given in DLG 1998 and refers to limitations to effluent management.

Table 1 - Soil Testing Results (Dept. Lands)

Lab No	Method	C1A/4	C2A/3	C5A/3 CEC & exchangeable cations (me/100g)						C8B/1		C6A/2	P9B/2
	Sample Id	EC (dS/m)	pH	CEC	Na	K	Ca	Mg	Al	P sorp (mg/kg)	P sorp index	OC (%)	EAT
1	07000168 Layer 1	0.01	5.1	6.6	0.4	0.2	0.9	1.0	<0.1	152	1.5	1.38	2(1)
2	07000168 Layer2	0.01	5.6	9.1	0.5	0.2	0.4	1.6	1.5	401	3.0	0.44	2(1)

Lab No	Method	P7B/1 Particle Size Analysis (%)						P8A/2	P7C/1 Particle Size Analysis – mechanical dispersion (%)					
	Sample Id	clay	silt	vf sand	cf sand	c sand	gravel	D%	clay	silt	vf sand	cf sand	c sand	gravel
1	07000168 Layer 1	7	12	32	13	32	4	54	4	13	31	13	35	4
2	07000168 Layer2	26	15	21	9	26	3	82	23	18	19	9	28	3

END OF TEST REPORT

3.2.3.5 Dispersion

The clay fraction of the subsoil is significantly dispersive: dispersion percentage of fines = 82%, dispersion percentage of whole soil = 26 percent.

3.2.3.6 Cation Exchange Capacity (C.E.C)

The C.E.C is the capacity of the soil to hold and exchange cations. It is a major controlling agent for soil structural stability and the ability of a soil to sorb nutrients and/or pollutants. The topsoil CEC was measured at 6.6 (low). The subsoils' CEC was 9.1 (low) *(Moderate Limitation).*

3.2.3.7 Phosphorus sorption (P-Sorption)

A soil's capacity for sorbing (fixing) phosphorus is related to its texture and clay mineralogy. Generally, as clay content increases so does the P-sorption ability. Conversely, as the volume of coarse fragments increases the P-sorption decreases (as fragments do not readily sorb phosphorous).

Assuming 250 mm of topsoil and 650 mm of subsoil, the calculated phosphorous sorption capacity is approximately 4,340 kg/ha *(Moderate Limitation).* DLG (1998) requires the *insitu* P-sorption capacity to taken as about 35% of the potential value (on the assumption that not all soil particles will be in contact with the percolated effluent). Therefore, the *insitu* P-sorption used in the nutrient balance (Section 5.5.3.2) is 1,447 kg/ha.

3.2.3.8 Sodicity

Sodicity refers to the level of exchangeable sodium cations in the soil. It relates to likely dispersion on wetting and to shrink/swell properties. The sodicity for both the topsoil and the subsoil is 5.5 - 6 (non-sodic but marginal sodic) (*Moderate limitation).*

3.2.3.9 Organic Content

Soils are generally low in organic content. Coupled with their fine sandy loam texture this means the topsoils could be hard-setting when exposed.

3.2.3.10 Coarse Fragments

Soils generally have less than 5 percent gravel *(Minor Limitation).*

3.2.4 Permeability

Soil permeability was not directly measured by SEEC but it can be inferred from the soil texture. AS/NZS1547 (2000) suggests that:

(i) the near surface soils (sandy loam) will have a K_{sat} of approx 1.4 - 3 m/day (Class 2b, *Minor Limitation*)

(ii) the subsoils (clay loam to light clay) will have an indicative permeability of 0.12 - 0.5 m/day. (Class 4b, *Minor Limitation*)

3.2.5 Salinity

Observations by SEEC staff did not identify any surface indications of salinity at this site. Tulau (1995) does not identify the soils to be prone to salinity. The electrical conductivity of the soils is very low.

3.2.6 Erodibility

The K-Factor is calculated at 0.025 (low) but the subsoils are potentially dispersible.

3.2.7 Acid Sulfate Soils (SEPP 62)

Acid sulfate soil risk mapping by the Department of Land and Water Conservation and Water identifies one area of potentially acid sulphate soils (PAS) on the eastern extremity of the peninsular of land on Lot 7 (Appendix 5). The area is identified as Eu1 - Estuarine, supra-tidal flat, within 1 m of the surface (if present). However, the area is also identified as *Low Risk - not expected to contain acid sulfate soils, although highly localised occurrences might be found - especially on the boundary with areas of high risk* – but that does not occur here.

We did not specifically investigate this area for acid sulphate soils because none of the proposed development is (in plan) close to it and, more importantly, all proposed development is on elevated lands, well above the level where PAS could occur. It is our opinion that there is no risk that acid sulfate soils will occur in land to be developed, although the future owner of Lot 7 should be aware of the low risk identified in Appendix 5.

3.2.8 Soils Summary

The soils pose a series of moderate limitations to effluent management, but no major ones. They have only a moderate to low ability to entrain pollutants and phosphorous and so disposal of primary treated effluent is not recommended on any lot. A minimum secondary level of treatment is required. Wastewater management is discussed in Section 5.5 where the limitations are addressed in more detail. The soils are not highly erodable but the subsoils are potentially dispersive (Type D, landcom, 2004).

3.3 Surface and Subsurface Hydrology

Most of the proposed development is on the east-facing side slope of Wonboyn Lake , with the ROW and the fire trail proposed on the plateau. Stormwater is shed from the plateau east and west towards the lake. On the eastern side it concentrates in three depressions (Figure 2) but there are no watercourses with defined bed or banks. The ROW crosses the upper reaches of these depressions. Up-slope catchments vary from 4 ha to 15 ha. The proposed fire trail alignment has been adopted so that it does not intercept any depressions or watercourses.

The soils are classified as hydrological Class C (Landcom, 2004) even though rainfall is expected to infiltrate the permeable near-surface soils. This is because they are shallow in nature and clayey at depth. Soils of this classification shed rainfall under moderate to high rainfall events.

We have not specifically investigated groundwater at this site and there are no registered bores on it from which to draw information. Infiltrated water would be expected to move along the bedrock surface, approximately parallel to the ground surface. In the development area the bedrock is a mix of permeable sandstone and less permeable siltstone and so perched watertables could occur at depth, especially on the plateaux areas.

3.4 Climate

Wonboyn has a temperate coastal climate, with warm summers and temperatures below 15°C in winter. Mean annual rainfall at nearby Eden (Green Cape) is about 750 mm (Australian Bureau of Meteorology) and mean annual evaporation is 1,242 mm (BOM supplied data for nearby Pambula).

Four different rainfall data sets are used in this report, each having a different function.

(i) Daily rainfall data is used for rainwater tank simulation (Section 6.1). The most complete, nearby, data for this is derived from Pambula Post Office (94 years, 95 percent completeness).

(ii) 70th percentile monthly rainfall data is used in the wastewater management hydraulic balances [2](Section 5.5.3.3). Again, the BOM have prepared this data for us for nearby Pambula Post Office [3], Table 2.

(iii) Two sets of pluviograph data in six-minute time sets are used in MUSIC modelling (Section 6.2). Pluviograph rainfall data is not measured at all climate stations and the closest suitable stations that do measure it are Green Cape and Genoa. From records supplied by

2 Per the requirements of Bega Valley Shire Council's DCP5

3 Pambula's rainfall is slightly more than the site's but the data set is more complete than Green Cape.

BOM we have extracted and used data for Green Cape 1/01/1978 to 31/12/1979 and for Genoa 1/01/1983 to 31/12/1987. Data for these periods were chosen because:

- The Green Cape data is mostly complete and has an average close to, but slightly less than, the mean rainfall (684 mm compared to 750 mm); and
- The Genoa data is mostly complete, has a similar rainfall pattern and represents significantly higher rainfall (985 mm compared to 750 mm).

NOTE: MUSIC requires a rainfall data set for a period of at least one year (the default data that comes with the software are this length). Therefore, adopting two and five year data sets is more than sufficient.

Table 2 - 70th Percentile rainfall and mean pan evaporation data for Pambula PO.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annu
70th Percentile Rainfall (mm)	105.2	97.8	108.3	83	66.3	77.5	58.8	61.1	70.8	73.8	92.6	85.3	957
Pan Evaporation (mm)	187	153	127	78	50	36	41	58	79	114	143	176	1241

3.5 Erosion Potential

The estimated rainfall erosivity (R-Factor) for Wonboyn is 2,500, which is moderate. The site has a generally low erosion risk (Figure 4.6, Landcom, 2004) but this increases to high (just) where the slope is greater than 10 percent (e.g. at the dwelling envelopes on Lots 5 and 6 and for part of the ROW where it is near a depression).

A Preliminary Erosion and Sediment Control Plan (DECC, 2008) has been prepared for the site by SEEC, reference (07000168-SWMP-01). In brief it shows that sediment basins are not required because of the low soil loss classes and so a general suite of best management practices are sufficient. Nevertheless, it will be critical to ensure ground cover is quickly reinstated to prevent the potentially dispersible subsoils being eroded.

3.6 Vegetation and Biodiversity

Vegetation and bushfire issues are addressed by others but suffice it say here that the site is heavily timbered with native vegetation and native biodiversity ranges from reasonable to excellent. Areas under native woodland are in very good condition.

3.7 Current Land Use

At the time of inspection, the majority of the site was unused and under native timber.

There is a 20 m wide electricity easement in the west of the site (Figure 6) and this has historically been used by the public to gain access to Picnic Point, which is off-site. The track is about 3 m wide but is now closed to public use. There is also an existing 3 m wide fire trail in the south east of the site.

3.8 Existing Issues

At the time of inspection the site was in very good condition. There were no key issues to water quality except some existing erosion along the electricity easement (Figure 6).

Figure 6 View north along existing transmission line. Notice sandy soils that are exposed to erosive forces.

4 Identifying Future Water Quality Issues

4.1 Production, Management and Disposal of Wastes

4.1.1 Domestic Waste

We anticipate that new residences will have access to Council's waste transfer stations (as part of annual rates). As such, we expect that no domestic waste will be deposited onsite.

4.1.2 Effluent Disposal

The site is not serviced by reticulated sewer, so each new house will require onsite wastewater treatment and disposal. This is discussed in Section 5.5.

4.1.3 Other Pollutants

It is unlikely that the proposed development will generate significant quantities of other pollutants that might become entrained in stormwater runoff.

4.2 Land Surface Changes

Land surface changes include (refer to plan in Figure 2):

(i) a new sealed ROW. This will:
- be approximately 1,000 m long;
- will be built in a 16 - 20 m road corridor;
- have a 4 m wide sealed pavement with passing bays (assumed 20 percent impervious);
- be crowned to drain to table drains on both sides wherever possible (Section 5.2)

(ii) although not technically part of this DA, it is assumed there will be seven new houses built on the site. Each will be contained in an inner asset protection zone of approximate dimensions 7,000 m^2 (40 m on three sides, 20 m on the lake side plus 20 m x 10 m house). Each is assumed to have a roof area of 300 m^2 and other impervious areas of 400 m^2);

(iii) although technically not part of this DA, each house will require an access. Where possible at least part of each access will be shared, to reduce the need for clearing. In total it is estimated there will be about 700 m of access at 4 m wide and contained in 16 m wide easements (25 percent impervious);

(iv) the unused fire trail in the south east of the property will be allowed to regenerate;

(v) a new 1 km long fire trail will be built from the end of the new ROW west to the boundary with Portion 11. It mostly follows a ridge and its alignment has been chosen specifically to avoid areas of concentrated flow (Figure 2). It will be 4 m wide in a 16 m easement (25 percent impervious).

4.3 Connectivity to Receiving Waters.

Only where pavements cross drainage depressions are they likely to lead to measurably higher flows in watercourses. In these locations, pavement drainage cannot be sheeted onto adjacent land and infiltrated before reaching them. The proposed ROW crosses three drainage depressions. However, assuming a spacing between mitre drains of 50 m, we estimate there is only about 300 m of pavement that would drain directly to watercourses.

Dwelling envelopes are situated at least 40 m from depressions and 75 m from Wonboyn Lake. Despite these buffers runoff from the "urbanised" areas (i.e the inner protection zone) will be infiltrated into the surrounding soils (Section 5.3), embracing the inherent treatment offered by the permeable soils at this site.

5 Water Cycle Management Plan – Water Sensitive Design

5.1 Construction Phase Erosion and Sediment Control

Soil and water management during the construction phase must be considered for proposals such as these. Volumes 2C and 2D of DECCW's series *Managing Urban Stormwater* apply to unsealed roads and main roads respectively. They require a Preliminary Erosion and Sediment Control Plan to be prepared. This has been done by SEEC in an accompanying report referenced 07000168-SWMP-01.

5.2 Pavement Design

5.2.1 Generic Design

(i) Wherever possible (and this is the case for most of the ROW, the drives and the fire trail) table drains will be built on both sides and the pavement cambered to drain to them, refer to SEEC Drawing number 07000168-08).

(ii) Tail-out drains will be provided at about 50 m intervals to regularly sheet water from the table drains onto well vegetated land. Tail-outs are to be at-grade and will have a sill at their end to encourage minor ponding of water (and subsequently to promote infiltration). If their gradient is more than 5 percent, rock check dams (Appendix 4, SD 5-4) will be installed to reduce it. This encourages infiltration.

(iii) The ROW table drains are to have the following characteristics and conceptual dimensions:

- a trapezoidal channel as follows:
  - base width: 0.5 m
  - top width: 2.3 m
  - depth: 0.3 m
  - side batters: 1(V):3(H).

(iv) Driveways will also be provided with table drains on either side (if slope permits). Driveway table drains will have the same conceptual dimensions as above.

(v) All table drains will:

- be lined with topsoil (pH adjusted) to promote grass growth;
- be lined with bitumen-sprayed jute matting *immediately* following construction, with grass seed sown under or onto the matting (depending on manufacturer's instructions); and

- discharge water onto an energy dissipater (Appendix 4, SD 5-8) (if discharging into a watercourse) or tail-out structures at 50 m spacings.

(vi) Discharge points are to be stabilised with an appropriately sized energy dissipater (Appendix 4, SD 5-8), made from riprap (i.e. locally-sourced rock).

(vii) Cut and fill batters will be stabilised immediately following construction and compaction using hydroseed or hydromulch spraying (or equivalent) to lower C-factors [4] and aid the establishment of grasses.

(viii) Cut and fill batters will not exceed 1(V):2.5(H). Any steeper makes vegetation establishment difficult in this climate.

(ix) Table drains will be stabilised immediately following construction using bitumen-sprayed jute matting (or equivalent).

(x) Sediment fencing will be erected 2 m from the toe of any fill batters until vegetation establishment has stabilised them sufficiently.

(xi) The ROW will be sealed for its entire length.

(xii) The driveways will also be sealed.

5.2.2 Watercourse Crossings

(i) The ROW crossings will use shallow causeways, sized according to the expected flow in the 100-year storm event. Trickle flow will be taken by concrete pipes under the causeway. Rip-Rap with geotextile underlay will be placed downslope of the causeways (Appendix 4, SD 5-8) to dissipate flow.

(ii) Any fill batters within 50 m of the watercourses will be stabilised immediately following construction with coconut fibre or jute fibre blankets. Grass seed will be sown onto or under (depending on manufacturer's recommendations) the blankets.

(iii) Any runoff from the pavement is not to be dropped into a watercourse from the pavement height. It is to discharge onto a stable energy dissipater.

5.2.3 Existing Power Line Easement

(i) The existing power line easement will be graded and drained to a series of mitre drains spaced at 50 m centres on either side. Refer to clause 5.2.1 (ii).

4 C-Factor is a measure of ground cover. It varies from 1.0 for bare soil to 0.05 for well vegetated land.

5.3 Home Sites

Water sensitive urban design measures will be incorporated into the design of each home site. Each new houses will include:

(i) A 100 kL rainwater tank (or series of tanks) to capture roof runoff. These tanks:

- are to have 10 kL dedicated to fire fighting;
- are to be plumbed to provide all internal and external water;
- are to be plumbed to capture as much of the roof runoff as is feasibly possible. This is normally easily achieved through the use of charged pipelines;
- are to have their overflow directed to the infiltration contour bank described below;
- are to have a first-flush device;
- are to be screened and sealed to prevent the entry of leaves, twigs and mosquitos;
- are to be installed and maintained according to the manufacturer's instructions.

(ii) Water saving fixtures for any fittings. Toilets are to have AAA-rated (minimum), dual flush cisterns.

(iii) An infiltration contour bank [5] (Figure 7) to trap and percolate runoff water into the soil. This contour bank will:

- be located downslope of each house, at the extremity of the inner protection zone;
- be long enough (about 100 m) to capture runoff from the entire urbanised area (inner protection zone);
- have a 1 m wide base that will be scarified and have gypsum incorporated into it to improve percolation rate and control potential dispersiveness;
- be well vegetated with local native grasses.

(iv) A stabilised up-slope diversion bank to deflect run-on away from the "urbanised" area. The up-slope diversion drain must not drain to the contour bank (to prevent the infiltration contour bank being over-loaded).

5 The use of measures that encourage infiltration of rainwater into soils is appropriate at this site, in keeping with the ideals of Water Sensitive Urban Design (WSUD)

Figure 7 - Infiltration contour bank. Diagrammatic only.

5.4 Vegetation Management

(i) Wherever possible, existing vegetation will be maintained as per the current NSW vegetation management regulations. Only those areas of native vegetation that require clearing for access, effluent management or for the inner asset protection zone will be cleared.

(ii) The outer asset protection zone will remain under native vegetation, although it will be thinned to the requirements of the bushfire management plan. Although it will be thinned, the ground cover will not be removed and so the change in vegetative cover will not be enough to affect water quality. Therefore, these areas are considered unchanged in the MUSIC model.

5.5 Onsite Wastewater Management

5.5.1 General Considerations

The site is not on reticulated sewer and so each lot must sustainably manage treated wastewater on site. There are a number of moderate constraints to onsite wastewater management, particularly regarding the soils:

- soils are mostly less than 1.0 m deep;
- the clay fraction of the subsoils is potentially dispersive;
- soils are infertile;
- soils have a low CEC;
- soils have a moderate phosphorous sorption; and
- soils are strongly acidic.

In addition:

- The 70th percentile rainfall is higher than the pan evaporation for five months of the year, and so we do not recommend surface spray irrigation on any lot.
- for Lots 5 and 6, the dwelling envelopes are on moderately steep land (15 percent) and so we recommend their effluent management areas (EMAs) are located upslope, on less steep land;
- the houses might not be occupied all the time (intermittent use);
- land available for effluent management is currently under native vegetation; and
- Wonboyn Lake requires a buffer from effluent management areas of at least 150 m and the dwelling envelopes are in closer proximity than that (75 m).

These constraints mean:

- The shallow, potentially dispersive, and clay rich subsoils preclude the use of a traditional septic tank to absorption trenches system;
- The low CEC precludes the use of a traditional septic tank to absorption trenches system;
- At least secondary treatment is recommended.
- Subsoil disposal (ETA beds) will require the addition of gypsum at 500 gsm (to control potential dispersion)

5.5.2 Proximity To Sensitive Environments

Council's DCP 5 does not permit effluent management areas (EMAs) to be located within defined buffer distances to particular sensitive environments, some of which occur at this site. Below is a commentary on each and how the proposal meets the objectives of DCP 5 (and the associated Guideline 4.1.3(d) (October 2009)).

(i) *Within 100 m of Identified Lands (Environmental Planning and Assessment Regulation 2000)*

- There are no environment protection zones within 100 m of any EMA.
- There are no national parks, historic sites, dedicated nature reserves or wilderness areas within 100 m of any EMA.

(ii) *Within 100 m of a natural water body, wetland or coastal dune field*

- There are no permanent creeks, wetlands or dune fields within 100 m of any proposed EMA.
- There are three intermittent watercourses through the site that require a 40 m buffer to any EMA.

(iii) *High Water Table, Groundwater Wells*

- The water table is more than 3 m deep.
- There are no registered bores on the site.

(iv) *Highly Permeable Soils (more than 2.5 m/day)*

- Soils are permeability classifications 2b (topsoil) and 4b (subsoil). Minor limitation (DLG, 1998).

(v) *Acid Sulfate or Saline soils*

- All proposed development is elevated well above the levels associated with acid sulfate soils.
- the soil testing did not show elevated levels of salt.

(vi) *Within a drinking catchment*

- The site is not located within 100 m of any permanent fresh water used for drinking.
- The site is not located within 2 km upstream of a town water intake point.

(vii) *Within 150 m of a nominated waterway*

- The proposed EMAs are not located within 150 m of a nominated waterway, as defined in Schedule 6 of BVSC LEP (2002) (includes tidal part of an oyster growing catchment).

5.5.3 System Requirements

5.5.3.1 General

At a minimum secondary treatment is recommended on all lots. There are a number of suitable options such as:

- An Aerated Wastewater Treatment System (AWTS)
- A biological filter system such as Biolytix®, Aqua Claris
- An amended soil system such as Ecomax®
- A sand filter system.

The final choice will depend on usage pattern and the preferences of the new owners. However, at a minimum, any system must be able to produce effluent of the following quality (NSW Health, 2008) (NWQMS, 2000):

(ii) BOD less than 20 mg/L

(iii) Suspended Solids less than 30 mg/L

(iv) Thermotolerant coliforms less than 1,000 cfu/100 ml

Note that disinfection is not required unless secondary treated effluent is disposed less than 300 mm from the ground surface (i.e. by irrigation) (NSW Health, 2008).

Bega Valley Shire Council DCP5 requires EMAs to be designed for a load of 1,000 L/day. This is significantly higher than AS/NZS1547:2000 suggests which, for a typical five bedroom home on tank water and with 7 persons, would be 805 L/day. Nevertheless, adopting a load of 1,000 L/day hydraulic and nutrient balances can be done (DLG 1998 and AS/NZS1547:2000).

5.5.3.2 Nutrient Balances

The aim of this report is not to provide a hydraulic and nutrient balance for all suitable systems but to recommend a minimum EMA size that will accommodate most. Experience has shown that for a site with permeable soils and moderate rainfall the nutrient balances will be determining. We have prepared nitrogen and phosphorous balances (Appendix 3) by assuming the following:

- a maximum nitrogen concentration in the secondary treated effluent of 35 mg/L
- a maximum phosphorus concentration in the secondary treated effluent of 12 mg/L (DLG.1998)
- a nitrogen uptake of 25 mg/m^2/day (native plants or slashed grass) (DLG.1998)
- a phosphorous plant uptake of 3 mg/m^2/day (native plants or slashed grass) (DLG.1998)
- an *insitu* p-sorption of 1,477 kg/ha; and
- a design life (phosphorous break-point) of 50 years (DLG.1998)

The limiting balance is the nitrogen balance, as it requires an area of 1,400 m^2 [6].

5.5.3.3 Hydraulic Balances

Within each EMA, and located within its upper reaches, there will be an actively dosed area. This area will be either:

6 There is an opportunity for a smaller EMA if the proponent adopts a system that actively reduces nutrients.

- 320 m^2 for irrigation (Appendix 3); or
- 135 m^2 for evapotranspiration/absorption beds (Appendix 3).

If irrigation is adopted it must be subsurface, as the 70th percentile monthly rainfall exceeds evaporation for five months of the year, and the effluent must be disinfected.

Drawing number 10000001-WCMS-01 shows the proposed locations of each EMA, after considering required buffers and topographical constraints.

5.5.4 *Cumulative Nutrient Impact Assessment SEPP 62 (Wastewater)*

5.5.4.1 By Surface Waters

The risk of treated effluent becoming entrained in surface water and reaching receiving waters will be minimal because:

(i) the EMAs have been designed using 70th percentile rainfall data per the requirements of Bega Valley Shire Council;

(ii) a 150 m buffer applies to Wonboyn Lake; and

(iii) subsurface disposal is proposed.

5.5.4.2 By Groundwater

The nutrient balances are done to ensure there is no impact of treated effluent disposal outside of the confines of each EMA, and, therefore, no impact outside the confines of the site. The soils and vegetation on each EMA are shown to be sufficient to entrain nutrients for a period of at least 50 years, which is the generally adopted design life for onsite wastewater management systems (DLG 1998). There will be little risk of impact to native vegetation outside of the EMA.

5.5.5 *Cumulative Pathogen Impact Assessment (SEPP 62).*

5.5.5.1 By Surface Waters

The risk of treated effluent becoming entrained in surface water and reaching receiving waters will be minimal because:

(i) the EMAs have been designed using 70th percentile rainfall data, per the requirements of Bega Valley Shire Council;

(ii) a 150 m buffer applies to Wonboyn Lake; and

(iii) subsurface disposal is proposed.

5.5.5.2 By Groundwater

Because of the highly sensitive nature of the receiving waters it is critical that pathogens do not reach them. Once in the soil pathogens and viruses will be outside of their preferred environment and they will progressively die over a period of time. The potential distance travelled during that time is dependant on the quality of the effluent, the temperature in the ground, the soil's permeability and the hydraulic gradient.

Cromer *et al*, 2001 describes a method of calculating the time and distance that pathogens and viruses can be expected to travel in soils. Secondary treatment is proposed on all lots and such treatment will result in a faecal colifirm count of no more than 10^3 cfu/100 ml. Therefore, to reach *no* residual coliforms (drinking water standard) an additional three log cycle reductions are required before the treated water reaches receiving waters. In this case the inputs are:

(i) Required additional log cycle reduction = 3 log cycles.

(ii) Permeability is 3 m/day [7].

(iii) Soil thicknesses (topsoil) = 0.25 m [8]

(iv) Porosity of the soil is 25 percent (0.25).

(v) Hydraulic gradient is 10 percent [9]

(vi) Ground temperature is taken as the mean annual temperature (16°C).

At a temperature of 16°C, the estimated time to achieve a three-log cycle reduction is 20 days (Cromer *et al*, 2001). Over that time, the calculated travel distance is approximately 24 m. This is much lower than the prescribed buffer distances to either intermittent watercourses/depressions or to the lake. Therefore, we conclude the risk of pathogen export from this site will be minimal (as long as the wastewater management systems are installed and managed according to this report). There is minimal risk of pathogens leaving the confines of the site and so there is minimal risk of a cumulative impact on the receiving waters (Wonboyn Lake).

5.6 Monitoring and Maintenance

An ongoing regime for maintenance of the various water quality control measures will be required to ensure their continued performance and stability. Monitoring and maintenance will need to consider the following:

5.6.1 Pavements and Watercourse Crossings

(i) These need to be checked regularly, paying particular attention to:

- table drains, to ensure they are stable and well armoured against erosion;
- pavement surfaces, to ensure they are not subject to deterioration;
- pipe outlets, to ensure they are free from blockages and are appropriately armoured against erosion;

7 represents a high value expected of massive sandy loam (AS/NZS1547:2000)

8 We have conservatively considered the wastewater movement in the more permeable topsoils.

9 Maximum grade in proposed EMAs and immediately downslope of them.

- batters, to ensure they are well vegetated and do not show signs of sheet or rill erosion;
- tail-out drains, to ensure:
  - they are not filled with sediment;
  - they are stable; and
  - they remain connected to the main table drains
- causeways, to ensure they are free from blockages and are providing suitable passage for water;
- drainage systems, to ensure they are operating as intended and are not causing erosion issues elsewhere.

5.6.2 Diversion Drains and Infiltration Contour Banks

These need to be checked regularly by the owners, paying particular attention to:

- the bases - to ensure they are well vegetated and stable under flow
- the level-spreader outlets (SD 5-8, Appendix 4) to ensure flow is dissipated.

5.6.3 Onsite Wastewater Management Systems

Applications to install wastewater management systems are assessed by Council under the requirements of the Local Government Act 1993 and the Environmental Planning and Assessment Act 1979.

Bega Valley Shire Council revised DCP 5 in 2008. One of the relevant procedures for DCP 5 is procedure 4.1.3(b) – *The Approvals to Operate and Reinspection Program.* The systems will be classified as *Low Risk* as no EMA is within prescribed buffer distances from a sensitive environment (Section 5.5.2). Therefore, they will be subject to a five-year operational approval and will be self-certified, after initial Council Inspection. Targeted re-inspections might occur by Council Officers.

We expect Council to require quarterly inspections of the systems by an approved wastewater contractor. At those times compliance with the system’s NSW Dept. Health’s approval document will be proved. Service reports will be submitted to Council as requested.

The home owners are required to understand their obligations to onsite wastewater management and they must periodically check their system and its EMA to ensure:

- Any alarm is responded to within 24 hours
- Any filters are cleaned
- Distribution lines are buried and protected

- No effluent is disposed at the surface
- The vegetation in the EMA is regularly maintained (trimmed, mown, slashed, weeded etc.)
- Any unusual odours are reported to the manufactures as soon as possible and remedial action taken if required.

6 Water Quality Modelling

6.1 Water Demand for New Homes

A 100 kL tank (or a series of tanks to that volume) is recommended for each new home. 20 kL will be reserved for fire fighting. To model the performance of such a tank we have modelled it in an in-house spreadsheet model known as RATES. RATES uses daily rainfall data (here for a period of 94 years from Pambula (95% reliability)) to model the collection and re-use of rainwater. Inputs are:

(i) an assumed roof area of 300 m^2

(ii) an assumed daily use of 690 L/day [10]

(iii) a collection coefficient of 90 percent (0.9).

The results are given in Table 3 and show that a 100 kL tank could be expected to supply 81 percent of its demand. However, experience suggests that, as a tank gets low, the owners would most likely lower their water use and achieve better than 81 percent. At 460 L/day [11] the tank could be expected to supply 99 percent of its demand.

10 Six people at 115L/day (AS/NZS1547:2000).

11 Four people at 115 L/day (AS/NZS 1547:2000).

Table 3 - RATES rainwater tank simulation.

SEEC
MORSE MCVEY

SEEC RATES IV Results
Site: Wonboyn
Rain station: Pamula Post Office 69024

Total years:	94.32	Avg annual rainfall (mm):	855.92
Total days:	34451	Max daily rainfall (mm):	422
Total no of days when rain fell:	7014	Longest dry spell (days):	119
Avg days per year when rain fell:	74.36386768	Days when rain > S1 initial loss:	6914
Avg wet day rainfall (mm):	11.51	Avg days/yr rain > S1 initial loss:	73.30365

Input statistics:	**Storage 1**		**Storage 2**	
Capacity (L):	80000		0	
Startup % full:	0		0	
Catchment area (sqm):	300		0	
Initial loss per day (mm):	0.3		1	
Runoff percentage:	90		90	
Apply use A on wet days (Y/N):	Y		N	
Apply use B on wet days (Y/N):	N		N	
Revert to mains at threshold (Y/N):	N		N	
Mains reversion threshold (% full):	0		0	
Overflows into Storage 2 (Y/N):	N		N/A	
USAGE stats (L/day):	**Storage 1**		**Storage 2**	
Usage type:	**A**	**B**	**A**	**B**
January	690	0	1	0
February	690	0	1	0
March	690	0	1	0
April	690	0	1	0
May	690	0	1	0
June	690	0	1	0
July	690	0	1	0
August	690	0	1	0
September	690	0	1	0
October	690	0	1	0
November	690	0	1	0
December	690	0	1	0
Results:	**Storage 1**		**Storage 2**	
% of time demand met:	80.54		0	
% of demand supplied from mains:	0		0	
Longest time storage ran dry (days):	112		34451	
Avg annual mains demand (L):	0		0	
Avg wet day overflow (L):	295.48		0	
Avg no of overflow events annually:	2.958015267		0	
Avg annual supply from rain in (L):	163482		0	
Max daily overflow (L):	60462		0	
Annual demand (L):	252027.0356		365.2565734	

6.2 MUSIC Modelling - Inputs

6.2.1 Modelling Introduction

MUSIC contains algorithms based on the known performance characteristics of common stormwater quality improvement structures used in Australia. These data are derived from research undertaken by the CRC for catchment hydrology and others. The models are appropriately calibrated and all amendments to MUSIC defaults are noted in Appendix 2. The modelling quantifies:

(i) the levels of the principal pollutants before and after the development; and

(ii) changes in export levels because the development is there.

Statistics are produced in MUSIC for the following parameters:

- Flow (ML/yr)
- TSS - Total Suspended Solids (kg/yr)
- TP - Total Phosphorus (kg/yr)
- TN - Total Nitrogen (kg/yr)
- Gross Pollutants (kg/yr).

Statistics can also be exported detailing pollutant concentrations in stormwater. We have not included gross pollutants in the modelling as MUSIC doesn't handle them well in rural style catchments.

6.2.2 Climate Data

Creation of a MUSIC catchment file requires an associated meteorological data file. The rainfall data required is known as pluviograph rainfall data. It is <u>not</u> the same as monthly data used for the hydraulic balance in Section 5.5.3.3 or the daily rainfall data used in RATES (Section 6.1). Pluviograph rainfall data is specialised data that measures rainfall in small time steps and is only available from a selected number of rainfall stations. The closest suitable rainfall stations to this site are Green Cape and Genoa. Therefore, data used here is that for Green Cape 1978/79 and for Genoa 1983 to 1987, both in 6 minute time steps. Data for these periods were chosen because:

- The Green Cape data is mostly complete and has an average close to, but slightly less than, the local mean rainfall (684 mm compared to 750 mm); and

- The Genoa data is mostly complete, has a similar rainfall pattern and represents significantly higher rainfall (985 mm compared to 750 mm). It represents a wet period.

Potential evapotranspiration (PET) data are derived from Genoa. Basic rainfall and PET statistics for Green Cape and Genoa are given in Tables 4 and 5 and the time-series graphs are in Figures 9 and 10.

Table 4 Rainfall and PET statistics for Green Cape, 1978/1979

Measure	Statistics						
	mean	**median**	**maximum**	**minimum**	**10%ile**	**90%ile**	**mean annual (mm)**
Rainfall (mm/6 minute steps)	0.008	0	10.03	0	0	0	684
Potential ET (mm/day)	3.061	2.67	5	1.29	1.33	4.68	1117

Table 5 Rainfall and PET statistics for Genoa, 1983 to 1987

Measure	Statistics						
	mean	**median**	**maximum**	**minimum**	**10%ile**	**90%ile**	**mean annual (mm)**
Rainfall (mm/6 minute steps)	0.011	0	11.3	0	0	0.005	985
Potential ET (mm/day)	2.865	2.17	5	1	1.13	4.52	1046

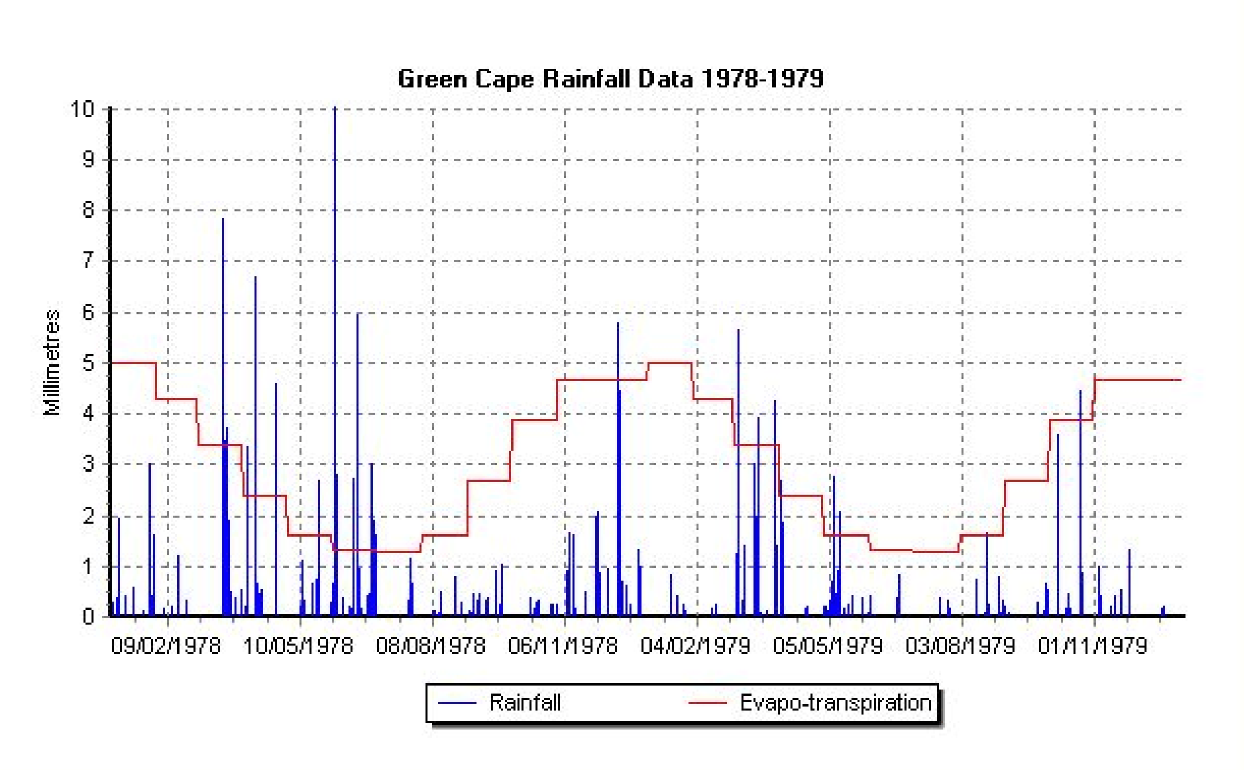

Figure 9 – Green Cape 6 min rainfall data 1974 - 1975

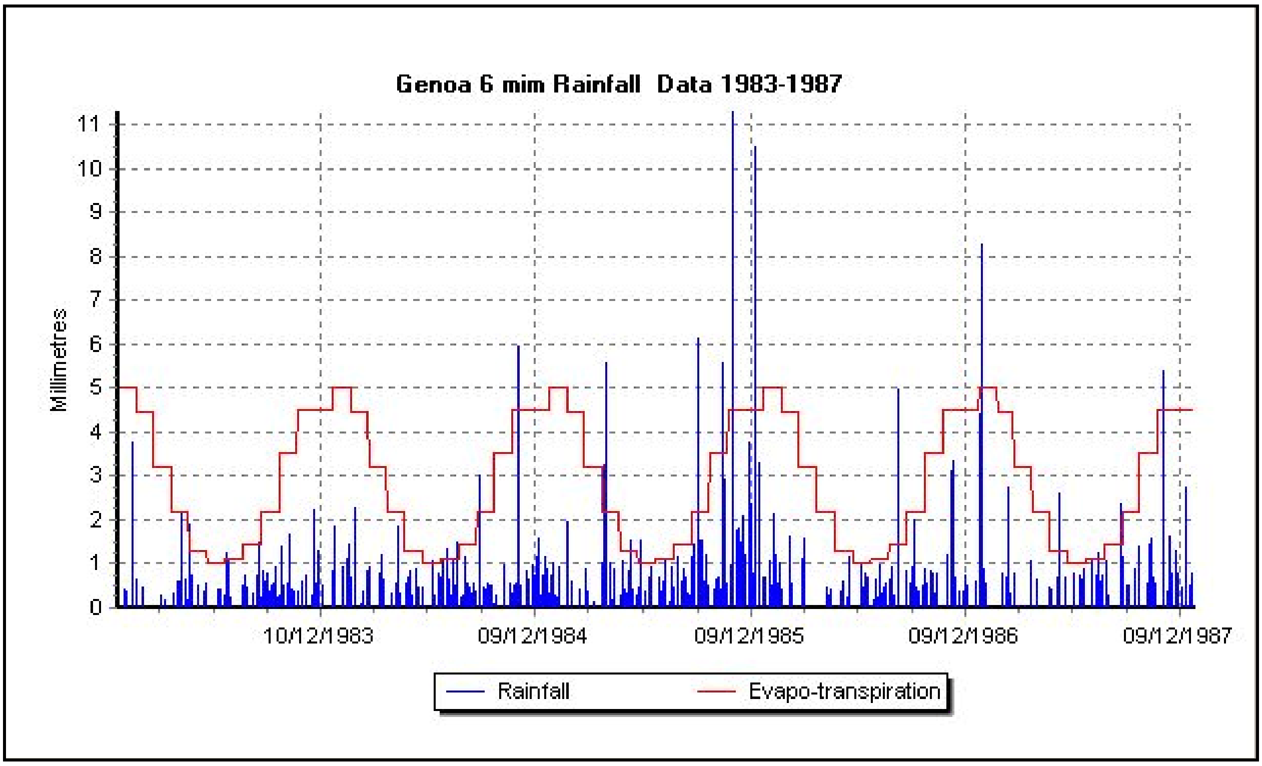

Figure 10 - Genoa 6 min rainfall data 1983 to 1987

6.2.3 Modelling Assumptions

MUSIC is primarily designed for urbanised catchments but it can be adapted for use with rural residential developments such as here. Source nodes are set up in the model to represent different land uses. Each of these nodes is given a percentage of imperviousness to represent paved surfaces/roofs etc. It is important to know that the nominated percentage of imperviousness is not necessarily the *actual* area of impervious surfaces but is an estimation of *effective* imperviousness. For instance, if stormwater from a paved surface around a house flows onto a broad area of well-vegetated land, it is not directly connected to receiving waters. In this case it is permissible to reduce the *actual* impervious area by a factor of half to give the *effective* impervious fraction (SCA, 2009). This has only been applied to the rural residential node representing the inner protection zones.

The MUSIC modelling is based on the following calculations and assumptions:

(i) Pre-Existing

- The whole site is modelled (total site area is 131.1 ha) and comprises:
  - 128.37 ha of forested land modelled with a "Forest" source node calibrated as in Tables 7 and 8, Appendix 2.

  - 1,000 m x 3 m (3,300 m^2) existing fire trail modelled with an "unsealed road" node calibrated as in Tables 7 and 8, Appendix 2.
  - 2.4 ha being the 20 m wide power line easement with a 3 m wide earth track (15 percent impervious). Modelled with an "unsealed road" node calibrated as in Tables 7 and 8, Appendix 2.
- The pervious area properties are calibrated based on 250 mm of sandy loam topsoil over 650 mm of sandy clay loam subsoil, Table 9 Appendix 2.
  - Forested lands are assumed to have a rooting depth of 0.9 m (average depth of soil over bedrock)
  - Cleared land is assumed to have a rooting depth of 0.5 m
- The infiltration and groundwater properties are calibrated using values in SCA, 2009.

(ii) Post Development

- The ROW will be 1,000 m long, 4 m wide in a 20 m easement and with passing bays. Impervious area = 25 percent. Modelled with a "sealed road" node calibrated as in Tables 7 and 8, Appendix 2.
- The driveways will be 4 m wide in a 16 m easement. There will be about 700 m of them. Impervious area = 25 percent. Modelled with a "sealed road" node calibrated as in Tables 7 and 8, Appendix 2.
- The Proposed Fire Trail is about 1,000 m long, 4 m wide in a 16 m easement. Impervious area 25 percent. Modelled with a "unsealed road" node calibrated as in Tables 7 and 8, Appendix 2.
- All pavements will be crowned and will drain to well formed, vegetated, table drains as described in Section 5.2. These drains are assumed to have an infiltration rate of 10 mm per hour.
- The houses will maintain appropriate buffers to watercourses and to Lake Wonboyn. Infiltration contour banks are proposed to trap runoff from the 'urbanised' area. Each house site is modelled as follows:
  - a 300 m^2 roof modelled with a "Roof" source node, calibrated as in Tables 7 and 8, Appendix 2 and draining to a 100 kL (80 kL usable) rainwater tank, with the overflow directed to the infiltration contour bank;

  - reuse from each tank is assumed to be 800 L/day;
  - 6,700 m^2 of other semi urbanised areas (the inner protection zone). Within this will be 400 m^2 of other impervious areas (paving, sheds etc) that drain onto vegetated land (actual impervious area = 6 percent, effective impervious area = 3 percent, (SCA 2009 [12])). This area is modelled with a "Rural Residential" source node calibrated as in Tables 7 and 8, Appendix 2.
  - the infiltration contour bank is modelled with a swale node, 100 m long, gradient of 2 percent and with a percolation rate of 10 mm/hour.
- The existing fire trail is allowed to re-generate back to forest.
- The power line track is re-graded and mitre drains installed. Mitre drains are modelled using a swale node (SCA,2009).
- Seven effluent management areas will be cleared. The total area is about 1 ha and the trees will be replaced by shallow rooting shrubs and/or grass. The rooting depth is assumed to be 0.5 m.
- The remaining land (118.08 ha) remains as forest.
- The pervious area properties are calibrated based on 250 mm of sandy loam topsoil over 650 mm of sandy clay loam subsoil, Table 9, Appendix 2.
  - Forested lands are assumed to have a rooting depth of 0.9 m (average depth of soil over bedrock)
  - Cleared (and re-vegetated) land is assumed to have a rooting depth of 0.5 m
- The infiltration and groundwater properties are calibrated using values in SCA, 2009.
- Section 5 of this report includes an extensive set of recommendations for good road and lot-access design to minimise the risk of stormwater pollution entering watercourses. These measures are designed to disconnect pavement runoff from natural concentrated flow. They are integral to the assumptions made in this modelling.
- Water that is infiltrated in the contour banks and the table drains is put back into the MUSIC model as base flow. Because

12 SCA, 2009 says that landscape paving and the like has an effective impervious area equal to half the actual impervious area.

this water is infiltrated some distance away from the lake, it is assumed that it will re-emerge into it as part of the general base flow. Therefore, it is calibrated to the base flow properties of a forest source node (Table 7, Appendix 2).

6.2.4 *Results of Modelling*

6.2.4.1 Mean Annual Loads

Two scenarios were modelled for each rainfall data set:

(i) Pre development (i.e. existing) conditions; and

(ii) Post development (i.e. proposed) conditions including the water quality management measures from Section 5.

Table 3 contains the results of the modelling.

Table 3 Results of MUSIC modelling

	Flow (ML/yr)	TSS (kg/yr)	TP (kg/yr)	TN (kg/yr)
Green Cape (684 mm)				
Pre Development (A)	130	8340	8.9	76.8
Post Development (B)	139	4040	8.1	83.1
Change Pre to Post Development (A vs B) %	**+7**	**-52**	**-9**	**+8**
Genoa (985 mm)				
Pre Development (A)	327	14,600	19.4	171
Post Development (B)	331	8650	18	183
Change Pre to Post Development (A vs B) %	**+1**	**-41**	**-7**	**+7**

The results show little change to overall flow, a reduction in suspended solids and phosphorous but a minor increase in nitrogen export.

6.2.4.2 Water Quality Targets - Pollution Concentrations

There are no specific water quality requirements that apply to development on these lands. However, BVSC DCP36 applies to the adjoining village precinct and, as the receiving waters are the same (the lake), it seems reasonable to assume that it may be adopted here. It gives target pollutant concentrations for individual development sites as follows:

(i) TP: 0.3 mg/L (50^{th} percentile); and

(ii) TN: 1.0 mg/L (50^{th} percentile).

MUSIC produces data for pollutant concentrations as cumulative frequency graphs. The results from MUSIC are shown in Figures 11 to 14. They show that the target pollutant concentrations will be met 100 percent of the time for phosphorous and 90 - 95 percent of the time for nitrogen. This exceeds the 50 percent requirement by a considerable margin.

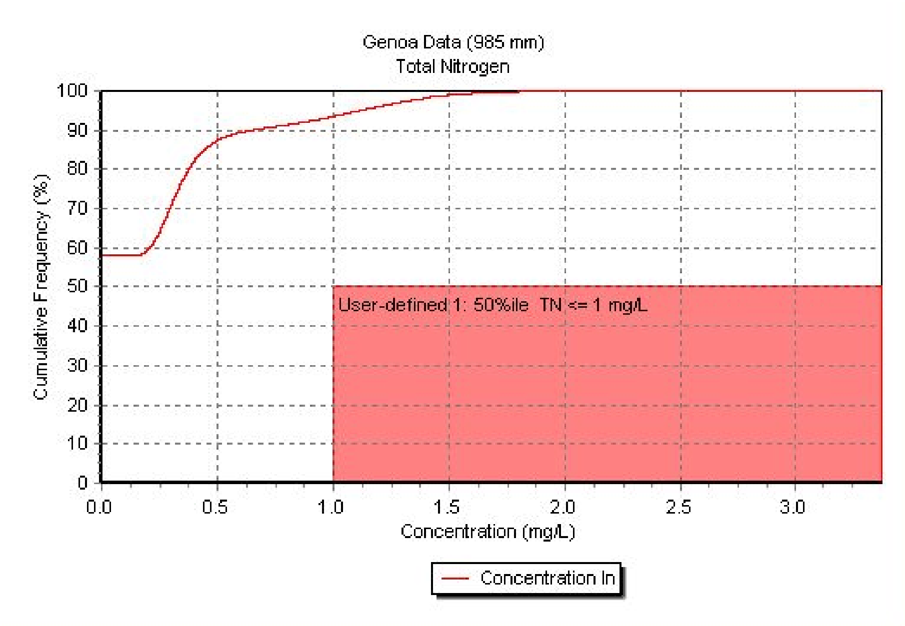

Figure 11 – Cumulative Frequency Graph. Nitrogen, Genoa Rainfall Data.

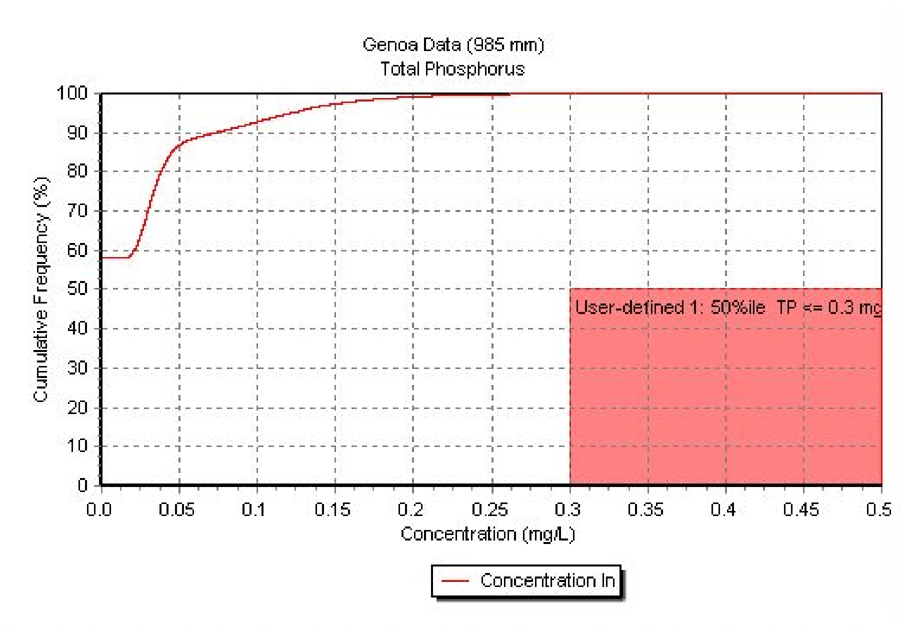

Figure 12 – Cumulative Frequency Graph. Phosphorous, Genoa Rainfall Data.

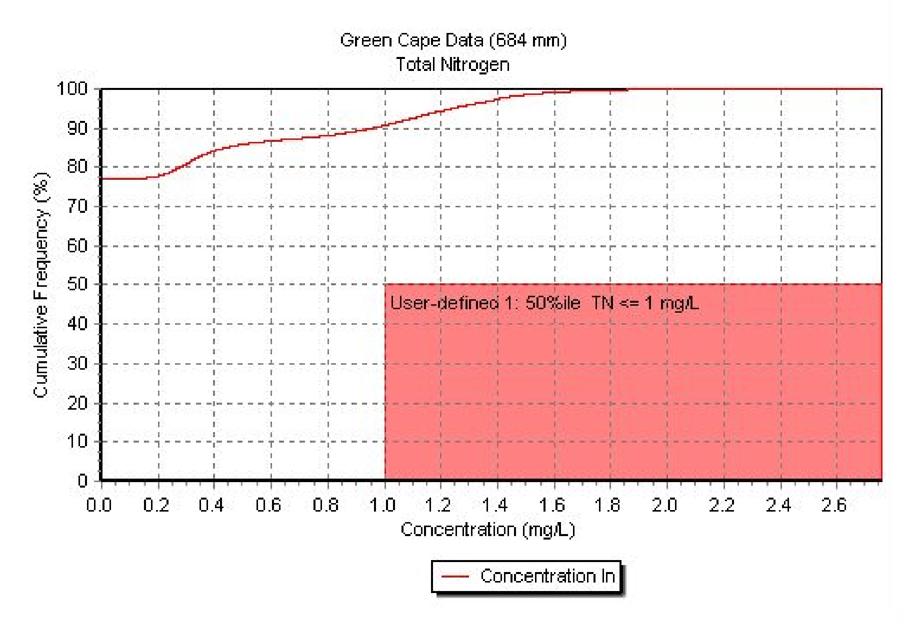

Figure 13 – Cumulative Frequency Graph. Nitrogen, Green Cape Rainfall Data.

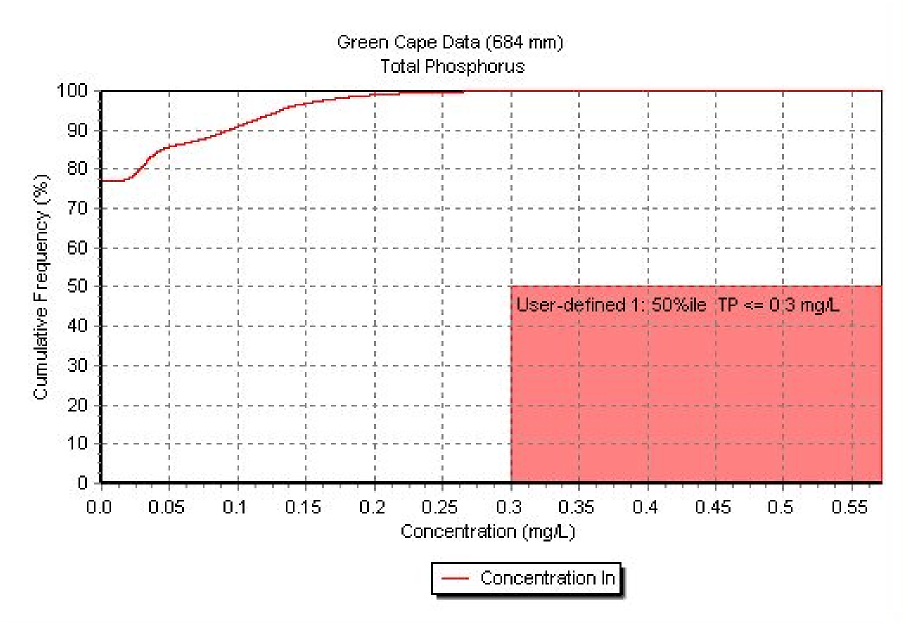

Figure 14 – Cumulative Frequency Graph. Phosphorous, Green Cape Rainfall Data.

6.2.4.3 Cumulative Impact Assessment. SEPP 62 (stormwater)

The MUSIC modelling predicts a neutral or beneficial effect on total flow, suspended solids and phosphorous export. It predicts a small increase in total nitrogen of about 8 percent, which equates to a mean annual load increase of about 6 to 12 kg/year (dry and wet periods respectively).

To estimate the cumulative effect of this on the lake we have modelled the lake's entire catchment (320 km^2) in MUSIC, assuming it is all forested (which it mostly is). MUSIC predicts the total nitrogen input from this catchment is in the order of 15-35 tonnes per year (dry and wet periods respectively). Therefore, the addition of 6 to 12 kg/year will not be measurable and is very unlikely to have an appreciable effect on the ecology of the lake or its oyster industry. ANZECC, 2000 (Table 4.4.3) gives a target value of 1 mg/L for total nitrogen, MUSIC predicts concentrations less than 0.3 mg/L (100 percentile).

6.3 Conclusions

It is proposed to develop Lot 14 DP 750222 Wonboyn Lake into 7 new rural lots. The water cycle management plan shows how wastewater and stormwater will be managed to ensure there is no appreciable effect on the water quality in Wonboyn Lake.

Wastewater will be managed by providing a suitably sized effluent management area in which pathogens, nitrogen and phosphorous will be contained. Water Sensitive Design will be incorporated to infiltrate and treat stormwater runoff from all “urbanised” surfaces. Modelling shows that phosphorous and suspended solids export will be less than or equal to that now. There is predicted to be a very small increase in nitrogen export (6-12 kg/year), which amounts to an approximate increase in nitrogen concentrations of less than 0.05 percent (probably not a measurable difference). The total flow from the site and the general hydrology of the site will remain essentially unaltered. The target pollutant exports required by BVSC DCP36 (which applies to adjoining land with the same receiving waters) are exceeded by a considerable margin.